Development of a Video Game to Teach Engineering Ethics in Canada

By

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Abstract

This thesis covers the design, implementation, and review of a video game designed to assist Canadian Engineering Interns in understanding and contextualizing engineering ethics. This understanding is essential during their professional practice exam and subsequently in their day-to-day lives as engineers.

In engineering schools, engineering ethics is traditionally taught either as a philosophical examination of how engineers should act — or as rote learning of the act, by-laws, and code of ethics that govern engineering practice. Most importantly, in the context of undergraduate engineering education, the amount of coverage is limited, and students are all too often focused on what is needed for the test, not mastery of the material for their own understanding.

Unlike university courses, playing this game is voluntary, no grades are assigned, and players are expected to game the system by choosing poor responses just to see what will happen to them. Learning occurs through exploring cause and effect relationships, by making ethical choices and experiencing how decisions often have trade-offs or conflicting right answers. To encourage reflection, players were asked to think about the cases, and how they reacted to the unprofessional behaviour of characters in the game, through this reflection process, players are encouraged to grow, understand, and adopt professional behaviours.

The research methodology was to create a proof of concept video game featuring five case studies of conflicts that an Engineer or Engineering Intern might reasonably encounter in their professional practice. The game then went through a design review, in which sixteen Professional Engineers and Engineering Interns played the game and reviewed the cases in detail to provide feedback on their realism and identify areas for improvement.

Based on the feedback from testers, the concept is sound, addresses a need within the engineering community and merits further research.

Acknowledgements

Professional ethics is never just about one right answer; it is about understanding the potential consequences of a myriad of decisions which change and evolve over time. This game is the result of a community of work. The consistent support of Engineers Geoscientists Manitoba has enabled this work to represent real engineering practice. The support of the association's executive, past presidents, investigation and discipline committee members, and engineers who tested this game all deserve my heartfelt thanks. They have allowed the vision of a game in which engineers could safely explore the consequences of their ethical choices to become a reality.

Special thanks go out to Tony Li at Pixel Crushers for developing the Dialogue System and providing excellent one-on-one support. As the technical core upon which this thesis is built, the programs the reliability, functionality, and stability across many versions of Unity has been a highlight of the development process.

Most of all, I wish to express sincere gratitude to my committee, the Engineering Design Office, my friends, and my family. A thesis is a significant time and emotional commitment not just for the student but to everyone that supports them. Their encouragement and support are the reason this thesis is completed.

A. Roncin, P. Eng.

Ethics Board Compliance

This process was done in compliance with the Education and Nursing Research Ethics Board at the University of Manitoba. The researcher is Tri-Council TCPS 2: Core certified and the research process was done in a fully transparent manner with informed participants who could withdraw at any time.

Copyright Compliance

All sounds, graphics, and source code used in the construction of this video game are done in compliance with copyright requirements. Music is provided with permission by Kevin MacLeod at Incompetech.com and licensed under Creative Commons: 3.0 By Attribution. Icons from Lorc [sic] and Freepik [sic] were used in this game. The Lorc icons are available at http://game-icons.net and licensed under Creative Commons: 3.0 By Attribution. Freepik icons are available from http://www.flaticon.com and licensed under Creative Commons: 3.0 By Attribution. The background image is "Digital Grunge 15" by Bill Scott at Texturemate.com and is provided royalty free for commercial and non-commercial use. *Unity* is a proprietary game engine available for free use by students. The *Dialogue System* and *Game Jam Template* were asset packages purchased through the *Unity Asset Store*

Roadmap

Chapter 1 Introduction: provides an overview of the thesis, including the motivation, scope, contribution, and researcher position.

Chapter 2 Motivation, Context, and Current Events in Canada: looks at the importance of engineering ethics and the types of challenges facing the profession today. The events around the Elliot Lake mall collapse, the Charbonneau Commission, and the portrayal of engineers in the media are presented as contemporary examples of the environment surrounding professional practice and engineering ethics.

Chapter 3 Research Context: provides a brief framework for literature review.

Chapter 4 Games: examines using video games as teaching environments and considers a few examples of games being used for social change, ethics teaching, and sustainability teaching.

Chapter 5 Gamification: looks at the debate around gamification and how the insights from this debate can be applied to this thesis.

Chapter 6 Engineering Ethics: examines the goals for ethics education, the context of Canadian practice, and the needs of engineers in Canada.

Chapter 7 Relevant Teaching Strategies: examines the relevant best practices for teaching along with instructional design considerations.

Chapter 8 Assessment: this project is not designed to be used in the context of a traditional classroom. This chapter examines the challenges of knowing what the players are doing and thinking and how this integrates with assessment as a whole.

Chapter 9 Instructional Design: focuses on how knowledge discussed in the literature review and the learning outcomes inform the game's design.

Chapter 10 Development Tools: highlights *Unity* game engine, the Pixel Crusher's *Dialogue* used in narrative development, and *Itch.Io* website used for distribution of the alpha version.

Chapter 11 Implementation: looks at how the game is constructed and offers insight into the motivation underlying each case in the game. Cases are discussed by providing background on the case and demonstrated using a potential dialogue path. The complete dialogue text is available in the appendices.

Chapter 12 Design Review: examines the results of a nine-question survey completed by playtesters. This chapter focuses on identifying themes, interpreting the underlying message, and discussing the lessons learned.

Chapter 13 Recommendations for Future Work: provides suggestions on how to improve testing, evaluation of players, and the interface, along with ideas for future spin-offs.

Chapter 14 Concluding Remarks: holistically summarizes the research contribuition and thanks the project supporters.

The Appendices: includes a glossary of terms, notes on source control, and the full dialogue used in the case studies.

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1 Introduction

This thesis was inspired by a discussion with a member of the Engineers Geoscientists Manitoba Discipline Committee. After being involved in a particularly challenging discipline case, the discipline committee member was left wondering what could be done to help Engineers and Engineering Interns understand the expectations and responsibilities that are the foundation of professional practice. How can ethics training be improved?

A critical component of answering how engineering ethics could be improved came as the result of interviewing two executive staff of Engineers Geoscientists Manitoba.[1] While both these gentlemen expressed different opinions about why engineers get into trouble and have complaints filed against them, the need for this research was apparent.

The first interviewee was the Director of Professional Standards, Mr. M. Gregoire who highlighted that as the staff member responsible for investigations and discipline — most of the investigation and discipline cases he was involved in related to unskilled practice; particularly of members who had failed to stay current in their field and were typically practicing to old standards or providing substandard information to regulatory bodies and permit offices.

The second interviewee was CEO and Registrar, Mr. G. Koropatnick who took a different perspective. This interview focused on how engineers get in trouble with their clients because of misunderstandings and unprofessional behaviour. When engineers go above and beyond their scope of work to make clients happy, those same clients would then expect the engineer to go beyond the scope of their agreements and solve/handle the entire problem. Lacking clear boundaries of work on the work being performed and failing to manage client expectations up front often lead to problems for the engineer.

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[1] Engineers Geoscientists Manitoba is the business name of the Association of Professional Engineers and Geoscientists of Manitoba (APEGM)

Subsequent conversations with Mr. Koropatnick focused on the idea that engineering revolves around trust and the actions engineers take represent both themselves and the companies they work for. A concept explored by Roncin, Britton, and Koropatnick (2017) in their *Canadian Engineering Education Association* paper *Professional Practice and Engineering Interns: Three cases for discussion*.

The idea that engineers get in trouble because of misunderstandings and unprofessional practice is important because it provides the central theme of the thesis and resulting game. It affects all engineers[2] regardless of discipline or point in their careers. It also affords the opportunity for this thesis to be distinct and separate from the codes and canons emphasized in many undergraduate programs.

1.1 Becoming an Engineer

Obtaining the Professional Engineer designation and the right to practice engineering in one of the provinces or territories in Canada has five requirements.[3] Applicants need to: (1) Demonstrate technical competency by either passing technical exams assigned by the provincial engineering association or have an undergraduate degree from an accredited institution. (2) Obtain four years of supervised professional work experience.[4] (3) Demonstrate good character.

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[2] According to the Engineers Canada, National Membership Report, As of December 31, 2015, there were just over 200 ,000 engineers in Canada, just over 5,200 of which were in Manitoba. https://engineerscanada.ca/reports/national-membership-report, accessed Jan 1, 2017.

[3] Registration requirements are administered on a province by province basis. Engineers Canada's s role is to provide consistency between jurisdictions. https://engineerscanada.ca/become-an-engineer/overview-of-licensing-process#, last accessed November 5, 2017.

[4] In Manitoba, Saskatchewan, and Quebec the internship process is mandatory while in other provinces it is highly recommended. Detailed comparison information about the requirement and duration of each province's Engineer-in-Training program can be found on the Engineers Canada website. https://engineerscanada.ca/become-an-engineer/information-for-engineers-in-training-and-members-in-training, last accessed November 5, 2017.

(4) Possess English or French language competency. And (5) pass the professional practice exam.

Of these five requirements, an opportunity for change exists in the study material for the Professional Practice Exam. Based on a review of the *Engineers Canada guideline on the professional practice exam* (Engineers Canada, 2013) and the *APEGA National Professional Practice Exam* website[5], it is apparent that the study material and learning resources for this critical test have remained largely unchanged from those required 15 years ago. However, the growth of the internet and the emergence of video games as a learning tool creates an environment in which it is reasonable to expand, enhance, and rethink the learning materials available to early-career engineers. Furthermore, members and executive staff of Engineers Geoscientists Manitoba (a member of Engineers Canada) have volunteered to support investigating and examining this possibility.

1.2 The Research Question

In light of the support from Engineers Geoscientists Manitoba and the University of Manitoba, the idea emerged of creating a video game that would offer a consequential-experiential learning environment, one that would allow early-career engineers to explore being an engineer and the ethical decisions they may face. As an exploratory tool, the cases are designed to let players be protagonists, thus allowing them to make varied and different choices in the face of ambiguity, and then experiencing the consequences that result from their decisions.

Video games are a contemporary medium that is well accepted by young people and well suited to exploring subjects that require taking action and exploring consequences in order to understand the subject matter. However, creating instructional video games is a multi-faceted and challenging problem. Instructional design by its self is a complicated endeavour of balancing student needs, learning outcomes, and assessment. In the context of video games, additional challenges arise from the fact that unlike classrooms, players become designers of

[5] https://www.apega.ca/apply/exams/national-professional-practice-exam-nppe/study-materials/, last accessed November 5, 2017.

their experience, and developers create the framework and learning environment in which that occurs. Furthermore, there is a tension between the game design needs of fun, interaction, and feedback with the instructional needs of factual content, understanding, and transfer to the real world.

The goal of this thesis is to: *Identify what is involved in creating a video game to teach Canadian engineering ethics — and then build a prototype for evaluation.*

To provide focus and specificity to this goal, the context of interest is preparing for the provincial engineering Professional Practice Exam (PPE), in which Engineering Interns demonstrate their understanding of the ethics, professionalism, and tort law in order to become Professional Engineers.

The problem of teaching ethics is a longstanding issue for Canadian regulators and one that continues to have importance at both the provincial and national levels. The idea of using a video game was to address the problems of (1) a large geographical area with isolated members, (2) an impersonal and rule-based curriculum, and (3) the resistance of graduates to taking yet another test. In contrast, a video game environment can create a self-driven, personal experience that encourages players to reflect and grow in their own professional practice.

1.3 Scope of Work

As the goal of this thesis is to create a prototype, the scope of work is as follows:

(1) Research professional engineering ethics in Canada.
(2) Examine the relevant educational theories.
(3) Design and construct a learning environment
(4) Have subject matter experts review the work.
(5) Identify areas of improvement based on the review.

1.4 Constraints

Based on old Professional Practice Exams from Ontario[6], review of the *Engineers Canada guideline on the professional practice exam* (Engineers Canada, 2013), and personal experience taking this exam — the questions focus on conflict of interest, protection of the public interest, and ethical business practices.

Given the nature of this exam and its role as a gatekeeper in the transitioning of early-career professionals from Engineering Interns into Professional Engineers, three constraints become apparent:

1. Although philosophical questions around engineering, sustainability ethics, and societal expectations of engineers are interesting, they are tangential to the Professional Practice Exam (Engineers Canada, 2013). The cases being used focus on recognizing ethical issues and acquiring the support of non-player characters to pursue the ethical course of action.
2. Participation in this learning experience is optional and voluntary. Grades and assessment are likely to have significantly less meaning to players then students in a traditional classroom. This constraint affects the assumptions of who the user is and their motivations for playing. This constraint is explored further in sections 4.3.
3. In order to be significant, the cases being used should accurately represent engineering practice and situations an engineer could reasonably find themselves in. They should not be extreme cases that are easily discounted as being unique or unlikely to happen. The design review presented in chapter 12 examines the validity of the cases in representing dilemmas in engineering practice and the playtesters reactions to them.

The learning experience should focus on helping Engineering Interns understand the impact of day-to-day interactions so that they have a richer context with which to understand and answer

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[6] The "Engineer on a Disk" website maintains a section of PEO exam questions from 1987 to 1998. http://engineeronadisk.com/V2/notes_engineer/engineeronadisk-12.html#pgfId-509919, last accessed November 5, 2017.

the questions within the Professional Practice Exam. Ideally, the experience should leave the players reflection on questioning what it means to be an ethical engineer and the expectations they have of others within the engineering profession.

1.5 Education, Ethics and Video Games

By its nature, game-based learning (GBL) can offer a safe virtual environment in which participants can explore, interact, and solve problems while at the same time working from home and learning at their own pace. This environment is particularly valuable to Engineering Interns preparing for the Professional Practice exam because, despite its appearance of being a simple set of rules to follow, professional ethics often involve situations of ambiguity, conflicting obligation, and the risk of personal loss. Having a safe environment to explore the subject matter without risk should simplify the learning environment and allow participants to see the consequences of their actions in a less threatening manner. Furthermore, Engineering Interns are likely to be working from remote locations, with personally demanding schedules. The ability to play a game at their convenience is a benefit that should not be overlooked.

Designing game-based learning environments that are both engaging and meaningful learning experiences is challenging. It requires working with experts in the subject matter and then synthesizing the necessary content, teaching methods, and gaming techniques into a coherent product in such a manner that users feel interested and rewarded. In many ways, this is more challenging than a traditional classroom environment because of the highly interactive nature, emphasis on game design, and integrating learning objectives as elements of gameplay. Three challenges that impact this thesis are player engagement, development costs, and uncertainty.

An underlying assumption in this thesis is that playing this game is voluntary and players expect to be entertained and engaged on a personal level. When players become bored, lack purpose, or become unengaged, they leave and don't come back. It is a competition for face time, and those who lose are quickly forgotten. Instructional designers need to infuse learning objectives and inform gameplay without compromising the elements of fun or undermining the story elements that make for memorable gameplay. Yet the instructional techniques taught for classroom use

are not sufficient for the highly integrated, interactive, and rapid assessment strategies used in video games (Hirumi, Appelman, Rieber, & Van Eck, Preparing Instructional Designers for Game-Based Learning: Part 3, 2010c). Thus the use of gamification and interactive narrative techniques are areas which will be considered during the design process.

The second challenge is that developing video games takes substantial time and money. Development costs for independent game companies can be thousands of dollars per day, while AAA games can cost millions. As a graduate research project being used for academic purposes, it is not reasonable or expected to compete with the multi-million dollar budgets.

The third challenge is that video game design is uncertainty. Unlike traditional gamification, game-based learning is not formulaic or found in a library. Each element of play is an artistic choice motivated by the need to keep the players engaged, yet and constrained by both the mechanics of the system and learning objectives that need to be met. Like many other design processes, the overall impact of each element in the design cannot be fully assessed and understood until the whole product exists and can be tested. Video games, in particular, have a rich history of failed games, so success should not be assumed or guaranteed.

Adding to the uncertainty of the design process is the problem of getting accurate and meaningful feedback. Although focus groups, videotaped play, and surveys can be used,

monitoring a player's behaviour is complicated.[7] [8] [9] However, adapting and changing the core instructional methods and game mechanics is not trivial.

This research project concludes with a design review by professional engineers in order to critique the design and provide insight for improvement — a practice consistent with software development practices in industry.

1.6 Foundations

1n 2010, Hirumi, Appelman, Rieber, and Van Eck wrote a series of journal articles on instructional design for game-based learning environments (2010a; 2010b; 2010c). In their first paper, Van Eck writes that "Relatively little is understood about how to apply what we know about teaching and learning to optimize game-based learning." (Hirumi, Appelman, Rieber, & Van Eck, 2010a, p. 29), a claim he substantiates by detailing the additional complexities involved in balancing good gameplay with instructional objectives (p. 32). From this viewpoint, a fundamental challenge for instructional design is the complexity of game systems due to their immersive nature and the opportunity for each participant to have a unique experience.

> "Part of the challenge in this is that commercial games are immersive learning environments, and most instructional designers were trained to develop for less immersive mediums (e.g., print, video, facilitator-led)." [Richard Van Eck, p. 31 in

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[7] *7 Things You Should Know About ... Intelligent Tutoring Systems.* This 2013 Educause article provides context in what Intelligent Tutoring Systems are, how they work, and the implications for teaching. https://library.educause.edu/~/media/files/library/2013/7/eli7098-pdf.pdf, last viewed Sept 9, 2017.

[8] *Intelligent Tutoring Systems: What Happened?* This article on instructional design explains what *Intelligent Tutoring Systems* are and why they have failed to enter the mainstream of teaching. https://elearningindustry.com/intelligent-tutoring-systems-what-happened, last viewed, Sept 9, 2017.

[9] The topic of *Intelligent Tutoring Systems* is an active area of research in artificial intelligence and beyond the scope of this work. For more information, the ITS conference proceedings are available from *Springer Link* https://link.springer.com/conference/its, last viewed, Sept 9, 2017.

(Hirumi, Appelman, Rieber, & Van Eck, Preparing Instructional Designers for Game-Based Learning: Part 1, 2010a) used with permission]

Like engineering design, instructional design is about understanding the needs and constraints of a system in order to create a usable product. In that way, the instructional designers, like engineers need to:

1. Work with content experts to discern the critical needs and constraints of the design.
2. Perform an analysis of the design requirements (learning outcomes), followed by the design and implementation of the product.
3. Bring an understanding of discipline-specific theory and practice to the design process.
4. Collaborate with stakeholders (contractors, programmers, artists, and subject matter experts) on the project to manage requirements and meet the design goals.

In this project, these four activities were conducted as follows:

1. Past and current executive of the Engineers Geoscientists Manitoba were consulted to understand the role of ethics in engineering practice and the common of actions/events that lead to investigations and disciplinary action by the association.
2. The project started from an analysis of Canadian engineering education and focused in on a situation in which ethics education could be improved. Once the solution was implemented, it was evaluated by members of the engineering profession in Manitoba.
3. The game was developed so that players are active agents determining how the story evolves and progresses. Specifically, players read a description of the current situation, choose an action, and receive immediate consequences (new situations) as a result of their choices. In addition to this, players received six sets of points to indicate their overall performance in balancing different aspects of professional practice.
4. Art, sound, and game design were all done by the instructional designer. Thus, the choices for mechanics, dynamics, and aesthetics resulted from both consideration of the instructional goal and what tools could be used to make the game fun.

1.7 Uniqueness

This game is a one-off experience, designed and developed from scratch with the assistance and direction of Professional Engineers and the assistance of Engineers Geoscientists Manitoba to meet the needs of engineers in Canada.[10] This project is unique because:

1. Video games have not been previously used in Manitoba to teach engineering ethics.
2. It is designed from the ground up to integrate learning outcomes with gameplay elements.
3. Uses interactive narrative as the mode of learning which is different from more traditional multiple choice or short answer evaluations.
4. Assumes participation is voluntary and that the participants are not motivated by classroom requirements or grades.
5. Uses the player's ability to control and manipulate the game (agency) along with the ability to take action (efficacy) as motivating aspects of the design. While the topics of agency and efficacy are prevalent in video game research, they are noticeably absent from papers in both education and ethics. The expectation that players will actively seek out either good or bad choices depending on their avatars persona is a novel way of approaching engineering ethics.
6. It focuses on Canadian engineering practice.
    a. Engineering regulations and practice are different in Canada from the United States of America and the United Kingdom. Most importantly for this research is the fact that Canadian engineers have to be registered with the regulator of jurisdiction in each province or territory they practice.
    b. Most information about Canadian Engineering Practice comes from the associations. *Canadian Professional Engineering Practice and Ethics* by Andrews and Kemper (1999) is one of the few books endorsed by most of the Canadian engineering associations to prepare for the provincial Professional Practice Exam.

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[10] Ian Bogost (Walz & Detarding, 2014, p. 68) uses the criteria of one-off, and developed from scratch to differentiate games "from generalized solutions offered by gamification consultants."

7. Peer reviewed by sixteen practicing engineers and engineering interns to ensure the validity of cases being presented, the feedback of which indicated that it was a learning experience for them and caused them to think about their professional responsibilities in a different manner.

1.8 Knowledge Gap

The fields of education, engineering, and ethics (Figure 1) are all fields in their own right. However, the interdisciplinary nature of this project, combined with the focus on Canadian Engineering practice results in an area that has been relatively unexplored. Because of the nature of the project and constraints in place, the following knowledge gaps exist:

1. Engineering ethics in Canada is poorly covered research topic. Aside from the Engineers Canada and the professional associations, very few publications appear in this area.
2. Because of the cultural, legal, and professional environment that exists in Canada, the equivalency of the information cannot be assumed. Academic papers, magazine articles, and websites must be viewed with due consideration for the author's legal and professional environment.
3. In keeping with Van Eck, applying instructional design principles to video games is more complicated because of the interactive nature of the environment. Each video game is unique and each players experience is unique.
4. While significant research exists on ethics in video games and teaching ethics with video games (Schrier & Gibson, 2010), none of the engineering ethics games surveyed utilized a non-linear dialogue in their design.
5. The majority of educational literature on teaching and instructional design for classrooms focuses on pedagogy rather than andragogy. This is a critical distinction when thinking about a player's expectations, motivation, and learning.

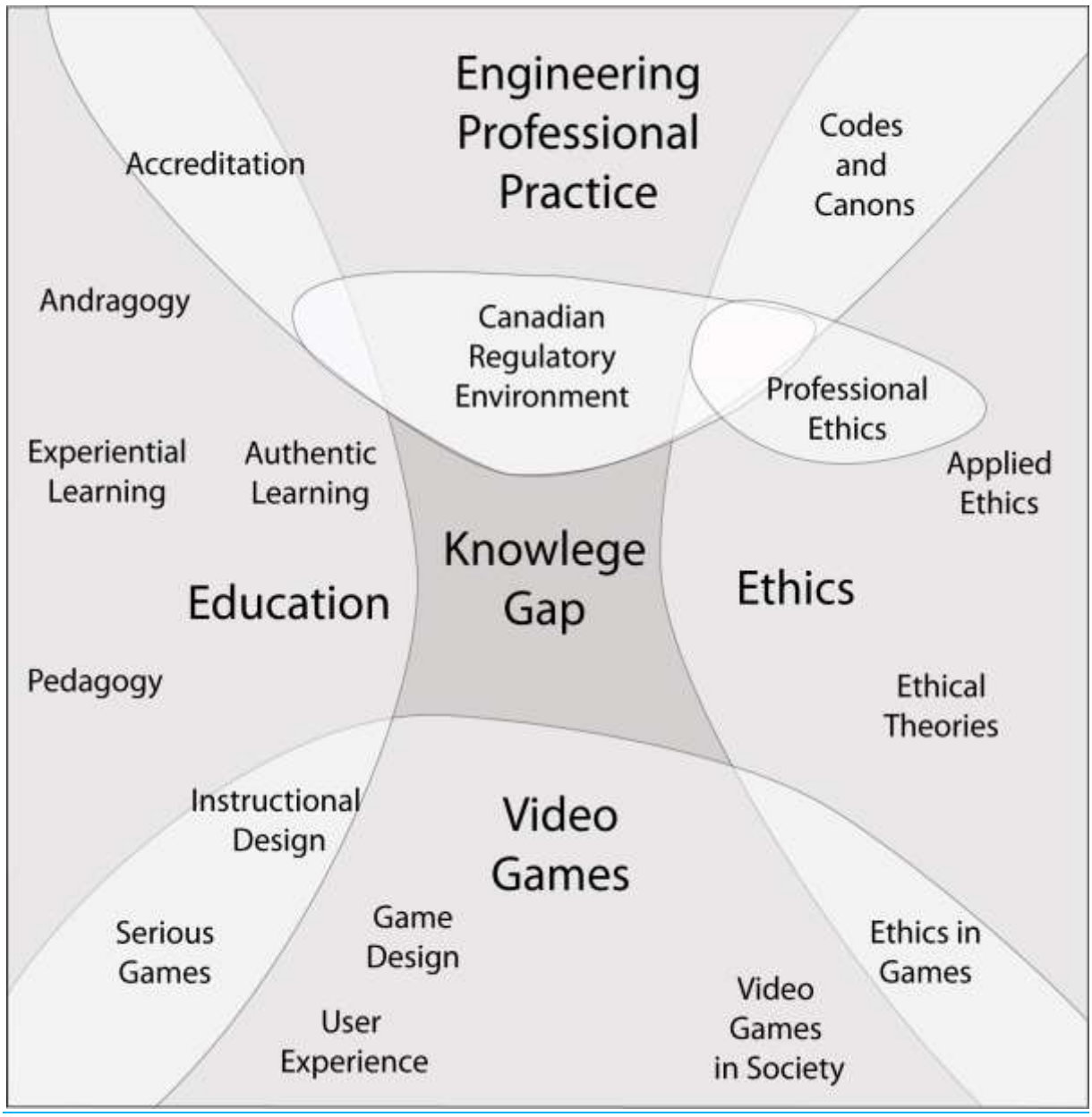

Figure 1: Knowledge Gap

1.9 Learning Outcomes

In this game the player will:

1. Appraise ethical situations and choose appropriate responses.
2. Enhance understanding of professional responsibility.
3. Develop an awareness of the role of the professional association in protecting the public interest.
4. Recognize and adapt to the social and organizational complexities found in engineering practice.
5. Act as an ethical agent and gain an understanding of the professional and ethical responsibilities of an engineer.

These learning outcomes along with the additional design constraints are covered in chapter 9. The key challenge is that video games are a second order design problem, in which developers create the environment and players create the story. Addressing this required that the learning outcomes be embedded into the procedural rhetoric (the mechanics and fabric) of the game so that regardless of the player's decisions, the underlying ideas would be encountered.

1.10 Research Contribution

The underlying goal of this research is to develop and assess an alternative way of teaching engineering interns about professional practice and professional ethics in Canada. To this end, this research has three significant contributions.

1. Developed a prototype narrative based video game to allow Engineering Interns to explore day-to-day situations surrounding engineering practice.

2. Conducted a design review with Professional Engineers and Engineering Interns to assess the validity of the cases being presented and obtain feedback for future enhancements. Analysis of the feedback is given in chapter 12.

3. Synthesized knowledge from education, video game design, and engineering focused on designing and implementing the game. While each of these disciplines has extensive research, the combination of all three is rare.

1.11 Researcher Position

This work is grounded in the engineering teaching philosophy of Conceive, Design, Implement and Operate (CDIO). The aim was to conceive an alternative solution to the problem of engineers needing a better of their professional and ethical obligations. Ideally, this solution would both accurately representative of engineering practice and be personally relevant to Engineering Interns. Doing this required extensive one-on-one meetings with both past presidents and current executive of Engineers Geoscientists Manitoba.

Based on the literature, the most productive design space was one in which students were given authentic (multi-faceted) experiences that accurately represented the engineering profession. Having lived through several ethical dilemmas as an engineering intern, being able to cite and recite the code of ethics did little to help me identify and solve professional in the real world. What would have been useful would have been the ability to *safely* role-play similar ethically challenging situations, *share* them with the community around me and *understand* what was expected of me. Unfortunately, it was not until long after these events, that I was able to find the guidance I needed.

Now, twenty years later, as I watched the events of the Charbonneau Commission and Elliot Lake inquiries unfold, I am left remembering the feelings I had as an Engineering Intern and wondering what the co-op students and engineering interns who worked for the engineering firms involved were learning about their professional responsibilities.

This work is motivated by a real need in the profession to provide better resources to Engineers and Engineering Interns to help them recognize understand the implications of ethical challenges within the engineering profession. For my part, I can sleep better knowing that I have done something to help guide and mentor early-career engineers in their career.

In this game, I have portrayed many of the non-engineers as being focused on profits, deadlines, or liability. This is not done to suggest that businesses always disregard ethical concerns but to

highlight the engineer's responsibility to recognize these biases and find solutions that benefit both their employer and the public interest. It is not easy to take a stand and resist the pressures around you, but the skills to deal with adversity are grown by being empowered to solve problems and take action. Video games can offer a safe place to experience conflict and be given the freedom to find solutions.

Engineering codes of ethics in Canada are fundamentally based on trust, technical competence, and duty to others. This project is about taking that understanding and helping others recognize it for themselves.

1.12 Summary

This chapter provided an overview of the thesis, identified the motivation, scope, and contribution of this thesis. The three key takeaways are:

1. The professional practice exam (PPE) is a critical component of licensure for engineers in Canada.
2. This thesis is about helping early-career engineers prepare for the PPE by providing a relevant context in which to apply the concepts of professionalism and engineering ethics.
3. The contribution of this thesis is the development of a learning game and subsequent design review by Professional Engineers

2 Motivation, Context, and Current Events in Canada

2.1 Overview

This chapter focuses on three components, (1) why ethics is essential to engineering, (2) significant events which compromise the reputation of engineers and (3) the kinds of ethical training that would be valuable for Engineering Interns.

2.2 Why Engineers Should Care About Ethics

Ethics is a foundational aspect of engineering because the products engineers design and create, interact with the real world and often change society. Whether it's designing cell phones to have an internet browser, planning traffic routes through a city, or placing transmission lines through a province, our society is directly affected by the decisions engineers make and the unforeseen consequences thereof.

Members of professions — whether it be law, clergy, or engineering — have specialized knowledge and use it to serve others. As members of the public, you and I trust that engineers will serve the public interest by making sure the products we buy are safe, work reliably, and have no unforeseen consequences. We trust that the cars we buy will keep us safe in an accident, start at -40°C, and not spontaneously burst into flames during an accident. We trust that our fridge will keep food cold, operate reliably for years, and not release toxic gases into our home. As members of the public, we expect our safety and our interests to be protected.

However, engineering as a profession is about design — it is about finding the best solution to ill-defined problems. And from an employer's point-of-view, they want engineers to use their skills to solve technical problems and meet the needs of customers in the most cost-effective and risk-free manner possible (Hubertz, 2009). In comparison, lawyers, accountants, managers, and executives are tasked with minimizing risks to the organization, ensuring profitability, and managing the resources available. The challenge occurs when the ethical expectations of these groups come into conflict with each other.

The ethical responsibilities of engineers are further complicated by the need for engineers to trust each other. In order to design products, engineers need accurate, factual, and reliable

information about the products and materials they are working with. Engineers rely on technical reports and product data sheets for information about the performance specifications, tolerances, and design models needed to use a product. When this information is incorrect, lacking or misleading, designing reliable products is virtually impossible.

Engineering is a profession based on specialized skills and trust. Skill to do engineering, and trust that it will be done correctly and in the best interest of all parties involved. Without trust, the engineering profession loses credibility both inside and out.

2.3 Engineering in the Public Eye

Unfortunately, this trust can be abused and broken both by engineers within Canada and without. The failures of products designed in other countries affect consumers trust in commercial design, and that loss of trust can affect engineers locally. The media circuses surrounding exploding Samsung batteries in cell phones,[11] Toyota's acceleration scandal,[12] or Volkswagen's emission performance during testing[13] all affected the public's impression about the trustworthiness of engineers and the products they design.

When Canadian engineers are involved in corruption (Charbonneau Commission, 2011), perform work incompetently (Elliot Lake Inquiry, 2012), or represent themselves in unprofessional manners (Shawn Simoes/Hydro One, 2015), the media attacks the event and leaves members of the public wondering why they put their trust in engineers and the regulators.

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[11] This article on the Samsung Note 7 battery failure provides easy to understand explanations on how the batteries were failing and the number of incidents involved. https://www.cnet.com/news/why-is-samsung-galaxy-note-7-exploding-overheating/, accessed July 7, 2017.

[12] This article outlines the factors around the $1.2 billion dollar fine give Toyota over the sudden acceleration problems. http://www.huffingtonpost.ca/2014/03/19/toyota-sudden-acceleration_n_4992272.html, accessed October 18, 2016.

[13] This article provides an overview and timeline of the Volkswagen environmental scandal. https://www.epa.gov/vw/learn-about-volkswagen-violations, accessed October 18, 2016.

2.3.1 The Charbonneau Commission

In 2015, the Charbonneau Commission (Charbonneau & Lachance, 2015) concluded 261 days of hearings into widespread corruption and political financing in the province of Quebec.[14] [15] Although primarily published in French,[16] the findings and scope of proceedings could be inferred through news reports,[17] [18] the Engineers Canada partial translation[19] of the commission's recommendations (Engineers Canada, 2015) and an English translation of volume 3 of the report located on the University of British Columbia website.[20] Broad impacts of this commission on the engineering regulators were:

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[14] A summary of the Charbonneau Commission report aimed at lawyers. http://www.blg.com/en/newsandpublications/publication_4317, accessed October 11, 2016.

[15] An English language overview of the Charbonneau Commission. http://en.wikipedia.org/wiki/Charbonneau_Commission, accessed October 23, 2014.

[16] The official commission website (French only). https://www.ceic.gouv.qc.ca/la-commission.html, accessed November 7, 2017.

[17] A summary of nine key findings from the Charbonneau Commission. http://www.cbc.ca/news/canada/montreal/charbonneau-commission-report-recommendations-1.3335460, accessed October 11, 2016.

[18] A summary and timeline of the Charbonneau Commission. http://news.nationalpost.com/news/canada/charbonneau-commission-makes-recommendations-952836, accessed October 11, 2016.

[19] Recommendations from Charbonneau Commission (English translation), https://engineerscanada.ca/news/english-translation-of-recommendations-from-the-report-of-the-charbonneau-commission-now, accessed March 4, 2017.

[20] An English translations summarizing the commission and it findings can be found at the University of British Columbia law department website. https://icclr.law.ubc.ca/wp-content/uploads/2017/06/9503929_001_EN_Rapport_final_CEIC_Tome3.pdf, last accessed November 6, 2017

1. OIQ lost the right to self-govern shortly after the completion of the Charbonneau Commission. While this action is on record as being the result of financial mismanagement, the timing of this event coincides with the release of the commission's findings is not coincidental.
2. The loss of self-governing status has caused increased vigilance and action among the other Canadian engineering regulators to demonstrate their competence in regulating their members and protecting the public interest.

2.3.2 The Argo Mall Collapse

On June 23, 2012, ten weeks after former Engineer[21] Robert Wood had declared it safe[22] [23] the Argo Mall in Elliot Lake (Bélanger, 2014) collapsed killing two people. Despite the fact that the inquiry revealed long-term neglect, insufficient repairs, and pressure by the mall owners to falsify records, only Robert Wood went to trial.[24] [25] On June 1st, 2017, Mr. Wood was acquitted on three counts of criminal negligence.[26] This case highlights several ethical issues surrounding

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[21] In a media release following the Argo Mall collapse, Professional Engineers Ontario specified that that Robert Wood was not a Professional Engineer as he had lost his licence previously in an unrelated matter. http://www.peo.on.ca/index.php?ci_id=30240&la_id=1, accessed October 11, 2016.

[22] A summary of the Elliot Lake Inquiry posted by the Consulting Engineers of Ontario. http://www.ceo.on.ca/Issues/Build_Up_Ontario_/the-elliot-lake-inquiry.html, accessed October 11, 2016.

[23] A Maclean's article outlining why Robert Wood is the only one charged with criminal negligence in the Elliot Lake mall collapse. http://www.macleans.ca/news/why-one-man-faces-criminal-charges-in-the-elliot-lake-mall-collapse/, accessed September 14, 2016.

[24] Part of the day by day news reports on the trial proceedings against Robert Wood. http://www.cbc.ca/news/canada/sudbury/elliot-lake-mall-collapse-trial-1.3752908, accessed October 11, 2016.

[25] New coverage from the first day of the proceedings against Robert Wood. http://www.cbc.ca/news/canada/sudbury/robert-wood-trial-day-one-1.3750578, accessed October 11, 2016.

[26] News report stating that Robert Wood was acquitted in the Elliot Lake mall collapse. http://www.cbc.ca/news/canada/sudbury/verdict-elliot-lake-mall-collapse-trial-1.3943318, accessed July 19, 2017.

the engineering profession and the conflict between being a trustworthy agent for the client/employer and an engineer's duty to protect the public interest. It also highlights the challenges of regulating the engineering profession when people represent themselves as engineers despite having their license removed or failing to register as required by law.

Two takeaways from this unfortunate case are:

1. Engineers are entrusted to make decisions based on their specialized knowledge, and when necessary, take action to prevent clients or employers from putting the public at risk.
2. In the event of a disaster, Canadian engineers appear to be under higher ethical expectations than the managers and clients they work for.

2.3.3 Shawn Simoes

In 2016, Shawn Simoes, a "Network Engineer" at *Hydro One*, was fired for defending the sexual harassment of news reporter Shauna Hunt at a sporting event. After an unidentified person made disparaging remarks about the reporter, she singled out Simoes and accompanying people for a response. In his comments he encouraged the behaviour, saying he found the comments hilarious.[27] [28] [29] [30] As a result, the CEO of *Hydro One* immediately terminated Simoes. While

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[27] Article on the firing of Shawn Simoes. http://www.theglobeandmail.com/report-on-business/industry-news/the-law-page/firing-staff-for-off-hours-conduct-has-risks-rewards-for-companies/article24423867/, accessed October 11, 2016

[28] Article on the firing of Shawn Simoes. http://www.cbc.ca/news/business/firing-of-shawn-simoes-for-off-duty-fhritp-video-reflects-employment-trend-1.3071919, accessed October 11, 2016

[29] News reports discussing the arbitration process Shawn Simoes used to get rehired by Hydro One. http://www.huffingtonpost.ca/2015/11/02/shawn-simoes-hydro-one_n_8453012.html, November 2, 2015. Accessed Sept 15, 2016

[30] Legal summary outlining what lawyers can take away from Shawn Simoes grievance over being fired from Hydro One. http://www.williamshrlaw.com/the-reinstatement-of-hydro-ones-shawn-simoes-takeaways-for-employers/, November 13, 2015. Accessed Sept 15, 2016

this case has many implications in labour law, the implications of interest here lie with how the engineering profession was represented by the media. Despite the fact that a simple check of the PEO register revealed he was not a registered professional engineer[31] (Professional Engineers of Ontario, n.d.), the media used his title "Network Engineer" and the familiarity of Ontario One (the provinces main power utility) to portray Shawn as a disrespectful and irresponsible engineer. The subsequent reports of Shawn's legal action and return to work are only minimally covered in their relation to how/why employers can terminate employees.[32]

Two takeaways from this story are:

1. Despite legal restrictions on the use of Engineer in an employee's title, the media does not differentiate between those who use the title legally and those who do not. In the eyes of the media, having the title or acting as an engineer is sufficient enough.
2. Employees, particularly engineers need to appreciate how their comments and actions can be twisted and misshapen by the media. Making comments on subjects you are not an expert in, can be a career limiting event.

2.4 Reflection on the Cases Presented

In each of these contemporary Canadian cases, engineers and those perceived to be engineers were at the centre of a media blitz and remind us that the actions of a few can cast shadows on the profession as a whole. Thus, just like today's teenagers need to learn about the dangers of chat rooms, sexting, and being recorded at any time, engineering is in the public eye. Today's engineers need to know how and why their actions will be judged by both the media and their peers. For their own protection; engineers need to act accordingly.

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[31] PEO media release stating Shawn Simoes is not licensed by PEO and is not legally an engineer. http://www.peo.on.ca/index.php/ci_id/28805/la_id/1.htm, accessed October 11, 2016.

[32] Follow up story on Shawn Simoes. http://nationalpost.com/news/politics/hydro-one-employee-fired-over-sexual-harassment-of-a-reporter-has-been-rehired, Last Accessed November 6, 2017.

Unfortunately, given the hours of focus on engineering math programs on and science, many engineering students forget or do not understand the ethical and humanistic aspects of the engineering profession (Roncin, 2010).

As Thomas Seager and Evan Selinger (2009) point out in their paper on teaching sustainability, engineering students are emotionally vested in hard science and teaching them to think beyond this scope is challenging. The students have been indoctrinated into solving "tame problems" and framing and addressing problems using mathematics, engineering analysis, or lab work to solve them. Manners of thinking that are at odds with learning to collaborate with stakeholders and understanding non-engineering viewpoints.

2.5 Understanding Professional Ethics Requires Context and Experience

At its core, teaching professional ethics to engineering students is about raising students' understanding of what it means to be an engineer and what is expected of them by providing them with a framework to understand, recognize, and hopefully handle ethical issues before they become much more significant problems.

> Ethics ought not be neglected in engineering education, but more fundamental and prerequisite is for students to learn about the social, the organisational – even the political – complexities of practice. (Bucciarelli, 2008) [Reprinted with permission of Taylor and Francis]

The unfortunate reality is that real understanding comes with real experience. It comes from being faced with ethical challenges in the workplace, such as being confronted by supervisors looking to meet deadlines, being forced to cut costs, or just pass inspection. It comes from working with managers and lawyers whose professional ethics and responsibilities are different from those of engineers (Hubertz, 2009) and (Davis, 1999, pp. 62 - 77).

Engineering Interns need to be shown exemplars of good engineering practice and the consequences of negligence. They can be trained to do calculations, write contracts, and work in teams. But they also need to understand and appreciate the potential consequences of

unprofessional practice, working beyond their expertise, and allowing non-engineers to railroad them into neglecting their due diligence.

Reflecting on the widespread corruption revealed by the Charbonneau Commission, it is easy to imagine early-career engineers being indoctrinated into giving bribes, using political connections for personal gain (graft), and rigging contracts. Looking at it from the perspective of these early-career professionals —it is what we do, not what we say that is the reality of how engineering practice is done.

2.6 Summary

Engineers are granted special status in society based on their specialized knowledge and the trust of the public that they will use this knowledge in a responsible manner that protects the public interest and safety. When engineers forget this obligation, it can lead to quite disastrous consequences for both the engineer and the profession as a whole.

Three takeaways from this chapter are:

1. The status of the engineering profession is based on technical competence and the trust of the public, the clients, and fellow engineers.
2. Engineering failures garner serious media attention and put the public's trust in jeopardy.
3. Early-career engineers learn from the people and environments they work in. Their beliefs about engineering practice are formed by what they see and what they do in the early years of practice.

3 Research Context

The challenge in this thesis is to synthesize the learning outcomes with the game elements in a manner that accurately reflects engineering practice in Canada. This is a challenge that requires understanding what engineering ethics is, how it is taught, and then using this understanding to embed this knowledge as foundational elements of the gameplay.

The knowledge gap being faced is that professional engineering practice, ethics, education, and video game design are four discrete fields of knowledge (Figure 1). Furthermore, even when these fields are synthesized, direction on how to implement virtual experiences that allow players to experience day-to-day engineering practice in a manner that encourages engagement, replay, and transfer of knowledge back to the real world has not been addressed.

From an instructional design perspective, three central questions need to be addressed; (1) what are the characteristics of the instructional environment, (2) what is the content, and (3) what teaching techniques can be applied? The literature review that follows in chapters 4 through 8 considers the different background fields which influence this thesis.

- Chapter 4 addresses the instructional environment by looking at the defining traits of games and how they can be used.
- Chapter 5 highlights the debates surrounding gamification and then discusses the value of using these elements in the game design.
- Chapter 6 looks at engineering ethics as a subject matter and the unique characteristics of professional practice and engineering ethics in Canada.
- Chapter 7 identifies teaching and learning concepts that can be adapted or applied to video game based learning.
- Chapter 8 considers the challenges of ethics assessment and integrating assessment and play together in this game.

From the literature review, Chapter 9 changes the perspective from one of context to one of implementation. Discussion of the development tools and actual implementation are left to chapters 10 and 11 respectively.

3.1 Instructional Challenges and Requirements for Teaching Ethics

At its core, ethical gameplay has personal relevance, tension, and constraints (Sicart, 2009). Players need to relate their own ethics and actions to the game's story and how it evolves. The challenge for developers is to create an environment confronts, the players with conflict, ethical choices, causality, and unknown consequences. Ideally, in a way that allows players to implement their own values and create changes in the game as a result.

In instructional design, ethical gameplay is about creating situations which cause reflection, build empathy, and encourage students to reshape and transfer their knowledge to new contexts. As discussed in section 6.1, perceiving, understanding, acting on, and evaluating the outcomes ethical issues and decisions are the key learning objectives.

The requirements for meeting these objectives are:

1) Informing players of the expectations on behaviour.
2) Encouraging reflection on one's own ethics.
3) Developing ethical reasoning skills:
    - Interpretation of ethical guidelines.
    - Recognition of the perspectives and viewpoints of others.
    - Systems thinking in identifying root problems.
    - Causal reasoning of the outcomes of selected actions.
4) Developing empathy through practice considering multiple perspectives.
5) Allowing players to express their own ethical biases and experience meaningful consequences as a result.
6) Creating an environment where players feel that ethical behaviour matters.
    - Agency (ability to change the world) and consequence when you do.
    - Engaging stories which encourage you to care about the outcome,
7) Identifying the core messages, learning events, and evidence required for assessment.

Video games are well suited to meeting these requirements, because they allow players to become active participants in the game world. They allow players to push boundaries,

experiment with new ideas, and experience the consequences thereof, without fear of reprisal or personal harm. The challenge, is that evaluating ethics is complicated, because the problems are ill-defined, and the solutions are highly influenced by personal morality and prior experience.

4 Games

In his seminal paper on designing interactive learning environments, Rieber (1996) works to dispel the misconception that play is something you grow out of and that "work is respectable, play is not" (p. 43). He does this by pointing out that extensive research in psychology, education, and anthropology demonstrates that play is a crucial component of learning and socialization. He also points out that, unlike the games played by children, adult games like chess, hobbies, and sports are typically quite challenging (p. 44).

This chapter examines video games as learning environments, an essential aspect of which is defining what constitutes a game and the defining traits it should have (Table 1). While the definitions provided show a discrepancy in how experts define video games, one particular difference is whether or not games have to be voluntary and the observation that it is typically not included in an educational context. The voluntary nature of play is relevant to this work because of the expectation that players will be professionals who have completed school and are playing for their own enjoyment, curiosity, and professional development. It has been conceived as a supplementary learning experience for engineers looking to contextualize their understanding of professional ethics. It is not intended for use in a classroom or for the assignment of letter grades.

This chapter also looks at the potential of video games for social change and teaching. It examines several examples of video games, simulators, and board games being used for social change, teaching ethics and exploring sustainability issues.

4.1 Game Design

"Game design and instructional design are similar in that both result from a process that mixes the artistic, empirical, and analytic." (Hirumi, Appelman, Rieber, & Van Eck, 2010b, p. 23) Furthermore, "The design of a game — educational or not — is one of the most sophisticated design problems one can attempt." (p. 24) While this statement may seem like an attack to diminish the work of engineers, it is worthwhile to consider Rieber's position. Game design is a multi-faceted design problem which requires the use of advanced computer science concepts in

combination with storytelling, motivational psychology, and artwork to create a compelling experience that draws users in and entices them to play.

Like the design of complex systems or the wicked problems encountered in sustainability engineering, the game designer and more so the instructional designer has many conflicting requirements, multiple stakeholders, and the demand to get the design right the first time. Like more traditional engineering design, the solution about how to design a game does not merely lie in the library. Game design is a constraint bound fusion of the designer's knowledge and experience with the environment, resources, and capabilities at the time.

One particularly useful idea for dealing with this complexity is Jesse Schell's "Lens of Elegance" (Schell, 2008, p. 198). Through this lens, developers are encouraged to reinforce the game elements at every turn, asking questions like: Do the game elements serve multiple purposes? Do the mechanics reinforce the experience? Do the rewards make sense? As a learning environment (Shute, Masduki, & Donmez, 2010; Rupp, Gushta, Mislevy, & Shaffer, 2010) this lens can be refined by adding evidential questions like: Do the players' actions provide evidenceabout their bias, understanding, and goals?

Game mechanics, animations, and audio-visual elements all require significant development times to create. And with limited resources, hard decisions often have to be made to cut ideas, control costs, or find alternative ways to create the game experience. In Schell's story about designing an interactive experience designing *Pirates of the Caribbean: Battle for the Buccaneer Gold*, Schell and his team were struggling to keep the project under budget without sacrificing gameplay. One decision they made was to reuse the host at the beginning of the game as the villain at the end. Doing so allowed the team to reduce development costs, make the character more interesting, and improve the interactive experience as a whole.

However, Schell also advises readers to be aware of how reducing a system to its core can actually destroy the underlying flaws and imperfections that make the game exciting and appealing. Hirumi offers similar advice by pointing out that games which focus on educational requirements often fall short in creating memorable experiences and fail to meet the expectations of both creators and players (Hirumi, Appelman, Rieber, & Van Eck, 2010c, p. 38).

Figure 2: Elements of Serious Game Design

4.2 The Defining Traits of Games

Multiple definitions of what constitutes a game exist within the field of game design. Salen and Zimmerman point out in their book *Rules of Play: Game Design Fundamentals* (2004) that defining the term game is a foolish endeavour, yet one required to formalize and define game design. Egenfeldt-Nielsen suggests that defining games is a very political action (2008, p. 23)

because it impacts which activities are considered games and ultimately what research gets funded.

Thus in an effort to define video games, the definitions presented by Egenfeldt-Nielsen (2008, p. 37), Salen and Zimmerman (2004, p. ch. 7), Schell (2008, pp. 26-41, 124-220, 261-298,345-352,403-414), McGonigal (2011, p. 21), and Costikyan (2002, pp. 10-21) are compared in Table 1.

The attributes in Table 1 are by no means exhaustive, and several of the referenced authors point out that not all games have all of these common attributes. Serious games, for example, are often involuntary because of their compulsory use by students. Similarly, surprise is a useful game element to foster engagement, but only Schell emphasizes it as part of the definition of what constitutes a game.

Table 1: Common Game Attributes

Attribute	Author				
	Egenfeldt-Nielsen (2011)	Salen and Zimmerman (2004)	McGonigal (2011)	Schell (2008)	Costikyan (2002)
Voluntary			✓	✓	
Goal	✓	✓	✓	✓	✓
Rules	✓	✓	✓	✓	✓
Feedback	✓		✓		
Purposeful interaction					✓
Interactive structure (dynamics)	✓			✓	✓
Endogenous meaning				✓	✓
Struggle		✓		✓	✓
Surprise, uncertainty				✓	

The game attributes most applicable to this thesis are voluntary play, goals, rules, feedback, purposeful interaction and interactive structure. These attributes align with the target audience of

early-career professionals who have grown up with video games and expect them to be fun, engaging, and goal-focused activities. They also align well with the guiding principles that games should afford players a sense of agency, by allowing them to make purposeful interactions within the mechanics of the goals, rules, and feedback of the game.

Table 2: Common Game Attributes Appearing in this Thesis

Attribute	Comments
Voluntary	Playing this game is optional. It is designed to be a supplementary experience.
Goal	To explore the ethical space as themselves, or as their avatar
Rules	The core mechanic of the game is choosing a course of action after each game narrative.
Feedback	Each choice leads to different consequences and narrative responses. Points are assigned on the basis of impact on the six ethical dimensions
Purposeful interaction	Ethical cases are similar to those seen in practice.
Interactive structure (dynamics)	The game responds to player decisions.

4.3 Games as a voluntary experience

Video game pundit Jane McGonigal's definition of games highlights that idea that they are voluntary experiences, meaning that players knowingly and willingly accept the rules and dynamics of the game — and that they are free to leave at any time.

Rieber (1996) offers a different perspective on the voluntary nature of games. Rieber argues that play is not always good or voluntary by using examples of playground bullies and being socially pressured to participate. In today's world, cyber-bullying, social media, and expression through electronic mediums are commonplace. The playground problems described by Rieber have not gone away, they have become less transparent. Spiteful forum posts, data mining, and malicious sites; undermine the playful experiences found in video games and social networking sites. Moreover, the practice of data mining a player's personal information and social networks to

keep players immersed in the game[33] undermines the voluntary aspect of them as well. In a world driven by dollars, freemium, micro-transaction, and ad-based games are often engineered to be social experiences that compel players to return often to the game environment in hopes of having players spend money or following ads.

An alternative example of how games can be both voluntary or not comes from considering hockey or basketball. At home, these games can be a fun voluntarily experiences shared between family members. At school, these same games can be requirements to pass gym class. Whereas in professional sports, hockey and basketball become lucrative business full of highly paid athletes in which the player's livelihood depends on their performance. Considering each of these contexts, in turn, it is easy to imagine a continuum in which play moves from being fun voluntary pastimes to demanding professional careers.

This distinction about the voluntary nature of games is important because it is one of the differentiating characteristics of this thesis from other learning experiences. This project focuses on creating a voluntary, self-assessed learning experience. Whereas much of the (academic) focus on engineering ethics is tied back to ABET[34] and CEAB[35] accreditation requirements. Engineering ethics projects *Interactive Simulator for Engineering Ethics Education* (*SEEE2)* (Alfred & Chung, 2011) and the *Engineering Ethical Reasoning Instrument* (EERI) (Zoltowski,

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[33] Extra Credits Season 14, episode 5, "Liminal Space — Incorporating Real Life into Games — Extra Credits. https://www.youtube.com/watch?v=cQ9s0GiEAFU, accessed November 19, 2017

[34] ABET is the accrediting body in the United States for engineering, computing, and applied science. Note: graduates still have to take a Fundamentals of Engineering exam to become Professional Engineers. http://www.abet.org/about-abet/, accessed December 30, 2016. https://www.nspe.org/resources/licensure/what-pe, accessed December 30, 2016.

[35] CEAB, is the Canadian Engineering Accreditation Board and part Engineers Canada. In Canada, graduating from an accredited program ensures students have the academic credentials for licensure as a professional engineer in Canada. https://engineerscanada.ca/accreditation/accreditation-board, accessed Jan 29, 2017

Buzzanell, & Oakes, 2013) are primarily concerned with testing and assessment, rather than with participant experience.

4.4 Games for Social Change and Social Influence

Modern games have the power to influence society and create change. Jane McGonigal[36] and Ian Bogost[37] are two developers doing that. While McGonigal and Bogost present compelling and often inspiring examples of how games can be used for social discourse, two problems exist when researching these authors: first, most of the games created by McGonigal and Bogost have been discontinued by the authors leaving only second-hand accounts of their game and their effect on the players. Second, the books by both authors appear to be written to inspire a mass audience and challenge social norms about what games are and how they can be used — they are not written to guide a game developer through the process and challenges involved in creating a game.

In their joint collaboration *Cruel2BKind*, McGonigal and Bogost use the game mechanic of "assassination" via acts of kindness and teamwork[38] as a way to promote positive interactions and social discourse. In addition to this game, McGonigal often uses augmented reality games to inspire people to take real-world action to address both global concerns (*A World Without Oil*) and personal challenges (*SuperBetter*). To McGonigal's credit, *SuperBetter* game is scientifically based and has been validated to help with anxiety and depression.

Ian Bogost and his company Persuasive Games[39] use flash games to challenge contemporary thinking. In his book *Persuasive Games*, Bogost demonstrates how games have "unique

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[36] JM: https://www.superbetter.com/

[37] Ian Bogost's personal website: http://bogost.com/

[38] Instructions for hosting the game are available at http://www.cruelgame.com/games/host.aspx, accessed November 12, 2017.

[39] Ian Bogost's game development company website: http://persuasivegames.com/, accessed November 12, 2017

persuasive powers" useful in "politics, advertising, and learning" (Bogost, Persuasive Games, 2007, p. ix). These persuasive powers, come through the ability of video games to represent a particular viewpoint of the world, a term he coins "procedural rhetoric" (Bogost, Persuasive Games, 2007, p. ix; Bogost, The Rhetoric or Video Games, 2008). To this end, his website is full of games titles like *Fatworld*, *Airport Insecurity* (discontinued), and *The Howard Dean for Iowa Game.* In *Fatworld,* players look to rule an empire of restaurants and convenience stores but are then faced with how their decisions lead to diabetes, heart disease and death. In *Airport Insecurity*, players act as airport security agents trying to block prohibited items in the scope of continuously changing rules. In the *Howard Dean for Iowa Game*, players try to win an election by generating grassroots support for Howard Dean. The procedural rhetoric here is that Howard Dean can win, and it is up to you as a supporter to make that happen. As token examples of the using video games to promote a viewpoint, these games deliver very diverse messages and examples of how video games can be tied to a much larger social conscience.

However, it is the use of persuasive games as propaganda games that the lines between game, reality, and political puppeteering becomes blurred. Bogost gives an excellent review of five games; *America's Army, A Force More Powerful, Antiwargame, Kabul Kaboom, and New York Defender* who's political and ideological messages are so strong that they could easily be considered propaganda games. Of these five, *America's Army* and *A Force More Powerful* stand out because of their diametrically opposed messages and fundamentally American bias'. *America's Army* is a recruitment and training game that teaches to fight battles like US soldiers — following American rules of engagement and fighting without conscience or consideration of why the opponent exists. In Contrast, the political agenda in *A Force More Powerful* is to promote western style non-violent democratic revolution by encouraging players to overthrow the current despotic government through recruitment, coalitions, and non-violent resistance. Yet as Bogost points out, the failing of this game is that the social and economic model is based on the United States and procedurally modelled as working everywhere.[40]

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[40] The astute reader of these cases will also notice that all the games presented, have a distinctly pro or anti America bias. However Bogost uses the terms "Western leaders" and "pro-Western politics" to generalize the message

A more contemporary example of using games to promote a political and ideological message is the app *Sesame Credit*. Developed by Ant Financial (an Alibaba affiliate), as part of China's push to develop a social credit system, this program uses financial transactions, purchases on Alibaba, and user activities to develop a social credit score which represents the person's adherence to social values and trustworthiness. But *Sesame Credit*[41] [42] [43] [44] also illustrates the pervasive and insidious nature in which persuasive games can be used to manipulate and govern populations.

Described as Orwellian in nature, *Sesame Credit* allows the Chinese government to monitor, assess, and make public a score to demonstrate how trustworthy and obedient a citizen you are. Sesame Credit tracks financial activities, purchases on Alibaba, user activities, and social networks. It already provides real-life rewards for compliance and allows users to report breaches of trust. While it is currently voluntary, the game will become mandatory in 2020. Yet

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without fair consideration of the differences between American, Canadian, European, and Australian cultures, attitudes, or games.

[41] Extra Credits, season 11, episode 19, *Propaganda Games: Sesame Credit — The True Danger of Gamification — Extra Credits*. https://www.youtube.com/watch?v=lHcTKWiZ8sI

[42] *I fixed my poor credit score by being a more loyal Alibaba consumer*, the article includes methods like using Alipay, an augmented-reality game, and a tipping service to increase social scores with the rewards for participation including waiving deposits for hotels and VIP status on dating sites. https://qz.com/1097766/i-fixed-my-poor-sesame-credit-score-by-being-a-more-loyal-user-of-alibabas-wallet-app-alipay-in-china/, accessed November 12, 2017.

[43] Financial Times, *China changes tack on 'social credit' scheme plan*. https://www.ft.com/content/f772a9ce-60c4-11e7-91a7-502f7ee26895, accessed November 12, 2017

[44] WIRED, *Big data meets Big Brother as China moves to rate its citizens*, http://www.wired.co.uk/article/chinese-government-social-credit-score-privacy-invasion, accessed November 12, 2017.

alarmingly, the system is being well received in China with early adopters happy to share their scores on dating sites and with news reporters.[45]

In her chapter *Counter-gamification: emerging tactics and practices against the rule of numbers* Daphne Dragona (Fuchs, Fizek, Ruffino, & Schrape, 2014, pp. 227-250) pulls back the veil on the exploitive use of gamification techniques to entice users to provide "post-demographic" information.[46] Through her lens, one can clearly see how organizations like Facebook, Google, Microsoft use gamification data (leaderboards, rewards, badges), gamified sites (Foursquare), geographic data and social networking services as gateways for collecting data on users. Data which they frequently exploit, sell to third parties, and use for targeted ads.[47] [48]

4.5 Games for Teaching Morality and Ethics

While the media tries to portray video games as promoting violence and anti-social behaviour, there is a growing body of academic research that shows video games as an effective venue for teaching ethics, pro-social behaviour, and collaboration. In his paper *What can we learn from violent videogames*, Van Eck (2015), challenges readers to consider the ethical players frequently make during video games, and how they contribute to meaningful and interesting play. He also

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[45] *China 'social credit': Beijing sets up huge system*, this BBC article details Sesame Credit, how it tracks financial activities, purchases, social networks. Currently voluntary, the system is being well received in China, and participants are happy to share their scores on dating sites and with news reporters. Although currently voluntary, the game will become mandatory in 2020,

[46] Post demographic information is data collected in social networking sites and is used to identify people by their tastes, purchasing histories, and other online behaviours.

[47] *Google broke Canada's privacy laws with targeted health ads, watchdog says*, Susan Krashinsky, The Globe and Mail, January 2014, https://www.theglobeandmail.com/technology/tech-news/google-broke-canadas-privacy-laws-with-targeted-ads-regulator-says/article16343346/. Accessed November 21, 2017.

[48] *How Facebook Uses Your Data to Target Ads, Even Offline*, Thorin Klosowski, Lifehacker, April 2013, https://lifehacker.com/5994380/how-facebook-uses-your-data-to-target-ads-even-offline. Accessed November 21, 2017.

encourages the reader to consider that if video games can promote negative behaviour, that the opposite must also be true. And while American main stream media suggests there is a correlation between gun violence and video game consumption, that relationship does not hold true in other countries and must be questioned.

In the article, *The banality of simulated evil: designing ethical gameplay*, Miguel Sicart (2009), analyzes ethical game design and how to use the incorporate ethics into the core of a video game. He suggests that the un-ethical view of games stems from their use of violence without consequence. The simulated banality of evil, lies in the idea that players are following the rules of the game. Rules that encourage killing people with a mouse click (action), picking up the dropped items (reward), while obscuring the consequences of those actions (social impact). Yet Sicart offers the counterpoint, that ethics can be designed into games, by encouraging players to see themselves as ethical agents (p. 199) and giving them the opportunity to impact and control the game through their ethical actions (agency).

Reflecting on these ideas from Van Eck and Sicart, it is easy for designers to create rules and mechanics that promote negative behaviour, but it is also possible to embed ethics and conflict in manners that encourage ethical play.

Karen Schrier (2015) at Marist College, studies using video games to teach ethics. In this work, she has developed the Ethics Practice and Implementation Categorization (EPIC) framework to help classify and incorporate games into ethics education. Framed against a backdrop of ethical education models including Kohlberg's Theory, Transformative model, and Fink's taxonomy. Schrier portrays ethical thinking as a set of skills and practices, comprising of reflection, information gathering, reasoning, and empathy that can be taught (pp. 394, 402).

4.6 Engineering Games

Several games have been created to teach engineering ethics (Dyrud, 2006; Lloyd & van de Poel, 2008; Alfred & Chung, 2011; Lau, Tan, & Goh, 2013) and sustainability ethics (Seager & Selinger, 2009; Sadowski, Spierre, Selinger, Seager, & Adams, 2015) with promising results. This section details three of these games; Thomas Seager's multi-player sustainability game called *Pisces*, Michael Alfred and Christopher Chung's *Simulator for Ethics Engineering*

Education by at the University of Houston, and the Lockheed-Martin's board game *The Ethics Challenge.*

Between 2009 and 2012, Thomas Seager, Evan Selinger and Braden Allenby developed "An Experiential Pedagogy for Sustainability Ethics" which is now known as the *Pisces* game.[49] This game is run as a moderated workshop with inter-university course modules across the United States and parts of Africa (Spierre Clark, et al., 2015; Spierre, et al., 2012). This game is significant because it works hard to address the wicked problems surrounding environmental sustainability using the tragedy of the commons model. In this game, individuals can experience how making decisions that are beneficial for their own survival can ultimately destroy the common good.

In papers surrounding the Pisces game, Seager argues the importance of sustainability and wicked problems as part of engineering training. Examining the professional practice expectations of both the National Society of Professional Engineers (NSPE)[50] [51] and Engineers Canada (2013) in light of these arguments reveals that while the concepts of engineering ethics and sustainability are listed separately and distinctly by these organizations, they are in fact complementary considerations within the engineering profession. In parallel with Seager's goals to educate students about the global and complicated challenges of sustainability, this game addresses the more mundane yet equally important day-to-day realities many engineers will face.

The *Simulator for Ethics Engineering Education* by Michael Alfred and Christopher Chung (2009; 2011) is another interactive approach to teaching ethics. In this simulator, students are

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[49] The *actionethics* website (https://actionethics.com/) provides quick promotional information about the Pisces game. However play requires registration with the Ethics CORE website: https://nationalethicscenter.org/members/1160. Accessed November 12, 2017.

[50] *National Society of Professional Engineers*, https://www.nspe.org/resources/issues-and-advocacy/take-action/position-statements/engineering-education-outcomes, November 12, 2017

[51] *National Society of Professional Engineers*, https://www.nspe.org/resources/ethics/code-ethics, November 12, 2017

presented with short cases and asked to identify the best solution (2009, p. 195). While the simulator appears to meet many instructional milestones including multiple modes of play and choices based on NSPE case data, an examination of the provided screenshots leaves the reader with the distinct impression that this is an interactive skin put upon a single right answer multiple choice test. From the information presented, one is left wondering about the player's ability to take action (efficacy) and their ability to affect the simulators outcome (agency).

The final example is Lockheed Martin's board game *The Ethics Challenge*, also known as the Dilbert Game. In this board game, players move Dilbert characters around the board answering ethics questions in order to score points. From the descriptions presented by Dyrud (2006) and Bekir (2001), the most compelling aspect of this game is the collaborative nature of the play; teams work together to evaluate information, identify relevant ethical values, consider the effects on stakeholders, and determine the best course of action. Unfortunately, like the SEEE simulator, the case card used during play reduce player discussion down to multiple choice answers with a single right answer (Dyrud, 2006, p. 7).

These games provide inspiration and validation that teaching engineering ethics using a game is possible and worthwhile. Each one represents a different solution to the problem of engaging students while raising their ethical awareness. However, each is developed for its own purposes and would likely need significant adaptation to reflect the social, cultural, and regulatory environment in Canada.

4.7 Rebuttals of Digital Game-Based Learning

A significant criticism of serious games is the lack of rigorous scientific study (Westera, 2015; All, Nuñez Castellar, & Van Looy, 2014; Hays, 2005). Westra counters the claims about digital game-based learning (DGBL) by stating that the rigorously controlled scientific study seen in other areas of research just isn't there. "The enthusiasm of these scholars is contagious, but it may readily conflict with academic standards of objectivity and critical analysis when it comes to making claims." (Westera, 2015). Hays reaches a similar conclusion in his 2005 technical report to the Naval Air Warfare Center. "There is no evidence to indicate that games are the preferred instructional method in all situations." (Hays, 2005, p. 53). "Instructor-less approaches (e.g.,

web-based instruction) must include all "instructor functions." These include performance evaluation, debriefing, and feedback." (Hays, 2005, p. 53).

However, Richard Van Eck (2015) points out that over the last ten years, detailed and analytic research of DGBL has been conducted. This statement is based on an exhaustive meta-analysis of digital game-based learning was done by SRI in 2012[52] which found 77 articles out of 61,877 having clear evidence-based research targeting K-12 students, consisting of pre and post testing as part of the evaluation (Clark, Tanner-Smith, & Killingsworth, 2014). Based on these results, Van Eck claims "that learners in game-based instruction performed 0.33 standard deviations (as much as one full letter grade) better when compared with learners in non-game-based instruction in general." (Van Eck, 2015, p. 16).

4.8 Summary

This chapter looked at the defining trait of games, how the criteria for voluntary play is optional. It also looked at how games can be used and abused to influence the opinions of others either through procedural rhetoric or data mining. Finally, it looked at criticism representative of the arguments against video game based learning.

In summary, three points to remember are:

- Designing a video game based learning environment is a complicated and challenging process. Instructional design and game design principles must be balanced and integrated throughout the design. Success is not guaranteed.
- Goals and rules are the only two elements consistently found in the definition of games. Additional elements such as fun, voluntary play, purposeful interaction, and feedback, frequently appear but are not required.

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[52] SRI International research publication, *Digital Games for Learning: A Systematic Review and Meta-Analysis*, sponsored by the Bill & Melinda Gates Foundation. https://www.sri.com/work/publications/digital-games-design-and-learning-systematic-review-and-meta-analysis-executive-su, accessed Feb 1, 2017

- Games and social apps have the power to influence players, but that power can be easily used and abused by companies and corporations involved.

5 Gamification

Gamification is about using game elements, game mechanics, and game design strategies in non-game contexts, most typically to make activities more interesting, compelling, and engaging.[53] [54] This topic is included in this research to because game mechanics like challenge-achievement-reward loops, points, and reward variability are commonly found in both games and gamified systems. These mechanics were considered in during the design phase and influenced the game's design.

In a positive way, gamification techniques can be applied in business to build customer loyalty, motivate employees, or just relieve tedium in the workplace (Reiners & Wood, 2015; Association for Project Management, 2014; Zichermann & Cunningham, 2011). This is because, gamification is about the strategic use of psychology to create a physiological pleasure response. Through the application of uncertainty, anticipation, and variable rewards. Using a "challenge-achievement-reward loop" the production of the neurotransmitter dopamine is triggered, which results in feelings of pleasure and achievement (Zichermann & Cunningham, 2011, p. 4).[55]

However, the use of these psychological techniques in such an exploitive manner is seen as diminishing and undermining the field of video game design. In his paper *Gamification is Bullshit* [56] and follow-up book chapter *Why Gamification is Bullshit* (Walz & Detarding, 2014), Ian Bogost takes aim at Zichermann and gamification in general by recasting the word

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[53] The "Introduction to Gamification" whitepaper by the Association of Project Management has a nice overview of the subject. Particularly how gamification can be used to motivate teams. https://www.apm.org.uk/sites/default/files/gamification%20-%20epdf.pdf, accessed Dec 25, 2016

[54] The book *Irresistible Apps* by Chris Lewis, identifies 27 different patterns used in game design to motivate and captivate users.

[55] The most powerful rewards are ones whose value cannot easily be determined, such as status, access, and power.

[56] *Gamification is Bullshit*, Ian Bogust, http://bogost.com/writing/blog/gamification_is_bullshit/, paper presented at: For the Win, Serious Gamification, Augut 2011, accessed December 16, 2017.

gamification as a consulting industry fad aimed at using the attractive elements of games as a one size fits all model through which business can exploit and entrap users, corrupting and undermining the value and merit of video games in the process.

Yet between these two polar positions, lies a useful middle ground. While gamification techniques are effective, they can often feel hollow, manufactured, or lacking inventiveness that makes games interesting. In the chapter *Why Fun Matters: in Search of Emergent Playful Experiences* Sonia Fizek (Rethinking Gamification, 2014, pp. 273-288) warns game developers to avoid being sucked in by the hype around gamification. Instead, she encourages game developers to reflect on the elements of fun and to go beyond point-based competitions in their creations.

Likewise, Sebastian Deterding's *Eudaimonic Design, or: Six Invitations to Rethink Gamification,* (Fuchs, Fizek, Ruffino, & Schrape, 2014, pp. 305-331) encourages readers to consider the people playing games and the context in which they are playing. They encourage designers to use the ludic[57] — goal focused, rule-bound, regulatory nature of games as tactics, while focusing on the paidia — playful, exploratory, and free-form aspects of play as the strategy. (Fuchs, Fizek, Ruffino, & Schrape, 2014, p. 314)

Gamifying a course, website, or project to include user interactions, uncertainty, and rewards does not make it a game. As Fizek and Detarding point out, the reason lies in the motivational aspects of games. In games, players internally determine their own goals and actions within the rules and mechanics of the game, whereas with gamification the goals are external and for the benefit of the organization sponsoring the content.

This distinction is important because gamification techniques work and are part of the milieu of game design. However, this thesis is more than a cookie cutter gamified system — it is a unique

[57] Paidia and Ludus as explained in *Gaming Conceptz*, http://gamingconceptz.blogspot.ca/2012/12/paidia-ludus.html, accessed Feb 6, 2018.

design, built around the concepts of teaching ethics, providing players with choice, and providing immediate feedback.

In summary, gamification was used as a starting point to understand compelling game mechanics. However, the term gamification is mired in academic debates, over how it used and manipulated as a marketing ploy. The more balanced opinions of Fuchs et al, point to the concept that these mechanics are common elements in games, but that play, fun, and internal goals are more important drivers for video games. Game design is about much more than implementing a few plug-and-play mechanics. It is about creating an immersive environment in which captures the imagination and interest of players.

6 Engineering Ethics

This chapter addresses the questions: (1) why do we teach engineering ethics, (2) what is meant by Canadian engineering ethics, and (3) what are the best teaching practices.

When presented with engineering problems in class, many engineering students do not recognize them as ethical problems. Rather they focus on creating a technical fix, thereby sidestepping the conflict (Lynch & Kline, 2000, pp. 213-214). To be effective, ethics education needs to get students recognizing the problems, considering the solutions, and becoming emotionally committed to pursuing the right course of action.

"A course in ethics can be nothing other than an abstract intellectual exercise, unless a student's feelings and imagination are stimulated." (Callahan & Bok, 1980, p. 65)

Given this statement, it is useful to understand the purpose and underlying goals of teaching engineering ethics. David Callahan's, founder of the Hastings Center outlined the five purposes of ethics education in the book *Ethics Teaching in Higher Education* (Callahan & Bok, 1980). These purposes focus on developing the awareness, skills, and fortitude required for dealing with ethical issues and are an excellent starting location for creating an ethics learning experience.

In Canada, professions fall under provincial jurisdiction, each province and territory govern the professions within, and each possesses slightly different acts, by-laws, regulations, code of ethics, and disciplinary procedures. The engineering associations in each province are responsible for the regulation of engineers within their province and with the exception of Quebec are self-governing.

In order to consider engineering ethics on a national level, the Engineers Canada *National Guideline on the code of ethics* (Engineers Canada, 2016) was used as a reference. While Engineers Canada is not a regulatory body and the guideline is not a binding document — Engineers Canada is the group through which the provincial regulatory bodies coordinate and advocate for the engineering profession in Canada. The guideline is a reference document whose purpose is to create consistency between the provinces.

Finally, typical engineering ethics instruction involves memorization of the relevant codes of ethics and passing judgement on isolated-single question cases. A better method is to use authentic, multi-faceted case studies, which engage the student as a protagonist within an ethical conflict.

As a whole, this chapter considers the ethical foundations upon which the learning environment is being created. It focuses on the purpose of ethics education, the unique aspects of Canadian practice, and the best methods for engaging student minds and teaching engineering ethics.

6.1 The Purpose of Ethics Education

Ethicist David Callahan (Callahan & Bok, 1980, pp. 64 - 67) identified that for ethics education to be useful, students need to become: (1) engaged with the moral issues, (2) able to recognize them in practice, (3) inspired to take action, (4) understand the consequences of what they are doing, and (5) appreciate that there are multiple viewpoints and solutions to the same problem.

Commonly, these five purposes are phrased as:

- Stimulating moral imagination.
- Recognizing ethical issues.
- Eliciting a sense of moral obligation.
- Developing analytical skills.
- Tolerating and reducing disagreement and ambiguity.

These purposes[58] are widely recognized within the academic community and frequently appear in engineering ethics research. Contemporary research papers by (Aközer & Aközer, 2017; Li & Fu, 2010; Hollander & Arenberg, 2009; Harris, Pritchard, & Rabins, 2005; Huff & Frey, 2005;

[58] These criteria are alternatively cited as coming from Michael Davis or James Rest. Michael Davis is contemporya author in engineering ethics education field. James Rest was active at the same time as Callahan and published the Four Component Model which highlights moral sensitivity, moral judgment, moral motivation, and moral character as the key elements of ethics education.

Muskavitch, 2005; Dyrud, Cases for Teaching Engineering Ethics, 2004; Harris, Davis, Pritchard, & Rabins, 1996) all validate the enduring nature of these purposes.

6.1.1 Moral Imagination

Stimulating moral imagination is the foundation of ethics education because it focuses on sparking interest, awareness, and thought on the ethics and morality of one's actions. It acknowledges the importance of getting people to pause, and reflect on the consequence of their action. In order for students to develop the intellectual, social and emotional resources they need to resolve ethical problems, they need to be put in active roles which develop their skills in life-like situations (Hollander & Arenberg, 2009, p. 26). Furthermore, even though the students are online, they need to be able to share their ideas with others and encouraged to seek out new resources to support their learning.

Video games can easily spark a player's moral imagination by making them protagonists in an ethical conflict and empowering them to take action. This empowerment allows players to take meaningful action, become emotionally invested in the outcome and get excited to see the consequence of their actions. The problem is that depending on how the situation is presented, players may not recognize or consider the issues and consequences that result from their actions.

In her chapter on using games to teach ethics to school children, Karen Schrier shows how games are an excellent way to engage a student’s (player's) moral imagination by offering them the chance to take on new identities and experience the consequences of their decisions (2014, p. 143). For example, the well-known game series Fallout allows players to become a post-apocalyptic survivor, struggling to survive and thrive. The ethical decisions about wasteland justice, whom to kill, and which quests to take offers players a rich environment full of opportunities to build and affect their character’s karma in many moral and immoral ways.

6.1.2 Recognizing Moral Issues

Students and players need the game's context to be personally meaningful and authentic (Schrier, 2014, p. 153). However, most ethics teaching is disconnected from professional practice because the "hypothetical cases" used to teach ethics "focus typically on the actions of an individual"

ignoring factors like "workplace routines … related decisions, resources available … or other agents facing similar issues." (Lynch & Kline, 2000, p. 198).

So in order to go beyond just a moral imagination, students should be taught how to recognize ethically challenging situations. A research bias presented in section 1.11 was the incorporation of conflict with managers and corporate executive. This bias was inspired by the conflicts between engineers, managers, and lawyers seen in the book *Inviting Disaster* (Chiles, 2001), the article *Interest, Professional Bargains: Ethical Conflicts Between Lawyers and Professional Engineers* (Hubertz, 2009), and the news articles surrounding the Elliot Lake inquiry (Bélanger, 2014). In all of these sources, the motivations of non-engineers were at odds with ethical engineering practice.

Ethically challenging situations are also present in academic institutions where graduate students will often go along with the established research practices of their advisors without question and without considering the ethical implications of what they are doing unless purposely encouraged to do so (Hollander & Arenberg, 2009).

By presenting players with conflicts and challenges which force them to recognize the positions of others and build consensus, they can grow and develop their ability to recognize moral and ethical issues before they become disastrous problems.

6.1.3 Willingness to Take Action

This purpose is the most interesting because the willingness to act comes from a sense of support, fortitude, and conviction. While spurring the imagination of students and teaching them to recognize the underlying ethical problems is useful — convincing them to take action is a much more difficult challenge. The motivation to take action is tied to one's sense of being a professional who is responsible for the safety of others, and one's sense of being capable of effecting change by choosing the right course of action (Hashemian & Loui, 2010, p. 211; Huff & Frey, 2005, pp. 391-392).

Three enablers of being willing or unwilling to take action are prior experience in a similar situation, understanding of the consequences, and comfort with the personal risks involved. Thus, the underlying goal of this game is to allow players to take action, and experience the

consequences in a safe environment. That way when similar situations appear in the real world, they have a sense of what actions they can take, and the consequences thereof.

6.1.4 Analyze the Outcome

Student's need to become interested and involved in the moral and ethical discussion, however, the imagination and emotions aroused by compelling stories and tragedies must also be tempered with cognitive and reflective thinking. Our feelings may deliver the moral message about what is right and what is wrong, but students must be able to differentiate "between what they *feel* is right or good, and what *is* right or good." (Callahan & Bok, 1980, p. 65).

For example, while watching a movie like *Batman,* it is easy to get caught up in the action, empathize with the characters, and want to become a vigilante. Yet in reality, Batman's behaviour is often destructive, works against the common good, and is rich with unforeseen consequences.

The challenge is to get students thinking about the broader implications of their actions and considering what is right and what is wrong. Ideally, they should be able to use their analytical skills to consider and predict the outcome and unintended consequences that may result. Caroline Whitbeck (1995) suggests that engineering design and ethical problem solving are strongly connected through four features; (1) there is rarely a unique correct solution; (2) there are definitely wrong answers, (3) the solutions will have different advantages, and (4) the solution must meet all the constraints of performance, specification, and human rights, without introducing new problems. Thus engineers can be encouraged to consider and analyze the outcome of their decisions in a structured and meaningful way.

Ethicists Huff and Bird reinforce this parallel between design and ethics by breaking the skills required for ethical problem solving into questions typical engineering terms like problem definition, stakeholder analysis, and action planning. The nine skills they advocate for are: (Hollander & Arenberg, 2009, pp. 12-13) are:

- Recognizing and defining ethical issues
- Identifying socio-technical systems and stakeholders
- Collecting data about the system and its stakeholders

- Understanding stakeholder perspectives
- Identifying value conflicts
- Identifying constraints and constructing alternative solutions
- Assessing the consequences of alternatives
- Engaging in reasoned dialogue
- Revising options, plans, or actions.

Just like performing technical design, engineers have a responsibility to collect information about the stakeholders, understand their values and perspectives, so that they can fully understand and assess the ethical consequences of their decisions.

Although the parallel between design and ethics may seem tenuous, it is useful to frame ethical problems in such a manner that engineers perceive them as valid constraints to the technical problems they are solving. Engineering is not value-neutral, it is by definition, about creating change in the environment in a manner that reflects the needs, values, and motivations of society. Design decisions can often have unintended consequences such as environmental impact, waste, or even widespread social change. Automobiles, batteries, and computers are all engineered objects with far-reaching consequences.

6.1.5 Tolerating Ambiguity

Students must learn to tolerate and reduce the moral ambiguity that often exists in ethics problems. Like many design problems, multiple factors, criteria, and solutions exist, often resulting in very different and possibly conflicting ways. For example, from an ethics perspective, is it better to follow a utilitarian, deontological, or virtue ethics when solving a problem?

The goal orientated problem-solving methods frequently taught in engineering suggest the utilitarian response, while the duties of an engineer to protect the public interest and the profession as a whole lead to a deontological response. Moreover, consistently following a virtue ethic may lead an engineer to become blackballed by companies looking to maximize their profits.

Engineers are often tasked with determining which means to an end is the best solution. Is it better to cut costs by designing highway turns for certain speeds knowing that some people may lose control or exceed the speed limit, or do we increase design costs and lower the risks to drivers? Utilitarian ethics teaches engineers to evaluate the greatest good for the greatest amount of happiness — typically thought of as a cost vs. benefit analysis. Kantian ethics, on the other hand, focuses on the engineer's duties — duties to protect the public, be competent in their area of practice, and be faithful to their employers. However, both models are typically taught at an introductory level, positioning them as caricatures (Rieder, 2008; Davis, 1999, p. 166) ready to be challenged.

Since the theories are simplified, they are easy to challenge and skew. In the case of Utilitarian ethics, a student could rightfully ask, whose happiness is most important, how is the greatest good evaluated? The answer from an engineering point of view often comes down to a cost-benefit analysis. For example, decisions around the gas tank in the Ford Pinto[59] were driven by Utilitarian ethics when demonstrating that was more beneficial to society (cost effective) to let people get hurt than it was to make the gas tank safer.

Similarly, with Kantian ethics, a student could ask which duties are more important than others. Given that the Kantian ethics are rules that you want everyone to follow, are there cases where following the rules unilaterally creates more harm than good?

In engineering, Kantian ethics form the basis of many codes of ethics — they at their core, the expectations and obligations that engineers expect of each other. The problem is that the practitioner is left to deal with conflicts between the other obligations. How for example should an engineer balance the requirement to be a faithful agent for his or her clients and employers against the need to conduct himself or herself with integrity, equity, and fairness?

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[59] For those unaware of the circumstances surrounding the Ford Pinto, the Case Study: The Ford Pinto by Michael Hoffman (9182) can serve as a nice introduction.
https://businessethics.qwriting.qc.cuny.edu/files/2012/01/HoffmanPinto.pdf, last viewed Sept 9, 2017.

Michael Davis (1999, pp. 166-168) offers a counter-argument by pointing out that there are four good reasons to avoid using moral theories in teaching engineering ethics.

- The theories are taught in a simplified form which makes them suspect (p. 166).
- Ethical theories are not required for good decision making. Teaching ethics requires common sense and a framework for orderly discussion (p. 166).
- Ethical theories are used to classify the thinking used. In practice when people are making decisions, they do not focus on one mode of thinking or another (p. 167).

Interestingly, while teaching engineering ethics courses, Michael Davis (1999, p. 168) observed that getting agreement on a course of action was often easier than getting agreement on which moral theory should be used. A good way to reduce moral ambiguity is by identifying solutions that are in agreement with multiple ethical models. Ideally, by creating cost-effective solutions, acting in the public interest (virtue), maximizing the social good (Utilitarian) — all while looking out for the best interest of their employer (Deontological).

6.1.6 Interpretation

Ethics education needs to highlight that ambiguity, differences of opinion on the facts and conflicting desired outcomes are all normal. Often engineers are expected to balance their duties (Kantian ethics) with finding the best solution (Utilitarian ethics) to a problem which has conflicting constraints and diverging solutions. It is not unreasonable for an engineer to encounter situations in which the expectations of co-workers, family, and employers are at odds with each other and limit the engineer's ethical choices (Porra, 2004, p. 362).

Perhaps then, the most valuable aspect of ethics education is to remind engineers that design is a human endeavour, fraught with conflicting intentions, implied meaning, and subjective evaluations of success.

6.2 Defining Engineering Ethics in Canada

To define engineering ethics in Canada, this thesis will consider three things: (1) how engineering ethics fits within the ethics continuum, (2) what is meant by Canadian engineering ethics, and (3) the differences between Canadian practice and American practice.

6.2.1 Engineering Ethics as Part of the Ethics Continuum

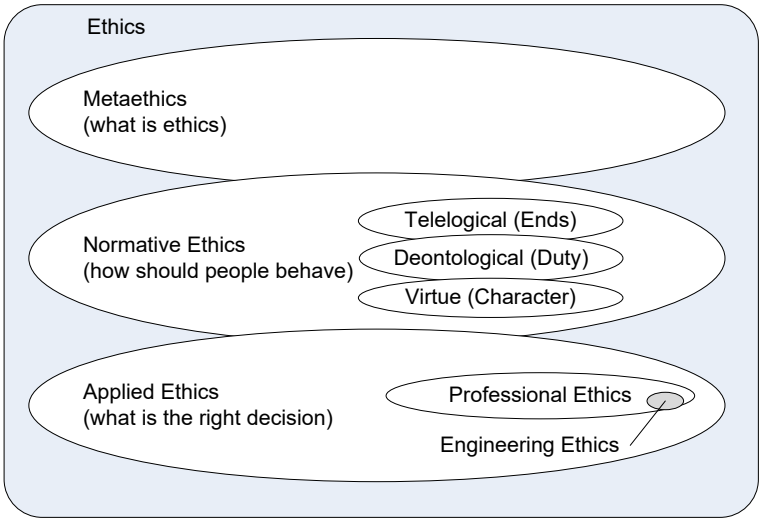

Figure 3: A Breakdown of Ethics Specializations

The field of ethics is broken into three major areas; metaethics, normative ethics, and applied ethics (Figure 3).[60] Metaethics is concerned with what ethics is and how it should be studied. Normative ethics looks at how society evaluates what is right and wrong. Applied ethics focuses on making decisions and choosing the right course of action without knowledge of the consequences. As part of applied ethics, engineering ethics is one of the professional ethics that focuses on decision making as it applies to the needs of a specific profession or group. The difference of importance here is that while Metaethics and Normative ethics are reflective in nature and used to understand decisions that have been made, applied ethics is about solving problems whose outcome has yet to be determined.

[60] The Internet Encyclopedia of Philosophy, http://www.iep.utm.edu/ethics/, accessed June 7, 2017

6.2.2 Canadian Practice

Most of the academic research in this paper comes from the United States. However, this project deals with the Canadian legal and ethical environment. As such, Canadian sources on professional practice, accreditation, and association governance were consulted. These sources included information on the *National Professional Practice Exam*[61] and Ontario *Professional Practice Exam*[62], the *National Guideline on the code of ethics* (Engineers Canada, 2016), the 2012 *Accreditation Criteria and Procedures* (Canadian Engineering Accreditation Board, 2012). Additional sources of information were meetings with current staff and past executive members Engineers Geoscientists Manitoba along with Professional Engineers and Engineering Interns who reviewed and commented on the validity of the game created.

An important difference between Canada and the United States is the requirement for registration with the provincial regulator to practice or teach professional engineering. The provincial regulators exist to protect the public interest by ensuring their members (legally practicing engineers) demonstrate technical competence, are current in their methods of practice and act in an ethical manner. Failure to do any of the above can result in suspension, limited ability to practice, or a requirement for additional training.

Like the state boards, the provincial Engineering Associations (regulators) were created by acts of the legislature within each province. Their acts, bylaws, and codes of ethics are legally

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[61] Syllabus for the National Professional Practice Exam, https://www.apega.ca/apply/exams/nppe/syllabus/, accessed December 29, 2016.

[62] PEO website providing details on their Professional Practice Exam, http://www.peo.on.ca/index.php?ci_id=2060&la_id=1, accessed December 29, 2016.

binding and control the environment in which all Professional Engineer practice, no industrial exemptions, title acts or title authorities exist.[63] [64]

Finally, disciplinary action by the association is covered under the laws and statutes of the jurisdiction and subject to a formal appeal process. Appeals are first reviewed by the association level for consistency with other disciplinary actions and can be appealed through the courts (Roncin, Britton, & Koropatnick, 2017).

6.2.3 Engineering Ethics and Regulation in Canada

In this thesis, the Engineers Canada *National Guideline on the code of ethics* (Engineers Canada, 2016) is used as a base for engineering ethics in Canada. Even though Engineers Canada does not enforce this code of ethics, its members are the engineering regulators in Canada, and this document was created to serve as a shared guideline between them. It represents the common ethical expectations of all the engineering regulators in Canada. Upon examination, the first three tenets of this guideline are serving the public interest, being technically qualified, and acting as "faithful agents" to employers.

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[63] Background paper for senate on the The Board for Professional Engineers, Land Surveeyors, and Geologists in California. http://www.bpelsg.ca.gov/pubs/2014-15_sunset_background_paper.pdf, last accessed April 5, 2018.

[64] Licensure exemptions are discussed on slides 13 and 14 of this 2012 National Council of Examiners for Engineering and Surveying (NCEES) presentation. http://www.aaes.org/sites/default/files/2012_NAE_Convocation_licensing_overview.pdf, last accessed April 5, 2018.

Table 3: Engineers Canada, National Guideline on the Code of Ethics

National Guideline on the code of ethics (Engineers Canada, 2016) [Reprinted with permission of Engineers Canada] [65]	
1	Hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace.
2	Offer services, advise on or undertake engineering assignments only in areas of their competence and practise in a careful and diligent manner and in compliance with applicable legislation.
3	Act as faithful agents of their clients or employers, maintain confidentiality and avoid conflicts of interest, but, where such conflict arises, fully disclose the circumstances without delay to the employer or client.
4	Keep themselves informed in order to maintain their competence and strive to advance the body of knowledge within which they practise.
5	Conduct themselves with integrity, equity, fairness, courtesy and good faith towards clients, colleagues and others, give credit where it is due, and accept, as well as give, honest and fair professional criticism.
6	Present clearly to employers and clients the possible consequences if engineering decisions or judgments are overruled or disregarded.
7	Report to their regulator other appropriate agencies any illegal or unethical engineering decisions or practices by registrants or others.
8	Be aware of, and ensure that clients and employers are made aware of, societal and environmental consequences of actions or projects and endeavour to interpret engineering issues to the public in an objective and truthful manner.
9	Treat equitably and promote the equitable and dignified treatment of people in accordance with human rights legislation.
10	Uphold and enhance the honour and dignity of the profession.

In Manitoba, the Engineering and Geoscientific Professions Act defines unskilled practice and professional misconduct subject to discipline. These laws govern the practice of engineering and are enforced by Engineers and Geoscientists Manitoba.

[65] This link may not be directly accessible but the document can be found by searching the Engineers Canada website for "guideline on the code of ethics". https://www.engineerscanada.ca/publications/national-guideline-on-the-code-of-ethics, accessed September 19, 2016.

Table 4: Section 46 of The Engineering And Geoscientific Professions Act Of Manitoba

Unskilled practice or professional misconduct[66] [Reprinted with Permission, Copyright Office Government of Manitoba]
46(1) Conduct of an investigated person that in the opinion of the panel (a) is detrimental to the public interest; (b) is conduct unbecoming a professional engineer or professional geoscientist; (c) is misconduct in the practice of professional engineering or professional geoscience; (d) contravenes this Act or the by-laws or the code of ethics adopted under section 11; (e) displays a lack of knowledge of or lack of skill or judgment in the practice of professional engineering or professional geoscience; or (f) demonstrates incapacity or unfitness to practise professional engineering or professional geoscience or demonstrates that the person is suffering from an ailment that might, if the person is allowed to continue to practise professional engineering or professional geoscience, constitute a danger to the public; constitutes either unskilled practice of professional engineering or professional geoscience or professional misconduct, or both, as the panel finds.

6.2.4 Alternative Definitions of Engineering Ethics

There are other definitions of engineering ethics found in academic literature from the United States. Unlike the *National Guideline on the code of ethics,* these academic definitions focus on the ethics of engineering and the artifacts created.

[66] The Government of Manitoba Engineering and Geoscientific Professions Act, http://web2.gov.mb.ca/laws/statutes/ccsm/e120e.php#46, accessed December 25, 2016. Used with permission.

> By “professional ethics” … we refer to those special morally permissible standards of conduct that, ideally, every member of a profession wants every other member to follow, even if that would mean having to do the same." (Harris, Davis, Pritchard, & Rabins, 1996) [Reprinted with permission of John Wiley and Sons]

> A key concept in engineering ethics is the notion of ‘professional responsibility’, which many ethicists characterize as a type of moral responsibility arising from special knowledge possessed by an individual. (Herkert, 2000, p. 304)
> [Reprinted with permission of Taylor & Francis]

> By ‘‘ethics’’ we mean those special (morally permissible) standards of conduct that apply to members of a group just because they are members of that group. A profession’s ethics are standards that apply to members of that profession just because they are members. Like the profession’s technical standards, of which they are in fact the most general part, they are an achievement of the profession, part of what makes a member of the profession something more than a mere individual expert. They help to standardize the work of the profession. (Davis & Keefer, 2011, p. 2) [Reprinted with permission of Springer]

6.2.5 First Principles

Looking back at the Engineers Canada National Guideline and the Manitoba Act, one can see that engineering is based on technical skill and trust — trust by the public and our fellow members that we will honestly represent our skills and faithfully protect them. As members of the public, we expect engineers to keep us safe, create products that work, and minimize the unintended consequences of their designs. As members of the profession, engineers expect each other to be accurate in their reports, provide objective analysis, and be skilled in their assessments.

Engineering is not without risk. Rather, it is about understanding, managing, and mitigating risk. Engineers should know that during design products can fail, compromises must be made, and assessments of the risks and benefits of the design decisions must be conducted. The

engineering side of design is about applying engineering science to minimize risks, provide reliable products, and reduce the impact of outside forces.

While solving problems, design products, and performing technical calculations are essential elements of engineering practice, they are not the entirety of being a professional engineer. While engineering has many classes in engineering science, very few exist to teach early-career engineers to be trustworthy, ethical, and accountable valued members of the engineering profession. Furthermore, these attributes are not rules to be remembered but aspects that need to be internalized and demonstrated through action.

Table 5: Dimensions of Professional Engineering Practice

Dimensions to be internalized	Guidelines	Descriptor
The trust of the public	1, 6, 8	Trust
A good reputation among one's peers	3, 5, 10	Reputation
The ability to manage risk	1, 6, 8	Risk
Following the provincial code of conduct and best practices of the engineering profession	5, 7, 8	Code
Demonstrating technical competence	2, 4, 6	Competence
Demonstrating fairness and being forthright with clients and co-workers	3, 5, 9	Fairness

6.3 Engineering Ethics Teaching

As much as the debate about what engineering ethics is, the debate about how it is taught is also ongoing. On one side are schools that offload the material as a service course in other departments, while on the other side are schools which create an ethics spine in their teaching revisiting it frequently throughout their courses. Overall, the message in this debate is the same one found at the beginning of this chapter — the more students engage with the material, see it as part of engineering and become accustomed to making ethical decisions, the better.

As part of the social complexities of engineering practice, Seager and Selinger (2009) suggest that (1) engineering students often perceive ethics as being at the periphery of their profession and at odds with what engineering is supposed to be, (2) engineers are inculcated to solve tame problems, (3) there is a need to teach students to collaborate with stakeholders, and understand the limitations of their own habitual ways of framing problems. They further state that "the

simplistic, rules-based approaches that have dominated the development of professional ethics … are significantly challenged by problems of sustainability, where scale, complexity and equity considerations are of extraordinary importance." (Seager & Selinger, 2009, p. 1)

Seager and Selinger articulate a real problem within the engineering profession. The training is not authentic; it does not represent the complexities of real-world practice. In order for it to do so, students need to see themselves as practitioners being challenged to solve ethical dilemmas in a way that requires them to understand and collaborate with others.

This section looks at the best practices for teaching ethics from the perspective of engineering academics teaching in a classroom environment and addresses both the style and content of an engineering ethics course. Overwhelmingly, the message is to make engineering ethics an authentic experience that focuses on recognizing and resolving problems rather than memorizing a set of professional codes. The one caveat that is important here is that in Canada, during the professional practice test, engineers are expected to be able to recognize the sources of conflict and cite the specific codes and cannons that are being violated.

Starting from this perspective of knowing what students must know, the two most common methods of teaching engineering ethics are (1) studying engineering codes and canons and (2) evaluating Utilitarian and Deontological[67] models (Hamad, Hasanain, Abdulwahed, & Al-Ammari, 2013; Li & Fu, 2010; Seager & Selinger, 2009; Bucciarelli, 2008).

6.3.1 Contextual

Asking students to memorize and recite a list of professional codes and obligations is the worst way of teaching ethics (Davis & Keefer, 2011). They find it lacking context, and ineffective in helping them recognize and resolve conflicts when the need arises. It is training the students won't be able to use in practice. A better way is to present interesting problems, allowing

[67] Normative ethics is the study how society determines right and wrong conduct. http://www.iep.utm.edu/ethics/ The Utilitarian and Deontological theories are the two theories most commonly discussed in engineering, Utilitarian because it is essentially a cost benefit analysis and Deontological because it speaks to the duties of engineers. Accessed July 7, 2017

students to explore the relevant literature and discuss alternatives to the problems (Davis & Keefer, 2011, p. 5).

The context of engineering practice is important because students question the value of ethics education and need to see it closely connected to engineering practice. Simplistic ethical problems do not represent engineering practice. To be more meaningful, the teaching of engineering ethics should better represent real practice (Conlon & Zandvoort, 2011; Bucciarelli, 2008; Porra, 2004; Augustine, 2002; Lynch & Kline, 2000; Harris, Davis, Pritchard, & Rabins, 1996).

Veikko Porra (2004) describes this real-world practice as one where engineers are largely cogs in a broader system. Seven aspects he cites are included here because they influence how the engineers, managers, and others in within the cases are portrayed.

- Engineers work in teams with colleagues and customers.
- Technology is controlled by the organization, not the engineer.
- Ideas come from developers, producers, and customers.
- Engineers may be involved in different phases and not know each other.
- Important decisions are not made by engineers.
- Ethical conflicts are resolved within the company.
- Products are in the market before all the effects become visible.

While creating authentic simulations of reality is ideal, it is not the best teaching practice. The work environments and organizational systems engineers will find themselves in are often complex, and incorrect mental models could easily be created. A better method is to create a simplified version of the world or fish-tank in which the players can more easily see the cause and effect of events. Once a good understanding of the cause and effect within the system is understood, complexity can be increased to encourage a depth of learning and mastery of the topic.

6.3.2 Authentic Ethical Problems

Davis and Keefer (2011) along with Bucciarelli (2008) expressly state that students should be exposed to authentic, ill-defined problems, rich with contextual information. A method they hope will better prepare the students for real-world practice.

> "One common mistake in designing an ethics curriculum is to think that the objective is to teach students ethical principles as such. The result is a direct presentation of standards or obligations. The thinking is something like, ‘‘We know we want them to be aware of their professional obligations, so why not start with those?’’ There are various instructional strategies and materials that fit this approach, most of which we would not recommend. **Least effective would be simply asking students to enumerate their professional obligations or to commit to memory important code provisions**. Somewhat more creative would be asking students to generate the provisions that could apply to selected problems or scenarios. These approaches are not likely to be successful. Students find such generative tasks both difficult and boring. **But more important, since the principles are not presented within a context in which they are solving practical problems, there is little chance that students will know what to do with them when they confront an actual problem**." (Davis & Keefer, 2011, p. 5) [With permission of Springer, emphasis added for clarity]

> While teaching the ‘fundamentals’ of science and mathematics, and the engineering sciences are necessary, **we must do so in more authentic contexts, that show how social and political interests contribute in important ways to the forms of technologies we produce.** We ought not as faculty imply as we do, that solving single answer problems or finding optimum designs alone, uncontaminated by the legitimate interests of others is what engineers do all of the time. This is irresponsible. (Bucciarelli, 2008, p. 147) [With permission of Taylor and Francis, emphasis added for clarity]

Lynch and Kline (2000, pp. 212-215), offer three specific suggestions on how these authentic environments can be incorporated

- Add elements about the corporate cultural found in real practice (p. 212).
- Reflect on the complexities of engineering practice rather than just focusing on value conflicts (p. 213).
- Consider how routines, policies, and procedures create ethical problems and have students justify the positions of each party involved (pp. 214-215).

In this way, students can be taught to look at the context of problems and see how their decisions and the decisions of the company will form the ethical environment in which people work.to

6.3.3 Case Studies

In order to get away from the memorization of codes and cannons, many instructors turn to case studies because they help students engage with the material by challenging students to engage in constructive analysis, anticipate alternatives and consider the consequences (Li & Fu, 2010; Huff & Frey, 2005, pp. 398-399; Harris, Pritchard, & Rabins, 2005, p. 19; Dyrud, 2004).

Beyond creating a more engaging environment, case studies allow instructors to create a learning environment in which higher stages of thinking can be modelled (Long, 2001, p. 60) and where students can test and evaluate their opinions against their peer group (Huff & Frey, 2005, p. 399; Lynch & Kline, 2000, p. 214).

When creating case studies, it is recognized that students need to see both ethical misconduct and ethical fortitude. Focusing on disaster and unethical behaviour send's the wrong message, causing students to disassociate from the learning because they perceive these case studies as outliers, things that happen to other people and not representative of the day-to-day realities of their own lives (Seager & Selinger, 2009; Huff & Frey, 2005, p. 401; Davis, 1999, p. 155; Harris, Davis, Pritchard, & Rabins, 1996). By having balance between cases of good and bad behaviour, allows students to see that day to day design decisions are part of the ethical practice of engineers and help the students recognize ethical problems in situations that they might otherwise perceive as strictly technical problems (Harris, Pritchard, & Rabins, 2005, p. 19).

6.4 Summary

This chapter covered a wide range of topics within engineering ethics. It looked at why we teach; the obligations of Canadian Engineers, and the importance of authentic learning and case studies in engineering ethics education. Three points to remember are:

- Ethics education is about helping students understand, recognize, and solve ethical problems. Ethics teaching needs to focus on having students consider ethical problems, recognize the issues, analyze the possible outcomes, deal with the inherent ambiguity, and develop the fortitude to take action,
- In Canada, Engineers can lose their right to practice for violating the code of ethics of the engineering association of jurisdiction under which they operate. This is different from the United States where engineers can operate under industrial exemptions and codes of ethics are tied to voluntary organizations like NSPE, IEEE, ASME, and CSME.
- Memorization of codes, canons, and ethical models does little to help engineers solve real-world dilemmas. A better alternative is to use case studies which embody professional practice and provide students with the opportunity to make decisions, experience the consequences and justify their decisions to others.

7 Relevant Teaching Strategies

The instructional design of video games has the same challenge as teaching in a classroom. Knowledge is constructed in the minds of the student (constructivism) and demonstrated through their actions and behaviours (behaviourism). While video games are often compared to Skinner boxes, in which behaviour is controlled and modified through the use of rewards and punishment, this is not the desired model for this learning environment. The educational theory being applied in this thesis follows a constructivist model, in which learning is created and constructed based on the experiences of the learner. This bias is due to my experience as an instructor, the influence of CDIO on engineering teaching, and the goal of creating an experientially based learning game.

While instructional design is often challenging, video game design has an additional dimension that makes it even more so. Instructional designers of video games, only get to create the space in which learning occurs. They do not control the actions players choose to take.

In her book *Learning, Education and Games, volume one*[68], Karen Schrier (2014, pp. 141-158) addresses the topic of designing games to teach ethics. While the definition she uses of ethics are founded on social morality rather than engineering ethics, the challenges are similar. In chapter 8, she specifically addresses teaching ethics, recommending that instructional designers include consequences, authentic scenarios, and allowing players to form relationships with the characters (p. 153).

The challenge for the instructional designer is to balance learning objectives, with a game environment that engages players and results in transfer and retention -- most typically through an experiential-based learning environment.

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[68] Learning Education and Games volumes one and two are a collection of papers on game design written by members of the Learning Education and Games Special Interest Group of the International Game Developers Association. This series focuses on providing a diversity of opinions, cases studies, and actionable information to game developers.

"The most effective way to teach engineering ethics, is by having the students be actors/agents rather than observers in the ethical situation" (Alfred & Chung, 2011, p. 2). That way, they practice using the knowledge required while being personally vested in the solutions.

7.1 Personal Relevance

Pedagogy is the teaching of children. Andragogy is the teaching of adults. Malcolm Knowles defined andragogy as the teaching of adults in 1970 in an effort to differentiate the needs of adult learners as compared to children. In his book, *The Modern Practice of Adult Education: From pedagogy to andragogy* (1980, pp. 43 - 44), Knowles identified adults as seeing "education as a process of developing increased competence to achieve their full potential in life." They expect more from their education than children. They want self-expression, involvement, and the ability to apply the knowledge to solve their problems. "People become ready to learn something when they experience a need to learn it in order to cope more satisfyingly with real-life tasks or problems." (Knowles, 1980, pp. 43 - 44).

When adults attend a speaker, seminar, or other educational programs, they are there because they want to be, not because they have to be. They are giving their time, money, and attention, and expect to improve their lives in return. As such, the true test of an educator's or speaker's effectiveness comes not from a letter grade assigned by the teacher but rather from the participants themselves.

One of the most useful descriptions of effective teaching I have encountered comes the professional speaking business. In that industry, most keynote bookings are the result of personal recommendations of people involved in planning the event. Their endorsement carries weight because it implies they have enjoyed the speaker, found his/her material valuable, and still remember the message. In comparison to a traditional classroom where the teacher evaluates the students, a professional speaker's income is directly tied to how audience members evaluate them.

This frame of reference is especially important because the target audience for this project is 22 to 30-year-old recently graduated engineering students beginning their professional careers. At this point in their career, they are likely to feel that they have already written enough tests to

prove their worth. Voluntary experiences like this one should be valuable for the player without having to have a grade assigned. For these early-career engineers, professional development means taking charge of their own learning, finding opportunities to grow, and understanding how to be an engineer. For subject matter to be effectively taught, it must enable these early-career engineers to further their professional goals and leave them wanting to endorse the experience. To this end, the design review (chapter 12) asked professional engineers if the cases seemed realistic, and if it made players think about their professional responsibility.

Professional speaking coach Craig Valentine[69] articulates that the way to establish personal relevance and value comes from showing the audience how the presentation will allow them to Effect more, Do more, Get more, and Esteem more so that they can have an EDGE in life. (Valentine & Meyerson, 2009, p. 72). Effective teaching is about *engaging the audience* and *building memorable* experiences that enable them to *improve the quality of their lives.*

Table 6: Elements of Engaging Teaching

Elements of Engaging Teaching[70] [Reprinted with permission of Springer]	Student questions
Focused goals	Do I know where I am going?
Challenging tasks	Do I grow as a result?
Clear and compelling standards	Do I know how I will be evaluated?
Protection from adverse consequences	Is it safe for me to fail?
Affirmation of performance	Do I feel a sense of accomplishment?
Affiliation with others	Do I get to work with others?
Novelty and variety	Is it interesting?
Choice	Do my decisions matter?
Authenticity	Can I apply this concept to real life?

[69] Craig Valentine is a Toastmasters International World Champion of Public Speaking. Since 1999 he has been training professional speakers how to world class public speakers. http://www.craigvalentine.com/

[70] The following websites gives tips for instructors trying to improve classroom engagement. https://www.edutopia.org/blog/golden-rules-for-engaging-students-nicolas-pino-james, Accessed Jan 29, 2017 http://www.classroomtoolkit.com/documents/engaged-learning-indicators.pdf, Accessed Jan 29, 2017

In order to create memorable material, it needs to engage the audience and get them thinking (Anderson, Courter, Nathans-Kelly, Nicometo, & McGlamery, 2009; Crawley, Malmqvist, Östlund, & Brodeur, 2007, p. 20). But successfully doing so, requires creating an environment that is focused, challenging, and safe. Michele D. Dickey (2005) summarizes the elements of engaging teaching as an instructor (Table 6). The flipside of importance to a game developer or instructional designer is what questions or feeling will the player have that I have to answer.

7.2 Transfer and Retention

Effective education is not just engaging; it also has to transfer meaningful knowledge, inspire reflection and allows the learner to perform new tasks. For learning to be effective, it has to be retained and transferable to the real world. "Meaningful learning" is learning in which students go well beyond memorizing facts, but rather are able to recall the information and transfer it into new contexts (Mayer, 2002). This occurs when learners think about an activity for themselves, connect the information with the knowledge they already have, and resolve any discrepancies in the mental model. Learning depends on thinking and processing the knowledge, rather than simply replicating an action (Cooperstein & Kocevar-Weidinger, 2004, p. 144).

In their book, *How People Learn: Brain, Mind, Experience, and School*, Bransford, Brown, and Cocking (2000) analyze the challenges of meaningful learning and constructing knowledge at length. They emphasize that transfer goes beyond one-shot tests and is truly evaluated when learners can take the information and use it in a new situation (pp. 235-236). However, they also caution the reader to pay attention to the knowledge and beliefs a learner has and use that as a starting point for instruction (pp. 10-11).

Based on scientific evidence, Bransford, Brown, and Cocking identify three key components of effective teaching and learning (Table 7).

Table 7: Bransford, Brown, and Cocking Effective Learning and Teaching

No.	Component	Learning	Teaching
1.	Preconceptions and prior knowledge must be engaged.	p. 14	p. 19
2.	Information must be factual, organized, and covered in depth.	p. 16	p. 20
3	Metacognition -- reflection, assessment, and integration of the knowledge need to be supported.	p. 18	p. 21

These three points remind us that the cases being created have to mesh with the players existing understanding of engineering. Then, those cases need to have substance to them so that the players can learn a useful skill and apply it to the real world. Finally, the game needs to provide feedback which shows players that their understanding and abilities are increasing and then leverage that feedback so that players are able to identify any problems in their understanding. Playing games does not ensure learning. Players must use their knowledge and skills to make choices that transform the situation (Barab, Gresalfi, & Arici, 2009).

7.3 Experiential Learning

Based on an analysis of 55 educational games and documentation supporting how they were constructed, experiential learning is the most common instructional method used in educational games (Kebritchi & Hirumi, 2008). This makes intuitive sense because, video game design is about creating player-centric experiences (Schell, 2008).

Experiential learning is the process of resolving conflicts between existing mental models and the experiences the learner is having by interacting with their environment (Kolb & Kolb, 2005a, p. 194; Kolb & Kolb, 2005b, p. 2). The six defining traits of experiential learning environments are summarized in Table 8.

Table 8: Aspects of Experiential Learning

	Aspects of experiential learning	Description
1	Process not outcome	Learning should be thought of as a process rather than an outcome or destination. The process requires engaging students and providing feedback about their effectiveness.
2	Learning is integration	All learning is relearning — ideas and beliefs need to be drawn out so they can be examined, tested, and integrated with new ideas.
3	Resolution of conflict	Learning requires adaptation and the resolution of the conflict between what is being experienced and prior interpretations of the events. It is the moving of understanding from one point to another.
4	Holistic adaptation	Learning involves the whole person, how they think, feel, perceive, and behave.
5	Assimilating interactions	Learning results from interactions with the environment and the assimilation of new experiences with old ones
6	Constructivist	Learning is the construction of knowledge inside oneself through the transformation and interpretation of experience.

The key to experiential learning discussed in University teaching documents [71] [72] [73] is the importance of is having students become emotionally invested in the material, seeing the bigger picture, and reflecting on it. Thus tying the integration of knowledge with the values and needs of the learner.

[71] Introduction to experiential learning, this page features motivation and background information on experiential learning. https://uwaterloo.ca/centre-for-teaching-excellence/resources/integrative-learning/experiential-learning, accessed Feb 6, 2017

[72] This document offers guidelines for assessing experiential learning. https://www.mcgill.ca/tls/files/tls/guidelines_-_assessment_of_experiential_learning_1.pdf, accessed Feb 6, 2017

[73] This is an excellent document for seasoned instructors on the best practices surrounding experiential learning. http://www.ryerson.ca/content/dam/lt/resources/handouts/ExperientialLearningReport.pdf, accessed Feb 6, 2017

Experiential learning is holistically assimilating and resolving conflict, ideally, in a manner that accurately represents the environment in which the skills will be used.

7.4 Authentic Learning Environments

Students want their learning to be more active, personal, and memorable (Prensky, 2005). They should be allowed to contextualize the problems, explore the background situations, make decisions, and evaluate the outcomes of making ethical decisions (Barab, Gresalfi, & Arici, 2009; Schrier & Gibson, Ethics and Game Design: Teaching Values Through Play, 2010). Simply logging onto a website and clicking through an online tutorial is not sufficient — participants expect more (Muskavitch, 2005).

Marilyn Lombardi (Table 9) defines authentic learning as learning that focuses on the real world and solving complex problems through the use of role-playing exercises, problem-based activities, and communities of practice

While multiple definitions exist, authentic learning environments focus on letting participants solve ill-defined, complex problems in a personally meaningful manner using real-world methodologies.. Authentic learning is about having students work with ill-defined, multi-faceted problems, with multiple perspectives and solutions. It is about understanding that isolated facts and formulae (rote learning) have no meaning until the learner understands why they are valuable and what they can be used for (Lombardi, 2007, p. 2).

Herrington, Reeves, and Oliver (Table 9) define authentic learning in much the same way as Lombardi. However, one particular point of interest is that *authentic learning environments do not require real-world practice* (2014, pp. 401-412). Practice can be staged (simulated) through environments like a classroom, a theatre or a virtual world.

Herrington, Reeves, and Oliver, also identify that access to expert information, collaboration with others, communicating ideas, mentoring, scaffolding, and authentic assessment are all expected (Herrington, Reeves, & Oliver, 2014, p. 404). Authentic learning is not about checking boxes on multiple choice tests — it's about dealing with complexity.

Table 9: Aspects of Authentic Learning

	Aspects of authentic learning[74] [75]	Description
1	Authentic tasks	Ill-defined tasks that have real-world relevance requiring sustained interaction.
2	Real-world relevance	Context matches the way knowledge will be applied in real life.
3	Ill-defined problem	Require interpretations and multi-stage problem-solving.
4	Sustained investigation	Prolonged interaction with the problem.
5	Access to experts	Role models are required for improved understanding.
6	Reflection	Enables learners to reflect on their learning and their decisions.
7	Interdisciplinary perspective	Solutions are not just technical and limited to one discipline.
8	Authentic and Integrated assessment	Evaluation is seamlessly integrated with the activity. Work is evaluated at many points, not just at the end.
9	Multiple interpretations and outcomes	No one right answer problems. Answers should allow for the complexities of design, interpretation and competing solutions.
10	Multiple perspectives	Encouragement to consider alternative points of view.
11	Collaboration	Engage in discussions with a community of learners
12	Products	Participants create a final product.
13	Authentic assessment	Opportunities to demonstrate knowledge in a manner consistent with the problem being solved.

7.5 Game-Based Learning

Game based-learning is influenced by behavioural, cognitive, social, constructivist, and humanistic learning theories (Becker, 2019). What is interesting about this, is that different styles of games, and different aspects of games draw out different aspects of learning theories. Behaviourist approaches can be seen in the response-stimulus nature of racing and twitch games along with the action-reward cycle of opening loot boxes (pp. 31-33). Cognitive approaches are used when players orientate themselves to a new genre, adapt to new game situations and

[74] Lombardi, Authentic Learning for the 21st Century: An Overview, pp. 3-4

[75] Herrington, Reeves & Oliver, et al, Authentic Learning Environments, pp. 403 - 404.

mechanics, or when developers define rule sets for the games artificial intelligence (p. 34). Social development theory is extensively used to balance games to match the difficulty with the player's skills so that they stay in the zone of proximal development (Vygotsky). This is critical to keep players engaged, because if a game is too easy, players get bored, and if it is too hard, the players become frustrated and leave. Social constructivism is also important for developing the constructs of taking on roles in the game, situated learning, and players becoming involved in social groups to share the gaming experience (Becker, 2019, pp. 37-40). Constructivist learning can is important from the development side, as games are a subset of reality, and developers have to direct players attention and actions in a manner that facilitate learning through trial and error combined with real-time feedback (Becker, 2019, p. 41). And humanistic approaches, to provide growth and alternative viewpoints by allowing players to consume a game in many different ways (Becker, 2019, p. 44).

Game based-learning environments, have several common attributes that the Federation of American Scientists have identified as being useful for learning (Becker, 2019, p. 52). They close the gap between theory and practice by allowing players to utilize skills in a contextual setting. Encouraging players to achieve specific goals or quests and encouraging a high time-on-task. Foster motivation even during failure by framing failure as an opportunity to try again, with more knowledge and skills (save spamming). Provide feedback, learning cues, and just-in-time instruction to players to reduce cognitive load. Create personalized experiences by creating interactive rather than passive experiences. And do so in a patient manner, free from classroom time constraints.

These common attributes are strong motivators for using game-based learning in the teaching of engineering ethics. It supports the multi-faceted and diverse challenges of teaching by focusing on the needs of players and creating a supportive learning environment.

7.6 Summary

This section summarized the important teaching concepts which guide game development. The game should use a consequential-experiential based methodology which promotes authentic learning. The purpose of which was to create engaged learners who can retain and apply their understanding to the real world. The key takeaways being:

- Personal relevance, engagement, motivation, are critical to learning.
- Meaningful learning allows students to transfer their knowledge back to the real world.
- Learning experiences should accurately represent the complexities of the real world.
- Authentic learning environments can occur in games, role-play, and group-work.

Each of these takeaways can be supported through game-based learning by creating an environment in which the players experience interacts with cases that feel meaningful and authentic, personal relevance, and engagement can be easily fostered. Game-based learning is about creating learning spaces where the player is in charge, and consumes the experience in their own manner. It is interactive, personal, and motivating.

8 Assessment

Traditional summative and formative assessment in a classroom environment is about measuring progress and assigning grades. However, such a method is often inappropriate in-game environments. Forcing traditional assessment methods into a game may, in fact, undermine the flow of the story, disrupt gameplay, and kill a player's sense of flow. (Hirumi, Appelman, Rieber, & Van Eck, Preparing Instructional Designers for Game-Based Learning: Part 3, 2010c)

Instructional design based on simple multiple-choice tests does not suffice in-game environments (Hirumi, Appelman, Rieber, & Van Eck, 2010a; Hirumi, Appelman, Rieber, & Van Eck, 2010b; Hirumi, Appelman, Rieber, & Van Eck, 2010c). Assessment needs to be integrated into the game mechanics, dynamics, and aesthetics. The learning outcomes and gameplay should, in fact, be inseparable. Furthermore, the application of gamification techniques such as badges, leaderboards, and variable reward schemes do not entice players to revisit a game or take on alternative points of view.

The challenges in ethics are threefold. First, no simple algorithm for measuring professional ethics exist.[76] Second, the use of the Defining Issues Tests beyond its intended scope as a morality test (Drake, Griffin, Kirkman, & Swann, 2005). Third, because of the game environment, players may be answering the questions in line with their avatar's persona or trying to test the game's scope in order to probe the underlying game mechanics.

In response to these problems, Evidence Centered Design (ECD) and Stealth Assessment offer guidance for creating a reliable assessment using statistical models and artificial intelligence.

8.1 Challenge — No Universal Assessment Technique

The first challenge in assessing ethics games is that each situation is unique and there is no clear, vetted, universal assessment technique for ethical testing (Schrier, 2014, p. 151).

[76] ESIT, SEEQ, and other engineering research projects for assessing engineering professional ethics have stopped publishing, and provided little information on the underlying evaluation methods used.

Participants at the 2008 National Academy of Engineering workshop on research ethics (RCR), noted that the assessment of ethics instruction was "at an early stage of development." (Hollander & Arenberg, 2009) Citing the fact that even, differential measurement of pre/post testing results may not good indicators of students ability recall and transfer the knowledge learned, as even the assessment tools themselves may not be validated or appropriate for the target audience (Hollander & Arenberg, 2009, p. 31).

While articles on ethics in games, and teaching ethics do exist, rigorous and objective assessment method for *engineering* ethics has not been widely addressed. Rather, it is left to the instructor to subjectively interpret student responses in light of the specific codes of ethics being taught and the student's ability to take on multiple perspectives.

8.2 Challenge 2 — Relevant Assessment Methods are Not Validated

The second challenge is that the assessment tools being used are not validated for the target audience. Institutions are trying to use the Defining Issues Test (DIT) to assess and demonstrate the effectiveness of their engineering ethics courses (Drake, Griffin, Kirkman, & Swann, 2005). While the DIT is a rigorously tested instrument with a long history of use, it is not designed to evaluate professional ethics. "The DIT tests only for improved *moral* judgment, not for improved *professional* judgement" (Davis, 2006). A criticism validated by the test developers, the DIT and DIT2 are morality tests designed to assess Kohlberg's stages of moral development (Rest, Narvaez, Bebeau, & Thoma, 1999).

Additionally, completing an online version of the DIT[77] revealed that it is founded on an understanding of the political, cultural, and legal system used in the United States, further reducing its usefulness in evaluating the learning of Canadian engineers.

[77] A 2007 version of the DIT-2 is available at http://www.surveymonkey.com/s/LD65SNC, accessed Nov 8, 2016

8.3 Challenge 3— Players can choose their own goals

The third challenge is that people play games for their own purposes, because they want to, and that means they may appear to be playing in an unpredictable manner, unfocused on the goals (Ke, Shute, Clark, & Erlebacher, 2019, p. 19). Some players could be intentionally seeking alternative goals or choosing unethical answers just to see what happens in the game.

This player-defined purpose is one of the most challenging aspects of assessment in a game. It is easy to argue that poor choices or poor performance represent unethical or uninformed behaviour, but that assumption is flawed. In video games, it is typical that exploration (incorrect answers) will lead to unique rewards, opportunities, and enhanced understanding. Furthermore, it is these moments of exploration in which instructional designers can create opportunities to further a player's understanding by demonstrating the consequences of their choices.

8.4 Video Games and Assessment

An advantage that video games have over traditional assessment is the creation of rich data sets, based on the continuous collection of data on players actions, responses, and timing of events. This tangible data can then be mined for information about a player's levels of interest skills, and understanding.

When designing a learning experience, ECD (Rupp, Gushta, Mislevy, & Shaffer, 2010) starts with the desired statistical data or metric first and challenges designers to create events that provide the required evidence. This based off of research work by Messick, an appears similar in nature to the backwards design promoted by Wiggins and McTighe. Where outcomes drive assessment which then determines the programming and learning experiences. The difference between ECD and backwards design appears to be the focus on generating statistically reliable data for measuring player attributes like systems-thinking, communication and collaboration skills, and disciplinary-specific thinking.

This assessment is predicated on developing a game whose core mechanics mimic professional practice. And that instead of being a side product, professional real-life decisions are at the heart of the game. This is paired with providing information to the players to develop and better understand the epistemic frame. Two forms of data that are collected about users are process

data and product data. Process data follows the interactions of the players surrounding the game, while product data monitors the player's tangible work (in-game interactions). The advantage for ECD in-game environments is that the tasks performed to create a rich and multi-layer data set from which competencies are inferred.

Stealth Assessment (Ifenthaler, Warren, & Eseryel, 2015, pp. 301-319; Shute, Masduki, & Donmez, 2010) extends ECD through the use of Bayesian networks to analyze and predict player performance. Shute also adds the criteria that data acquisition is hidden from the player so that it doesn't interfere with gameplay. Thus, tasks become player actions, allowing learning and assessment elements are built into the fabric of the game, without the feel of discrete testing.

Implementing stealth assessment is a recommendation for future work, as it requires a significant amount of work in coding player actions, interpreting the skills being demonstrated, and training a neural network to recognize patterns of behaviour in the general population.

8.5 Metrics and Measurements

In light of the research on ECD and Stealth Assessment, this section identifies several patterns and indicators that could be integrated into the game to facilitate automated assessment. These suggestions focus on measuring tangible aspects of gameplay tied to the purposes of ethics education in chapter

Given the challenges identified in sections 8.1, 8.2, and 8.3 the design and evaluation of ethical behaviour are contextual and left to the instructional/game designer. While assessing moral imagination, recognition, fortitude, and planning may be hard. Patterns in the player's responses may provide a reliable and valid assessment technique.

For example, assessing the player's moral imagination could be assessed by monitoring the rate of decision making, and the degree of exploration. In this game, if players are clicking through the dialogues very quickly, that would imply that they have low interest and are not taking the time to read and reflect on the information being presented. Conversely, if they are taking a very long time to respond, it would imply inattentiveness. The degree of exploration would also indicate a player's willingness to revisit a case and explore problems from a different perspective. Given the branching and folding nature of the game, it is reasonable that a player

may only encounter 20% of the total dialogue in one run of the game. In fact, playtesters expressed relief in being told they did not have to test *every* dialogue path.

The *recognition of moral issues* could be assessed by looking for decisions that reflect the multi-dimensional nature of ethical decisions. Specifically, do players favour one evaluation criteria or choose a balanced response which maximizes their score in all the attributes (code, trust, reputation, risk, competence, fairness) that are being evaluated. This could then be coupled with the consistency of responses to minimize the effect of random selection.

A second method for evaluating the recognition of moral issues would be to implement a DIT style test in which players are asked to identify what issues existed in the case, and at what factors affected their decision. This technique was introduced in the reflection portion of the cases, but it undermined the player's experience by making the players feel trapped and tested.

A third method for evaluating the recognition of moral issues would be to embed digital assistants who provide feedback on the player's choices. The time spent reading or listening the feedback could be monitored, along with measures to see if the player was favouring the code aspect in their choices. Which would represent a deeper understanding of the code of ethics, and the behaviours expected of engineers.

Moral fortitude could be assessed by examining if players followed the same course of ethical action across multiple cases. For example, did they consistently choose ethical actions that resolved the situation in a positive manner, or did they capitulate to those in power?

Assessing this outcome could be evaluated, by flipping the question back on the players and encouraging them to "rate the case." During the design review, evaluators were asked to if the end of scenario questions made sense. Their responses indicated a lot of thought about what should be happening in the game and facilitated differences in expectations between the players and the developers. By incorporating these questions as part of the assessment and data collection, both tangible evidence and insight into player understanding could be gained.

Finally, *tolerating ambiguity* could be evaluated by including (1) responses that allow the player to gain additional insight into the situation, and (2) help features to explain what is going on the case and how it relates to the Act, Bylaws, and Code of Ethics for a provincial association.

During testing, a common theme in the feedback was for greater depth and context for the decisions being made. Along with specific references to the Act, Bylaws, and Code of Ethics the game was built around. It seemed that Engineers were more comfortable dealing with the ambiguity inherent in the cases then the Engineering Interns. The engineers saw the cases as a place to test their knowledge, while the Interns saw the cases as preparation for a test with specific right answers.

8.6 Summary

This chapter focused on the challenges inherent in assessing ethics, and the lack of a well-established computer based assessment model to work from. However, this challenge can be addressed by developing specific tasks or actions as part of the core game mechanic and inferring performance based on the tangible data. Future work in this area should include Evidence Centered Design and Stealth Assessment to better capture the players understanding of the subject matter and form a reliable and valid testing environment.

9 Instructional Design

This chapter examines the challenges, learning outcomes, and considerations that impact the game design. While these items appear linearly in this chapter, they are holistic in nature and heavily influence each other.

9.1 Challenges

9.1.1 Second order design

Video game design is a second order design problem (Zimmerman & Salen, 2004), in which the designer creates the rules and environment in which the player creates the story. This separation from creating the story makes game instructional design particularly challenging. Furthermore, it affects assessment because the gameplay emerges from the interaction and functioning of the rules with the player's choices. Thus anticipating the system's behaviour is not always possible.

From an assessment standpoint, second-order design means that in order to ensure interaction with the instructional objectives, learning outcomes should be built into the core game mechanics and the procedural rhetoric of the game. To do this, the learning outcomes were integrated into the core mechanic (choice) and feedback mechanisms (attribute points). The procedural rhetoric of the game was that day-to-day decisions have consequences which you have to live with.

9.1.2 Player motivation

An interesting aspect of the second order design is that the players control the experience and their motivation, goals or intentions may run counter to the intended outcomes of the game. The players may lack the knowledge or understanding to appropriately assess ethical situations. However, as they gain experience, they will likely begin to test the system and make "bad" choices specifically to see what responses they get. Additionally, they may be adjusting their responses to play in character with an avatar they have chosen. While there is no easy way to know what the player's intentions are, it is reasonable to allow them to make "bad" choices and experience the consequences that result. In fact, this facilitates learning through failure and the ability to create better mental models about the rules that govern ethical behaviour.

9.2 Learning Outcomes

This section examines each of the learning outcomes identified in section 1.9 and how they influence the game design.

9.2.1 Appraise ethical situations and choose appropriate responses.

The ability to assess and effectively react to ethical situations is an overarching goal of applied ethics education. As a result of playing this game, players should be better able to recognize and understand the ethical dilemmas, so that they can predict the outcomes and take preventative action. In order to do this, players need to practice making ethical decisions in a safe environment. Doing so allows them to improve their problem-solving skills through the process of matching the stories to similar experiences, forecasting the outcomes of the actions they are taking, and experience cognitive dissonance as the monitor the experiences that result.

In order to have players appraise the ethical outcomes of their decisions, the core game mechanic is making choices with ethical implications where you cannot undo your decisions. Each choice is ambiguous and ill-defined, yet has implied consequences the players should consider.

Using a non-linear dialogue allowed the narrative to easily branch, loop, move forward in such a way that outcome fit the choices being made. Ultimately allowing player's to control the story while having the learning outcomes embedded in their actions.

Sometimes the choices are not popular with characters in the game and other times they come with trade-offs. The key is, the player's always have a choice and live with the consequences.

9.2.2 Enhanced understanding of professional responsibility.

This learning outcome is embedded as a theme throughout the cases. In most of the cases, the player needs to gather support for their ethical position and finds that it is in conflict with managers or others within the organization.

A common dilemma early-career engineers may face is the difference in responsibilities and ethics of engineers, lawyers, and executives. As highlighted in the chapter on professional ethics, each group has substantially different professional obligations to the corporation. The engineer is expected to protect the public interest (canon #1), lawyers are expected to fight for

and protect their clients, while executive officers like CEOs and CFOs are expected to ensure shareholder profit and long-term success of the company. In order to highlight these differences of opinion and the professional responsibility, the conflict between the player's position and those of management were the central theme of the *ESD* and *Bad Software* cases.

Another common dilemma early-career engineers may face is internal tension between their personal, professional, and business obligations. Being a good engineer, may put their career at risk and compromise their ability to take care of their family. The reality that poor ethical choices can result in worse consequences may be something they have not considered or are aware of.

9.2.3 Develop an awareness of the role of the professional association in protecting the public interest.

Protecting the public interest is the first and foremost obligation for engineers and a key reason for the existence of engineering regulatory bodies. Understanding the role engineering associations play in protecting the public interest and subsequently the profession important understanding for every engineer.

Video games allow players to take on alternative identities and roleplay other viewpoints through their avatars. This ability to explore and understand alternative viewpoints is at the heart of the "friendly conversation" case. In this case, the player advocates on behalf of the profession with a friend who is considering unlicensed practice. By role-playing an alternative viewpoint, players are forced to recognize and articulate the values of the association.

9.2.4 Recognize and adapt to the social and organizational complexities found in engineering practice.

The importance of this learning outcome cannot be understated — as such; it was a key item in the questions posed during the design review.

Navigating the social and organizational realities of the workplace is often complex and challenging. The motivations of others, fear of consequence and withheld information all make the problems feel much more complex than they really are.

To embed this learning outcome throughout the game, it became part of the procedural rhetoric. Throughout the game, professional and business obligations are positioned against each other. Acting in the public interest (trust) and following the engineering code of ethics (code) may come at the expense of the player's reputation with their coworkers (rep). In order for players to advance in all three categories, they need to evaluate their choices carefully. Like real-world practice, a player who understands their professional responsibilities should do very well in the game, by finding ways to navigate the corporate structure and convince their superiors to follow ethical business practices.

The challenge here is to ensure that the cases, situations, and consequences are reasonable representations of real world (authentic) practice. To ensure this, two key questions during the design review were: "...do the cases seem realistic" and "...did the questions and answers make sense?"

9.2.5 Act as an ethical agent and gain an understanding of the professional and ethical responsibilities of an engineer.

In a traditional classroom, this outcome is evaluated by instructors evaluating papers based on considering a variety of viewpoints, identifying the appropriate codes or canons, and then identifying the ethical implications of the decisions for each of the parties involved.

Because game-based learning tightly integrates learning and assessment, a better method was to let players engage in unethical behaviours and see the consequences of their action. This idea of learning through failure encourages reflection and realization that there are consequence to our choices. Much like student breaking concrete beams and observing the fractures, ethical students should break the ethical mould in order to understand why it exists.

9.3 Additional Constraints and Considerations

Complexity, transparency, play styles, and authentic design all influenced the overall design of this game. Complexity affected the project's scope, while transparency affected the legal and ethical requirements. Assumptions about the players being engineers and explorers caused the design to focus on decision making as a key element of gameplay. Finally, the desire to create a

consequential-experiential authentic learning environment drove subtle choices in the attribute system and narrative.

9.3.1 Complexity

Video games are large, complex projects. The development of game mechanics, interactions, and interface all take significant time and expertise. Defining the player act as an ethical agent implies a first-person role-playing style game in which the player is able to make decisions, much like the games found in *Elder Scrolls* and *Fallout*. However, these AAA games are an incredible amount of work and well beyond the scope of a single person research project. For example, Ubisoft, creators of Assassins Creed have over 12,000 developers in 30 studios across 18 countries.[78]

In order to provide a focus for the game and restrict development to the core activities, it was decided to pursue a simplistic non-linear narrative format which could be easily tested and evaluated. The branching structure of the dialogue allowed multiple cases to be easily generated while still providing the complexity, depth, and surprise necessary to be engaging.

Thus, to provide focus and manage complexity, an interactive, choose-your-own-adventure narrative was chosen. In this way, the player can be the central character in a story, without adding the complexities of graphics, animation, and audio.

9.3.2 Ethical and Legal Requirements

In order to perform this research, it is imperative that all the ethical and legal requirements surrounding research transparency and data privacy are being met. For research ethics approval, participants should be fully aware of their involvement, voluntarily consent to the process, and be able to withdraw at any time. Additionally, collecting, storing, and mining personal information has significant legal requirements to protect the privacy of the individuals involved.

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[78] April 6th,2018 Ubisoft announces a new facility in Winnipeg. http://www.cbc.ca/news/canada/manitoba/ubisoft-winnipeg-office-1.4607796, accessed April 6, 2018

While the use of analytics, the real-time data collection on people's choices, behaviours, interactions, and interests is common practice in marketing and app development, it lacks both the high level of transparency desired for this project and creates significant challenges for data management.

In order to achieve the research goals while being transparent and providing reasonable security of personal information, the choice was made to have playtesters submit surveys and log files by email correspondence. In that way, playtesters could be well informed about the specific data being collected, retain the option to opt-out at any time, and ensure no private information is being collected.

9.3.3 Players

Games cannot be all things to all people, so a foundational consideration in game design is the question, *who are your players?*

Richard Bartle identified four enduring and often cited personality types[79] [80] Killers, Achievers, Socialisers, Explorers (Ralph & Monu, 2015, p. 87; Zichermann & Cunningham, 2011, p. 22; Schell, 2008, p. 110; Bartle, 1996). Players will drift between all four styles but do have a primary style and reason for play. Bartle explains these four styles as:

- *Killers (competition and destruction): Enjoy getting others upset by causing pain and killing off their characters. These players want to demonstrate their mastery/power over other players often by killing them.*

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[79] *Hearts, Clubs, Diamonds, Spades: Players Who Suit MUDS*; is a seminal article by Richard Bartle summarizing the 4 player arch types found in gaming. The research is based on analyzing player discussions about why they play Multi-User Dungeons (precursor to Massively Multiplayer Online games). http://mud.co.uk/richard/hcds.htm, last accessed December 23, 2017.

[80] *Personality and Play Styles: A Unified Model*; this article presents a practical comparison between the different motivational models of players.
https://www.gamasutra.com/view/feature/134842/personality_and_play_styles_a_.php, last accessed December 23, 2017

- *Achievers (challenge): Enjoy gathering points and gaining riches. They feel pride in demonstrating their mastery, and the formal status within the game.*
- *Explorers (discovery): Enjoy finding interesting game features, bugs, and the internal mechanisms of a game. Explorers want to interact with the game world and discover surprises.*
- *Socialisers (fellowship): Enjoy interacting with others, getting to know the other players and building relationships. The game world is just a backdrop to meeting new people/characters and developing long-term relationships.*

For the purposes of this game, I have assumed that the players are explorers. They are intelligent, intrinsically motivated players who set their own goals. Thus, I anticipate that they will replay the game several times in order to investigate, test, and break the system just for fun.

When playing a game, some players will seek out alternative choices from their normal course of action in order to test the limits of the system, experience different gameplay, or align with their avatar's persona (Schrier & Gibson, 2010, p. 64). It is not that these players are any less ethical, rather they are exploring the ethical domain to see what consequences have been embedded within the game. In doing so, they are better able to understand the developer's biases and procedural rhetoric that exists within the game.

9.3.4 The Learning Environment

Authentic learning experiences often fail if the whole design; goals, content, instructional design, learner tasks, learner roles, instructor roles, technological affordances, and assessment are not considered (Lombardi, 2007, p. 9).

Creating the authentic problems (sections 6.3 and 7.4), leads to developing multi-stage cases with ill-defined problems and subjective evaluation of the player's actions. While this runs counter to the factual and easy to assess teaching environment advocated by Bransford, Brown and Cocking (2000), it does lend itself to more authentic and integrated assessment which favours multiple interpretations and outcomes.

The sections on experiential learning (7.3) and authentic learning (7.4) identified several considerations for game design. How these concepts influenced the game design is discussed below.

9.3.4.1 Experiential Learning Concepts

Process not outcome: Game design has a weak evaluation strategy based on experiencing the consequence of choices. Feedback is in the form of narrative responses and attribute scores being adjusted.

Learning is integration: Creating an environment which engaged preconceptions and facilitated a transfer the knowledge back to their workplaces drove the choice to focus on interpersonal conflict within engineering practice. The belief about what does it mean to be an engineer and how do we engage others to share our viewpoints.

Resolution of conflict: Two enduring understandings built into the procedural rhetoric of this game are, you always have a choice, and your day-to-day ethical decisions matter. This focus is fundamentally different from the one-question, one right answer, focus of many engineering schools. Thus the conflict is to resolve thinking about engineering as both a science and a people based skill set.

Holistic adaptation: Learning is a holistic process of changing and adapting knowledge to a person's thinking, feeling and ways of behaving. If successful, users will be able to transfer their knowledge from this game to the real world and subsequently their own reactions/behaviours in times of conflict.

Assimilating interactions: Learners need to match the current experience to existing ones in order to make/adjust the mental models they have. The choice to use day-to-day activities is based on the recognition that many engineering students discount cases like the Ocean Sea Ranger and Challenger as being extraordinary things that will not happen to them. It is a much harder argument to discount meeting with vendors, discovering errors in an existing design, and working in teams.

Constructivist: Mental models are constructed based on a person's prior knowledge, past experiences and integrating the new information with past understanding. In order to ensure the correct mental models are built, it is important to engage prior understanding, allow the players to see the consequences thereof and provide opportunities for them to take corrective action. Thus allowing them to test, validate, and refine their understanding. In this game, the non-linear narrative gives many opportunities to recognize they are on a slippery slope and to take corrective action. This functionality is a key reason the narrative is so complex.

9.3.4.2 Authentic Learning Concepts

Authentic tasks: Based on situated cognition, authentic learning is focused around doing tasks that match up to real-world practice. These tasks need to provide the purpose and motivation for learning. In this game, the consequences experienced by players should match real-world practice.

Real-world relevance: Dealing with managers, lawyers, and salespeople who have different ethical biases is part of professional practice. The cases included were inspired by accounts by practicing engineers.

Ill-defined problem: Like stories, more information is left out then is put in. The role of a good storyteller is to capture the reader's mind and let their imagination fill in the details. Given the use of a text-based narrative, the players have to let their imaginations fill in the details. Their experiences, understanding, and biases will all affect how they interpret the information presented and the course of action that should be taken.

Sustained investigation: With over 600 dialogue entries, this game takes somewhere between two to five hours to play through, more if the player wishes to revisit the game and try again.

Collaboration/Access to experts: As engineering interns, the players should have a well-developed personal network of engineers and fellow interns to discuss the game and its consequences with. Additionally, it is reasonable to expect that players would create fan pages or forums discussing the game.

Reflection: Each case includes post-case questions designed to encourage reflection.

Interdisciplinary perspective/Multiple perspectives: The cases in this game are not tied to a specific branch of engineering. Rather they focus on the interactions of engineers with non-engineers. Thus, encouraging Engineering Interns to consider alternative perspectives and the role of engineers beyond technical problem solvers.

Authentic and integrated assessment: Like industry, the consequences of your choices represent the authentic assessment in this program. A secondary assessment exists in the points assigned to each of the six player attributes as a result of their choices. These two modes of assessment are done as the decisions are made in the game and are fully integrated with gameplay.

Multiple interpretations and outcomes: As discussed in the second order design, developers create the space in which players create the story. The purpose of choosing a non-linear dialogue was to support players having agency and efficacy. By giving the players choice, they are expected to interpret the information and make their own judgments on the correct course of action.

Products: Although playing video games are not products in the traditional engineering sense, video games allow players to produce experience and share their interpretations of circumstances and events with others.

9.4 Summary

This chapter focused on exploring the challenges, learning outcomes, and constraints that affect the design of this game. The goal is to create an environment that supports players in exploring ethical concepts in an authentic and personally meaningful manner. As a result, the game became a single player experience, built around an evolving narrative. In doing so, the goal was to create a simplified environment in which an Engineering Intern could experience some of the messiness of professional practice.

The subsequent chapters of this thesis address the implementation and design review of the game. Chapter 10 looks at development tools. Chapter 11 focus on the cases studies developed and chapter 12 examines the process and responses from Professional Engineers conducting a design review of the software.

10 Development Tools

This chapter covers three elements of fabricating and distributing the game; (1) the *Unity* game engine, (2) the *Dialogue System* asset, and (3) distribution using *Itch.Io*. The Unity game engine is a popular development environment for video games with a host of assets available for purchase. The Dialogue System is a non-linear narrative asset developed by Tony Li at Pixel Crushers and is the core engine for the game narrative. Itch.Io is a developer-friendly game distribution website which provides easy and secure hosting and sales of video games.

10.1 Unity

Unity was selected for this project for three reasons; functionality, price, and support. Furthermore, since the project started, *Unity* has been consistently improving in each of these aspects and is now the dominant game creation software for mobile platforms.[81]

Unity is a highly functional game development platform;[82] it provides developers with a stable multiplatform game engine upon which to create games ranging from 2d side-scrollers to immersive virtual-reality experiences. It has an excellent import pipeline, extensible code base, and scripting support. These features allow third-party developers to create and sell asset packages to extend the functionality of the game engine in a myriad of ways.

Unity's, pricing model and user agreement have changed over the lifecycle of this project. Originally only an independent developer and personal licence were free, while Institutional licences were on a per-seat basis. As of November 2016, Unity became free for academic institutions.[83]

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[81] Unity has over 5 billion downloads of games made with the Unity engine spread over 2.4 billion unique devices. https://unity3d.com/public-relations, accessed April 16, 2017.

[82] Unity capabilities: https://unity3d.com/unity/engine-features, accessed April 16, 2017

[83] Unity Blog, https://blogs.unity3d.com/2016/11/03/big-news-for-education-unity-is-now-free-for-qualifying-academic-institutions-at-all-levels/, last accessed April 27, 2018.

Finally, *Unity* has a well-developed video training series and comprehensive documentation[84] and strong community support in the *Unity* forum[85], StackExchange[86], StackOverflow[87], and YouTube[88] websites.

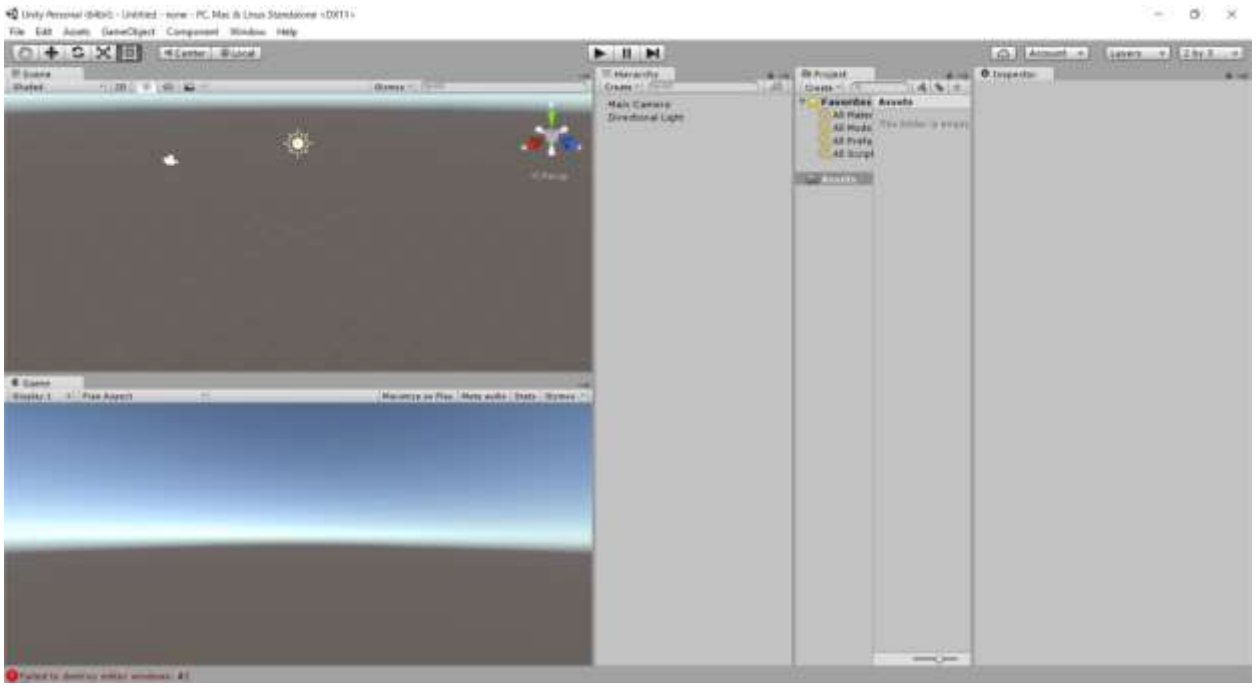

Figure 4: Unity Development Interface

[84] Unity training website: https://unity3d.com/learn, accessed Feb 26, 2017

[85] Unity community forum: http://answers.unity3d.com/, accessed Feb 26, 2017

[86] https://gamedev.stackexchange.com/questions/tagged/unity

[87] https://stackoverflow.com/questions/tagged/unity5

[88] Unity channel on YouTube, https://www.youtube.com/user/Unity3D, accessed July 20, 2017

10.2 Dialogue System for Unity

The *Dialogue System for Unity*[89] asset package by Pixel Crushers[90] (Figure 5) was instrumental in the construction of this project. This asset package extends *Unity's* functionality by adding support for; nonlinear dialogue, cutscenes, inventory, quests and in-game editing all of which are required for role-playing games.[91] This package has consistently proven to be stable and reliable. The error-free handling of exporting, modifying, and re-importing the dialogue database is noteworthy! Furthermore, the developer has provided consistent and outstanding including one-on-one product support and custom code on request.

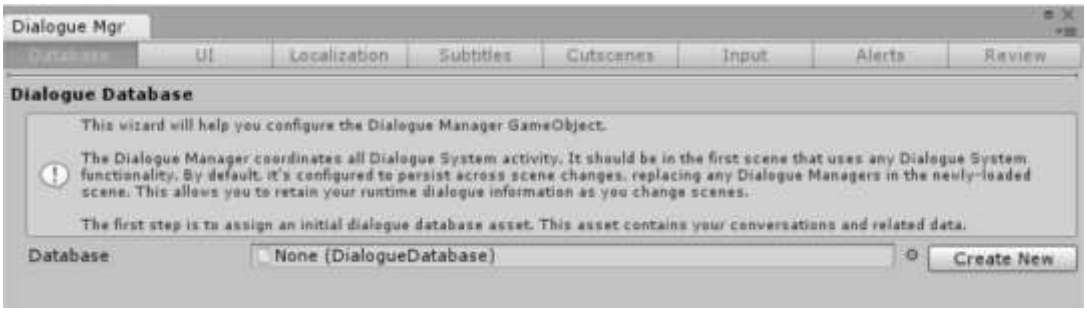

Figure 5: The Dialogue System — Database Configuration Screen

Figure 6 shows the *Dialogue System* conversation interface. The left-hand side is the conversation map, which allows nodes to be easily visualised and connected. The right-hand side is the node inspector window where dialogue, scripts, cut sequences, audio, and animations can all be controlled. Table 10 lists the dialogue fields available in the node inspector to illustrate the depth of information available to the developer.

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[89] The Dialogue System for Unity, https://www.assetstore.unity3d.com/en/#!/content/11672, accessed April 16, 2017.

[90] Dialogue System website and support, http://www.pixelcrushers.com/dialogue-system/, accessed May 16, 2017.

[91] The Dialogue System is available for purchase from the Unity Asset Store, https://www.assetstore.unity3d.com/en/#!/content/11672, accessed April 16, 2017.

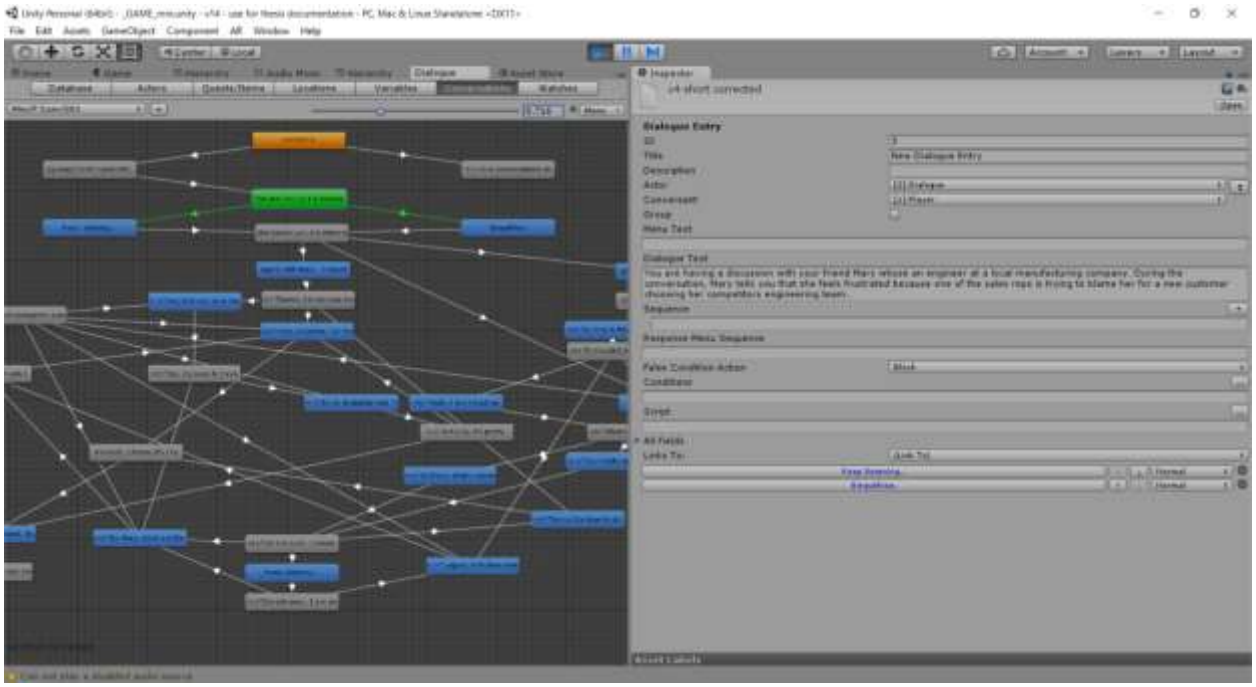

Figure 6: Dialogue System — Conversation Interface

Table 10: Dialogue Entry Item Fields.

Dialogue Entry Item	Notes
Node ID	The conversation ID and this node ID number uniquely identify each conversation in the game.
Title	Not shown to players
Menu Text	Default text displayed in the editor window. When it is blank, the dialogue text is shown.
Dialogue Text	Typical in-game text. Content is limited to a small block of text to prevent overrun of in-game the text area.
Sequence	Timed events including custom camera actions, cutscenes, animations, and sounds played during the dialogue.
Response Menu Sequence	Custom camera actions, cutscenes, animations, and sounds played during the response menu following this entry.
False Condition Action	Determines if the conditions allow a script to be shown or blocked.
Condition	Lua scripts for determining when this node should be shown.
All Fields	Shows the Lua table (database) entries relevant to this node.
Links To	Paths (edges) connecting to subsequent nodes in the dialogue. These paths (edges) are shown by the white lines between nodes.

10.3 Challenges

During development, four major challenges using the development tools existed: (1) *Unity's* architecture, (2) constant changes the engine, (3) text size and (4) switching between Lua and C# code libraries in the *Dialogue System* documentation.

10.3.1 Unity Architecture

Unity's architecture is based on an entity-component model,[92] [93] [94] which is very different from conventional object orientated programming methodologies. In the entity-component systems model, a number of small scripts (components) are attached to a game object (entity) to define its behaviour. Those scripts then interact with each other and system events to define how the system as a whole behaves.

This difference caused a lot of confusion when trying to learn both the C# language and the Unity system. Information about what kind of data structures to use, initialization methods, and even the role of public variables were all turned sideways. Furthermore, *Unity* uses a number of magic function names to control the timing and execution of player scripts.

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[92] Two articles which provide an introductory overview of the component entity model https://www.gamedev.net/resources/_/technical/game-programming/understanding-component-entity-systems-r3013, accessed April 16, 2017 and https://katatunix.wordpress.com/2016/01/26/oop-vs-ecs/, accessed April 16, 2017.

[93] Unity workflow overview https://docs.unity3d.com/Manual/UnityOverview.html and scripting overview, https://docs.unity3d.com/Manual/ScriptingConcepts.html, accessed April 16, 2017

[94] This webpage highlights the differences between the Entity-Component architecture used in Unity and the Model-View-Controller architecture used is some professional development environments. https://www.toptal.com/unity-unity3d/unity-with-mvc-how-to-level-up-your-game-development, accessed May 16, 2017

10.3.2 Unity Engine Changes

Since 2010 virtually every aspect of the *Unity* engine has changed significantly.[95] [96] The user interface, animation system, particle system, and sound systems have all been replaced with more powerful and complicated systems. And a host of powerful tools including a 2D engine, ads, analytics, and virtual reality support have all been added. This constant state of change with bi-monthly updates has meant using the game engine requires constant vigilance about code changes and methods that become obsolete (Figure 7, Figure 8). Case in point, this game was finalized using *Unity* 5.3.2f1. Within five months (version 5.5), the program would no longer compile as methods required for the *Dialogue System* had been deprecated. Updating the *Dialogue System*, required overwriting the existing asset and validating that the existing code still compiled and worked as expected.

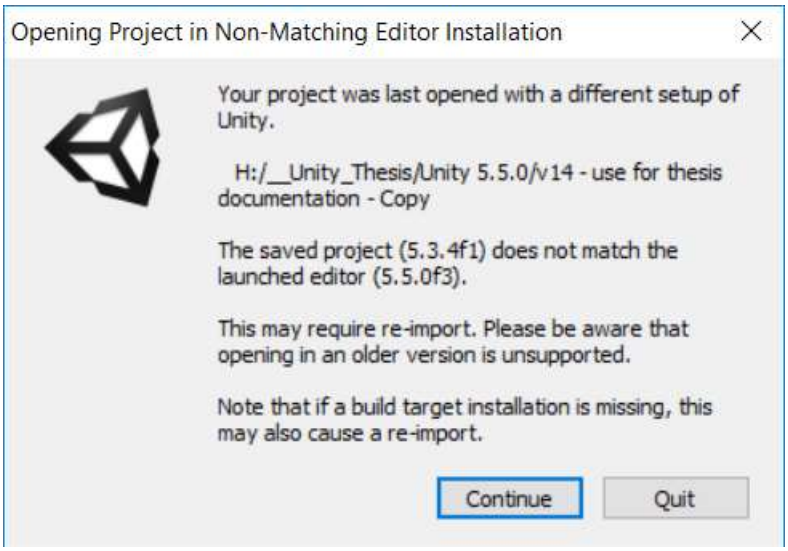

Figure 7: Unity Versioning Errors

[95] Unity roadmap outlining changes expected within the next year. https://unity3d.com/unity/roadmap

[96] Unity archive outlining the changes between version 5.3 (Dec 2015) and 5.6 (March 2017).https://unity3d.com/unity/roadmap/archive

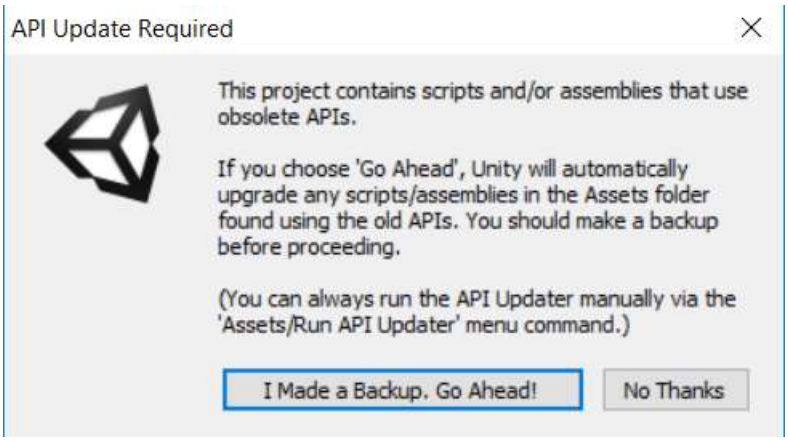

Figure 8: Unity, API Update Required

10.3.3 Dialogue System Text Entry

With the *Dialogue System*, a very different challenge existed — text entry was challenging and prone to error. Entering text into any *Unity* dialogue boxes can be very frustrating, text size is hardcoded into the engine and typically appears as 5 or 6 point font[97] on a 21", 1920x1080 monitor. This behaviour makes typos and improper punctuation very hard to find. In the case of the Dialogue system, resulting errors would cause the narrative engine to quit unexpectedly.

Furthermore, both the *Unity* and the *Dialogue System* editors do not contain any spell checking features, so all spelling and grammar checking has to be done through exported comma separated variable text files. However, the combination of code and dialogue made performing a spell check within Microsoft Office is virtually impossible.[98] In particular, new line characters "\n"

[97] This problem has been listed on the Unity feedback website for over since February 2011, https://feedback.unity3d.com/suggestions/change-font-size-in-unity-editor?page=1#comments, accessed July 16, 2017.

[98] While the popular grammar checking program Grammarly, supports Microsoft word and Outlook. A CSV or Comma Separated Variable file would likely be very frustrating to edit.

which are interpreted as a control sequence in Microsoft Word.[99] A partial solution was to use Notepad++[100] and set the file to be recognized as a Lua script. That way, the program would treat the text strings as if they were embedded inside of Lua functions.

10.3.4 Dialogue System Lua and C# Confusion

At its core, the *Dialogue System* interfaces between the game engine in C# and the Lua scripting environment which stores the role-playing game data. This leads to many places, where C# and Lua scripts exist side by side in the documentation. For new users to either language, this can be frustrating.

10.4 Distribution Using Itch.Io

Itch.Io was used to distribute the game prototype (Figure 10, **Error! Reference source not found.**) during testing because it allows easy and secure distribution of the software without requiring software developer kits, subscription fees, or licensing.[101] Recommended by professional game developers, *Itch.Io* hosts over 40,000 projects including game jams, beta tests, alongside titles featured on the Windows Store and Google Play Store.

For students wanting to securely distribute games, this web store allows independent developers to maintain control over their program, while providing secure downloads, analytics (Figure 11),

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[99] Searching for backslashes can be particularly challenging as these *Microsoft Word MVP FAQ Site* and *Superuser* websites report, https://wordmvp.com/FAQs/General/UsingWildcards.htm and https://superuser.com/questions/124759/replace-newline-character-with-another-in-word-2007. Both sites last accessed November 26, 2017

[100] Spellchecking worked in Notepad++ prior to version 6.8.1. As of version 6.8.1, spell checking was removed from Notepad++ and implemented as an add-on package.
https://notepad-plus-plus.org/community/topic/201/spellcheck/3, accessed July 16, 2017
https://notepad-plus-plus.org/community/topic/6966/spell-checker-plugin-issue-with-v6-8-1-missing-gnu-aspell-and-or-dictionaries, accessed July 16, 2017

[101] *Itch.Io* allows developers to set their commission rate. https://itch.io/docs/creators/pricing, accessed April 16, 2017.

and private web pages for free (Figure 12). It does not require greenlighting (Steam), special developer tools (Android), or place restrictions on the programs operation like the Windows Store and Google Play.

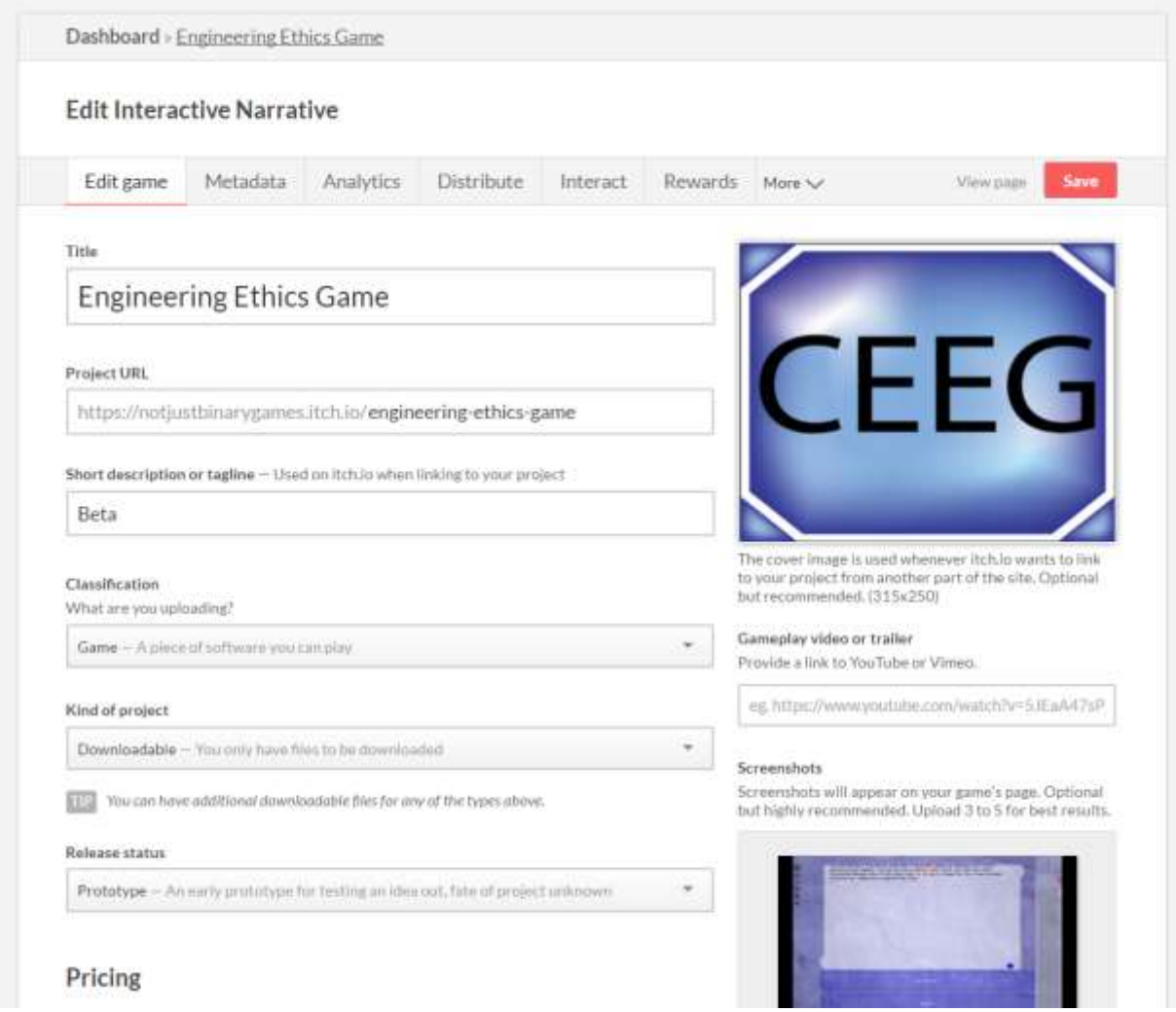

Figure 9: Itch.Io Game Information

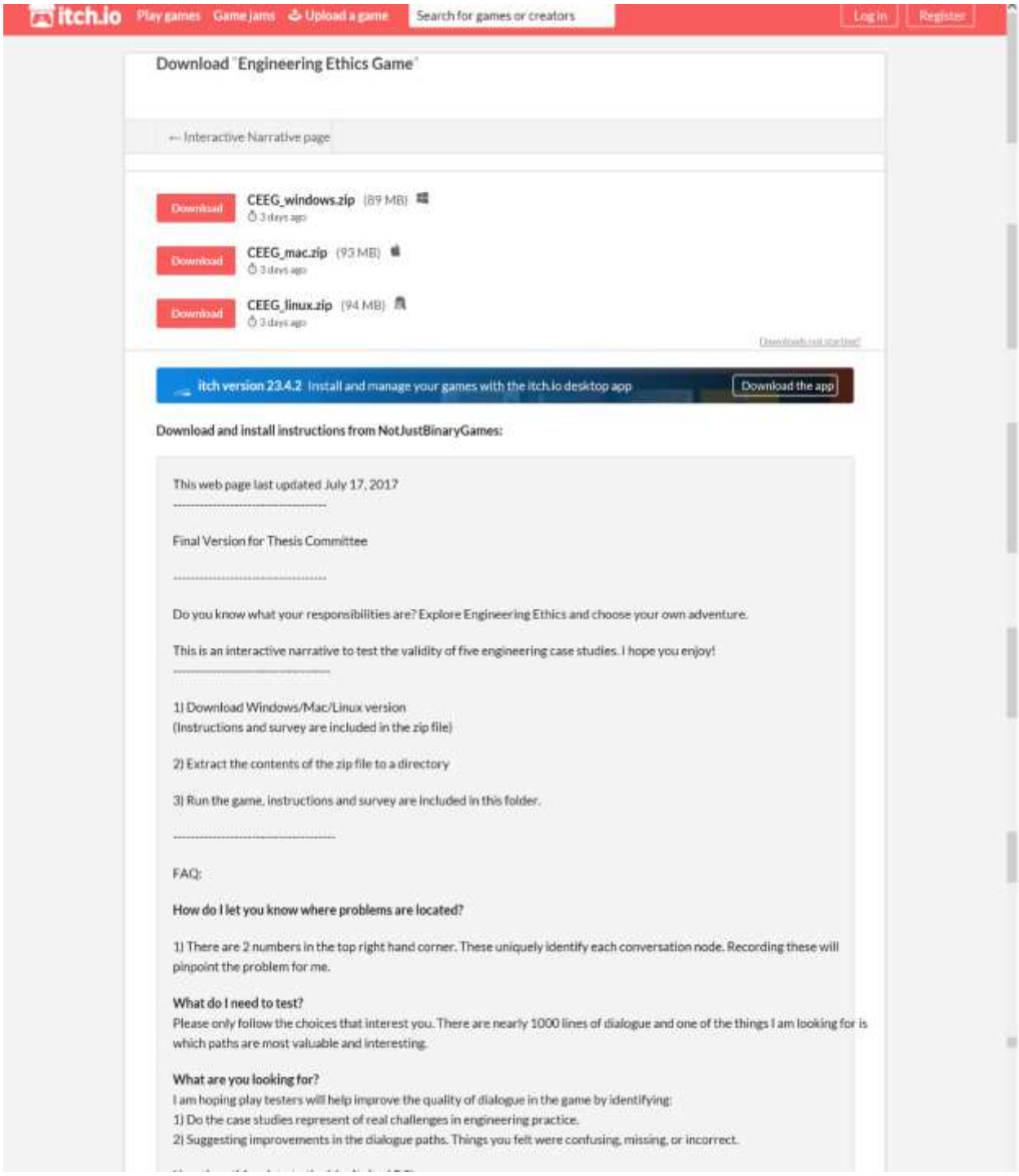

Figure 10: CEEG Download Page

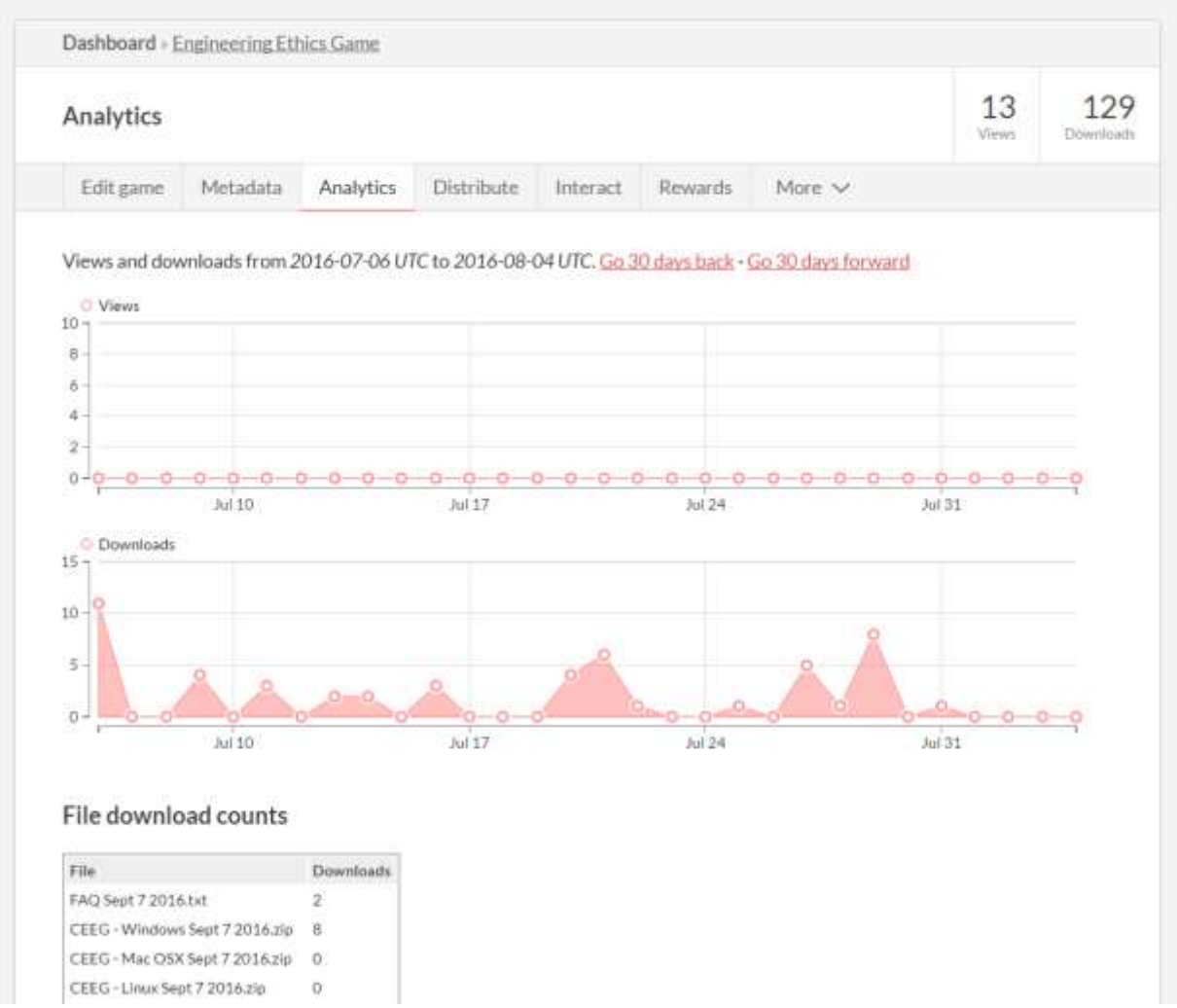

Figure 11: Itch.Io Analytics

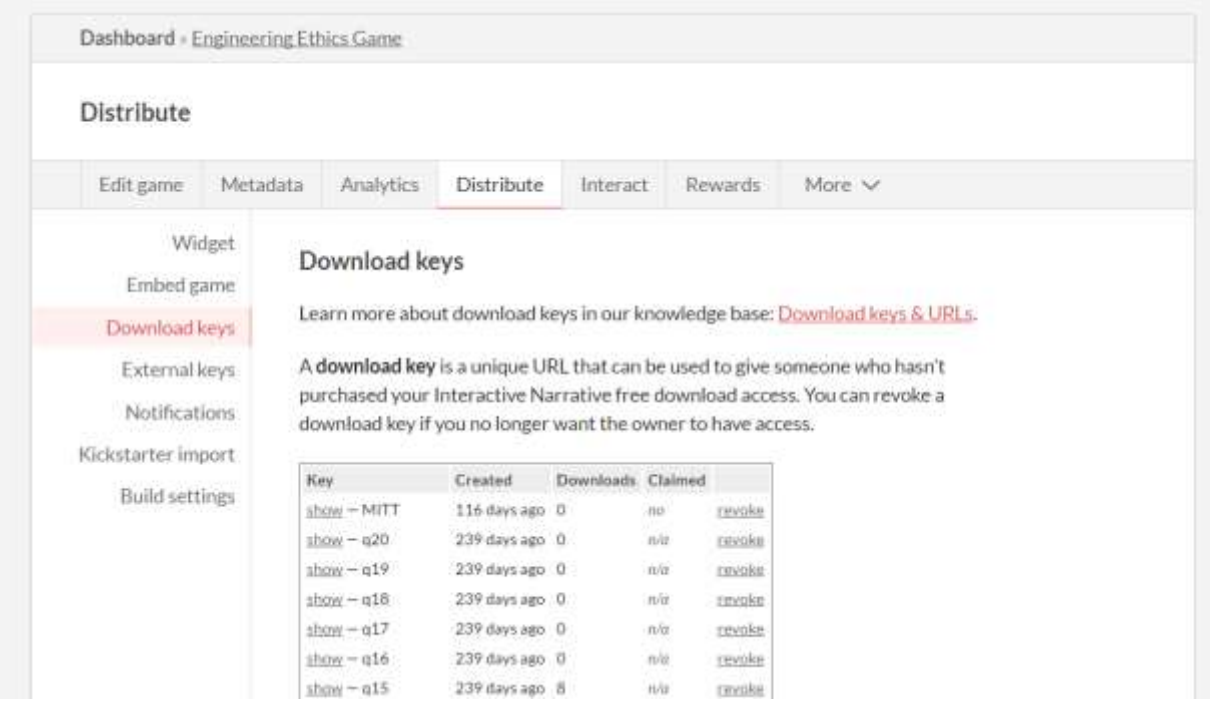

Figure 12: Itch.Io Distribution Tab and Download Keys

10.5 Summary

The goal of this chapter was to provide a balanced look at the development tools and the challenges involved. Unity has been an excellent game engine to work with because of its functionality and community support. Overall, the Unity framework allows developers to focus on developing their game without having to worry about platform limitations or engine mechanics. The Unity developers have been able to reduce the barriers of game development to the point that non-industry professionals willing to invest the time and effort can create working games.

That is not to say game development is trivial — far from it. Learning a new programming paradigm, two new languages, and the intricacies of Unity and the Dialogue System were significant and often frustrating parts of the learning process.

11 Implementation

Depending on the type of learning desired, quiz games, board games, or casual games could be used. Darryl Macer, wrote a book of 43 classroom games for teaching bioethics (Macer, 2008). Games can be many shapes and forms, depending on the desires of the developers.

Jeopardy is a classic quiz game, popular study technique and has been adapted for classroom use.[102] While great for creating competition, and emphasizing recall of facts, it does not create a learning environment that matches professional practice.

The Ethics Challenge[103] boardgame by Lockheed Martin, was based on the famous Dilbert series and used short case studies to challenge players to determine the right course of action. Like most board games, the responses could be memorized, or answers given inspire communication, while challenging players to resolve ethical challenges related to office politics. While this game appears interesting, it is no longer in print.

Casual games which are easy to pick up and put down, could easily have ethical challenges as well. Using a messaging platform, a team of players could be sent an ethical challenge every day, and compete against teams from other schools, or companies. The key here, would be to create an environment where the whole team was encouraged to talk and discuss the matter before they made a submission.

But games do not require computer technology, cell phones, or even a set of dice. Many of the games in Macer's book, simply require a group of people willing talk about a topic in a fun and supportive way. For this research project, the choice to use a branching dialogue was made for three reasons, to provide a quantifiable research artifact, and to draw the player into s sense of story. Unlike quiz games or in class participation, the aim was to cause reflection and empathy with characters over a broad range of ethical situations. From the authors experience playing

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[102] https://www.playfactile.com/

[103] https://boardgamegeek.com/boardgame/60686/ethics-challenge-featuring-dilbert-and-dogbert

XCOM, Elder Scrolls, and Fallout, which were all full of ethical conflict, using a role-playing-game seemed like a natural choice. The problem is, role-playing-games are one of the hardest genres to create. In order to limit the scope and focus on the research, the narrative was chosen to be the focus.

11.1 Description of the game

Ethical dilemmas are not always a choice between right and wrong, many times ethical dilemmas result from competing and conflicting "right" answers. Is the common good more important than one's duty, is it right to sacrifice one's well-being based on duty? In these situations, facts alone may not be sufficient — prior experiences, situations surrounding the decision, and expectations about the outcome will often bias what facts are considered, the success criteria are chosen, and the decisions ultimately being made. Thus, to capture some of these humanistic aspects of decision making, holes in the information and self-serving characters are featured in each of the cases.

This game is structured into 5 cases consisting of 689 nonlinear dialogue entries, which can be easily modified or extended if needed. Each case focuses on a different aspect of professional engineering and the topics included so far are; protection of the public interest, resisting bribery, responsibility for safety in the workplace, being pressured and following the law.

Figure 13: Engineering Ethics Cases

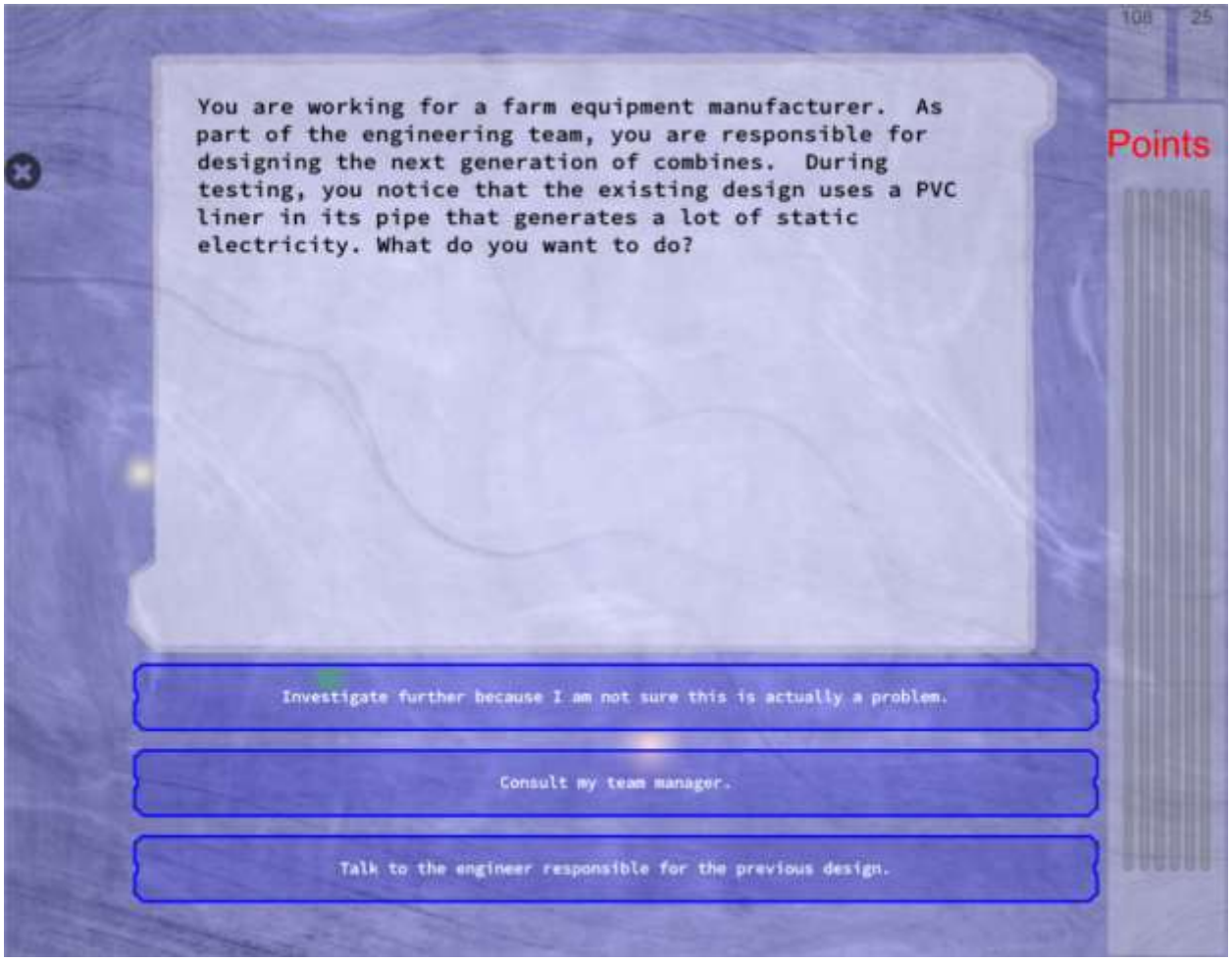


Figure 14: User Interface

The core game mechanic is that players read a block of narrative text and then choose from a variety of responses. Figure 14, shows the user interface — the narrative is shown on top, while the valid responses are shown on the bottom. As responses are chosen, the dialogue engine advances along the arrows seen in Figure 15 to display the next narrative/response combination. This creates the dynamic that players form their own path through the game experiencing the consequences and new choices created by their decisions.

In the node diagrams, the narrative and responses are either gray or blue depending on whether the player was selected to be the actor or conversant in the conversation. In the dialogue tables, however, narratives are shown in gray, while responses are shown in blue.

In each of the dialogue tables, the conversation ID, node ID, type of node, dialogue, and status indicator adjustments have been included. The conversation ID and node ID uniquely identify each node. The type of node is used for colour coding the table and denotes whether this node is a narrative (gray) or a response (blue).

As seen in Figure 14, narrative dialogues were shown on the top part of the user interface and responses were shown on the bottom. Finally, certain nodes in the game will affect the player's score (section 11.3) by activating scripts to modify the status indicators. In the Points column, the "code 10" designation on node 4 indicates the code of conduct attribute will be raised by 10 points.

Table 11: Symbols Used in the Conversation Node Map

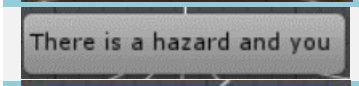
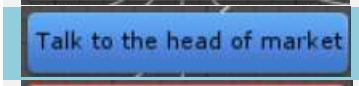
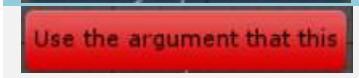
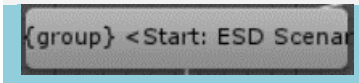
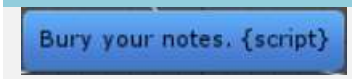
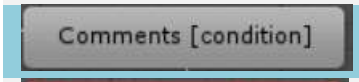
Image	Type	Description
	On-page connector (white)	Links two nodes on-page nodes together.
	Off-page connector (orange)	This node has 1 or more off page connections.
	End connector (red)	This node has no outgoing connections. An alternate version of the [End] node
	Start node (orange)	The starting point for each conversation (linking to other nodes is possible)
	Conversant node (gray)	Display either narrative or dialogue.
	Actor node (blue)	Display either narrative or dialogue.
	Unconnected node (Red)	This node has no entry connections
	{group} (gray)	These nodes are not displayed. They are typically used for scripts and flow control.
	{Script}	Contains a Lua script which is typically used to adjust attribute scores and status indicators.
	[Condition]	Contains release conditions that must be met before it can be displayed.
	[End]	This node has no outgoing connections.

Table 11 summarizes the symbols found in each of the conversation node diagrams. For illustration purposes, the node map (Figure 15) and associated dialogue (Table 12) are provided. This map and dialogue combination demonstrate one of the dialogue paths players could experience within the ESD case. As the node diagrams quickly become complex and hard to follow, the darkened path in the figure shows the nodes in the sample path for each case. A complete narrative path is included in section 11.2.1, and the complete dialogue for all the cases is located in Appendix A3.

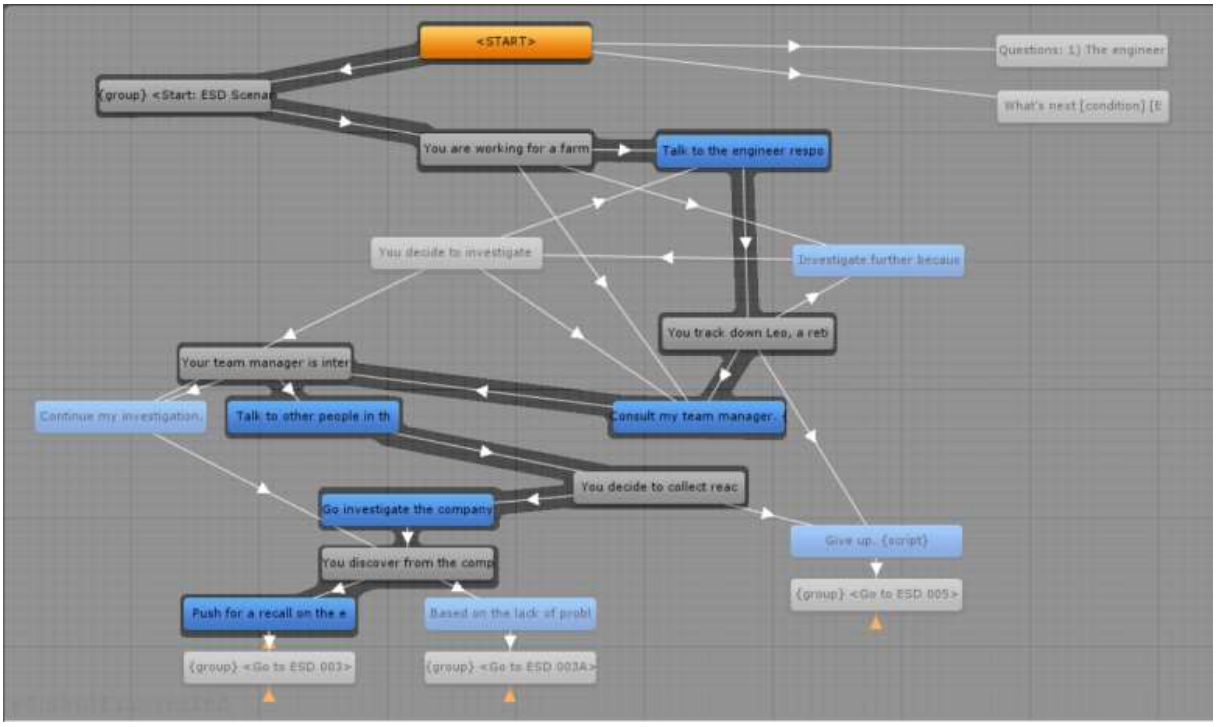


Figure 15: ESD — Sample Path — Part 1

Table 12: ESD — Sample Path — Dialogue Entries

Conv.	Node	Type	Text	Points
108	25	Narrative	You are working for a farm equipment manufacturer. As part of the engineering team, you are responsible for designing the next generation of combines. During testing, you notice that the existing design uses a PVC liner in its pipe that generates a lot of static electricity. What do you want to do?	
108	4	Response	Talk to the engineer responsible for the previous design.	Code 10
108	8	Narrative	You track down Leo, a retired engineer from the company and project lead for the previous combine design. He informs you that his design had a grounding wire inside the tube to minimize static charge and sparking. If that design change has occurred, it happened after he left the company.	
108	5	Response	Consult my team manager.	Rep 10
108	7	Narrative	Your team manager is interested in what you have found and wants you to make sure the current system is grounded. He directs you not to worry about the existing product as there have been no problems before.	
108	11	Response	Talk to other people in the company.	Rep 10
108	15	Narrative	You decide to collect reactions from your peers. And although they think your arguments have merit, they don't want to oppose the current manager.	
108	16	Response	Go investigate the company records.	Comp 10
108	12	Narrative	You discover from the company records that several years back, the engineering department was tasked with reducing the costs of the combine. These along with several other cost-cutting measures were approved by the Vice President. However, both the VP and the engineer who suggested the changes are no longer with the company.	
108	13	Response	Push for a recall on the existing combines.	trust 10

In Figure 15 and Table 10, the conversation (conversation ID 108) begins at the <START> (node 0), passes through the {group} node automatically (node 1), and displays (Node 25) the narrative, "You are working for a …" to the player. At this point, the player chooses from one of the three available responses and play continues to the next narrative. At the end of this

conversation, "Push for a recall …" the player reaches an off-page connector, and the conversation continues in a different conversation (Figure 17).

11.2 Cases

Each of the subsequent sub-sections follows a simple pattern: (1) an overview of the case (2) a summary of the guiding aspects, (3) sample narrative map, and (4) the associated dialogue. The complete dialogue is available in section A3.

11.2.1 Case 1: ESD — Design Flaws Discovered in an Existing Design

This case was built around the following questions:

- If an engineer suspects a design is unsafe, how should they proceed?
- How would they get support to investigate the problem further or make a design change?
- What is their ethical responsibility?

The underlying technical context for these questions was inspired by research on triboelectric charging and how a static charge buildup on grain moving through plastic pipes could lead to grain dust explosions. As grain moves through an insulating pipe, it will pick up charge and build up an electrostatic potential, much like shuffling your feet on a carpet. When the grain exits this pipe, the differences in electrostatic potential between the grain and pipe can be large enough to cause electrostatic discharges (spark) between the two materials. Unfortunately, the end of the tube is a location in which grain dust may be prevalent, and in the right concentrations, this dust can ignite causing an explosion.[104]

While this is a hypothetical case, the underlying challenges of whistle-blowing are very real. In the famous disasters of the Challenger explosion in 1986 (Chiles, 2001; Lynch & Kline, 2000) and the Bay Area Rapid Transport in 1971 (Van de Poel & Royakkers, 2011, pp. 32-33), engineers involved were not only terminated but blackballed within the industry.

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[104] This website contains http://www.dustexplosion.info/dust%20explosions%20-%20the%20basics.htm

The difficulty in situations like this is that people may not know or want to acknowledge there is a problem. Worse, they may actively ignore problems that have not yet revealed surfaced, justifying their actions based on the assumption that a design is safe because a catastrophic failure has not yet happened.

Figure 16 and Figure 17 outline the flow of the ESD case. Each gray node represents a narrative item, while the blue nodes represent player responses. The complete narrative (conversations 108 and 13) can be found in Section A1 of the appendices.

Table 13: ESD — Summary

Aspect	Summary
Situation	You are asked to rework an existing design. During which time, you discover that the existing design might be unsafe. However, the product has been out in the field for several years without incident.
Consequence	This case is about the choice to go along with the existing design or to pursue raising red flags until you are either terminated or get an appropriate response.
Relevant facts	Charge tribulation between PVC and grain dust can lead to sparks as the grain dust exits the PVC tube. In the right environment, grain dust can be explosive.
Ethical considerations	Due diligence. Demonstrating technical competence. When you learn a product design might be unsafe, what is your responsibility?
Emotional touchstones	The risk of challenging your superiors, your word against theirs. Are you willing to make allegations of misconduct without proof? Senior management deferring to your supervisor's decision (even if that person is not an engineer).
Desired experiences	How do you gain support for potentially expensive errors? Are companies willing to do a recall, or run the risk of customers being hurt? What burden of proof do you require to recall an existing product? What does it take before an engineer should blow the whistle?
Key choices	How far are you willing to go, when you feel a design might compromise the safety of those using your product?

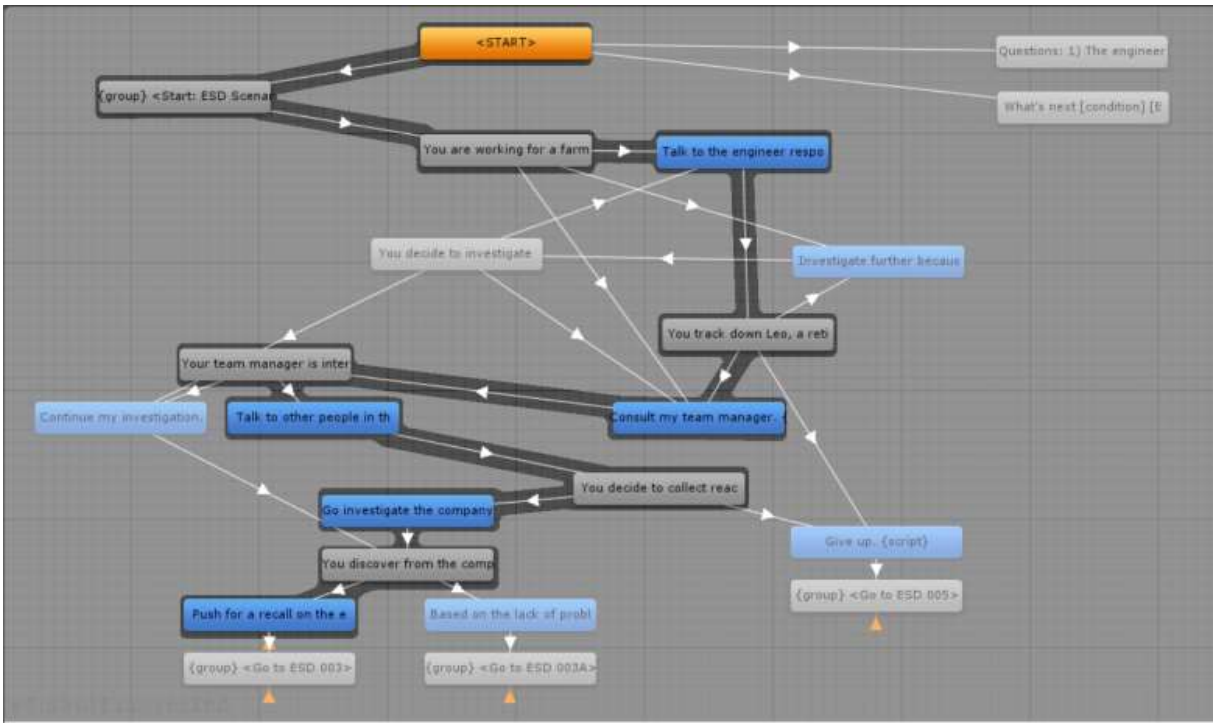

Figure 16: ESD — Sample Path — Part 1

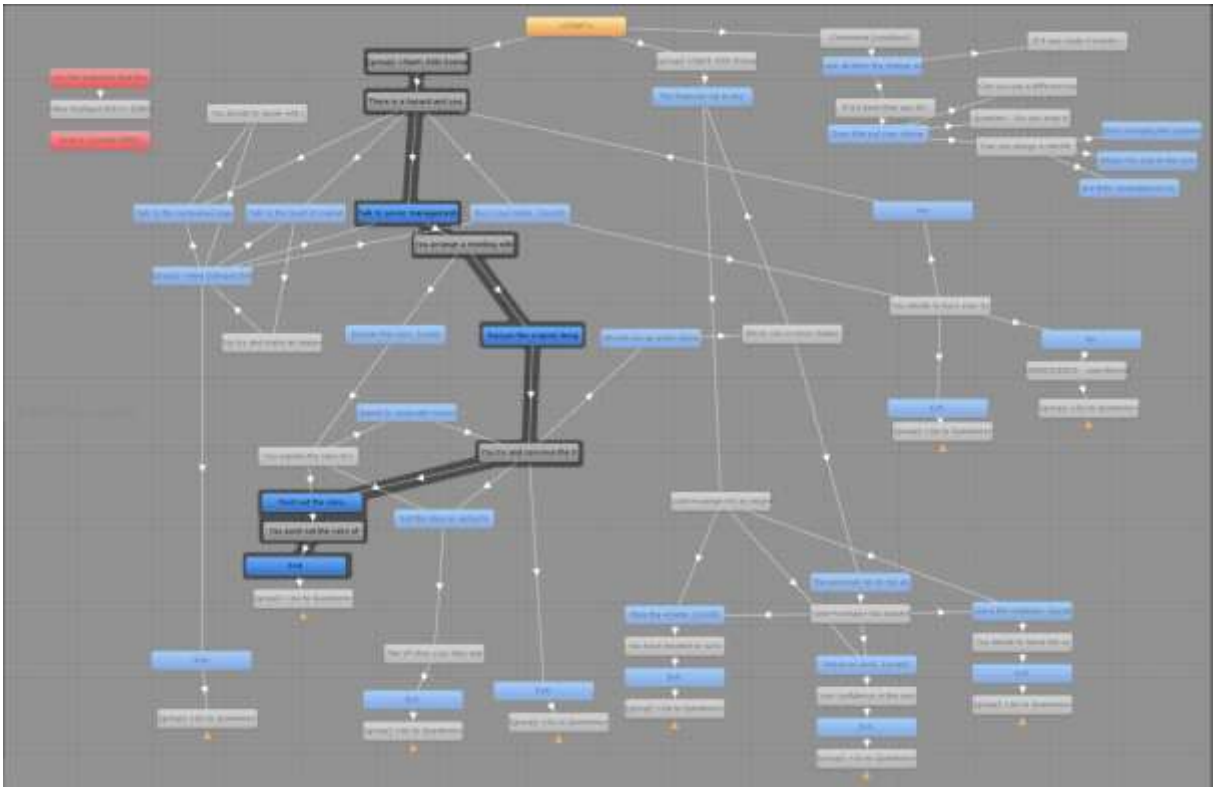

Figure 17: ESD — Sample Path — Part 2

Table 14: ESD — Sample Path — Dialogue Entries

Conv.	Node	Type	Text	Points
108	25	Narrative	You are working for a farm equipment manufacturer. As part of the engineering team, you are responsible for designing the next generation of combines. During testing, you notice that the existing design uses a PVC liner in its pipe that generates a lot of static electricity. What do you want to do?	
108	4	Response	Talk to the engineer responsible for the previous design.	Code 10
108	8	Narrative	You track down Leo, a retired engineer from the company and project lead for the previous combine design. He informs you that his design had a grounding wire inside the tube to minimize static charge and sparking. If that design change has occurred, it happened after he left the company.	
108	5	Response	Consult my team manager.	Rep 10
108	7	Narrative	Your team manager is interested in what you have found and wants you to make sure the current system is grounded. He directs you not to worry about the existing product as there have been no problems before.	
108	11	Response	Talk to other people in the company.	Rep 10
108	15	Narrative	You decide to collect reactions from your peers. And although they think your arguments have merit, they don't want to oppose the current manager.	
108	16	Response	Go investigate the company records.	Comp 10
108	12	Narrative	You discover from the company records that several years back, the engineering department was tasked with reducing the costs of the combine. These along with several other cost-cutting measures were approved by the Vice President. However, both the VP and the engineer who suggested the changes are no longer with the company.	
108	13	Response	Push for a recall on the existing combines.	trust 10

Conv.	Node	Type	Text	Points
13	26	Narrative	There is a hazard, and you know it. If it can be shown that this is something you should have known about, then the company is definitely at risk. In a lawsuit, your work could reveal the companies negligence. How would you like to proceed?	
13	47	Response	Talk to senior management.	Code 10 Comp 10 Rep 10
13	48	Narrative	You arrange a meeting with the VP of the company and explain your concern about how the combines could have a problem with grain dust.	
13	54	Response	Discuss the original design (with grounding).	Comp 10
13	65	Narrative	You try and convince the VP that the corporation should take responsibility for resolving this problem. Unfortunately, the VP supports your manager's decision that you are blowing the problem out of proportion.	
13	57	Response	Point out the risks.	
13	85	Narrative	You point out the explosion risk caused by grain dust and sparks, and the VP takes you very seriously. They arrange a meeting with the lawyer and agree to implement a recall and your solution.	Trust 10 Comp 10 Rep 100
13	96	Response	Exit.	

Table 15: ESD — Questions

Conv.	Node	Type	Text	Points
110	5	Narrative	Do you think the company should have listened to the junior engineer?	
110	3	Response	Yes.	
110	7	Narrative	As a junior engineer, should you inform the companies VP of a hazard even if your engineer team does not?	
110	8	Response	Yes.	
110	10	Narrative	Can you see a company terminating the junior engineer in a case like this?	
110	11	Response	Yes	

11.2.2 Case 2: A Friendly Conversation — Code of Ethics vs. Business Pressures

This case was built around the following questions:

- What is the value of being registered as an engineer?
- What role do engineers play in corporate structures?
- Why is it important for an engineer to protect the public interest?

This case was inspired by a conversation I had during my time as an Engineering Intern (EIT) that helped me understand the importance of being an engineer and encouraged me to complete the registration process. This case is designed to have the players choose encouraging arguments to help another engineer recognize the value of being registered.

Table 16: A Friendly Conversation — Summary

Aspect	Summary
Situation	An informal conversation with a friend who is thinking about resigning from the practice of engineering. The goal is to convince your friend that being a registered professional engineer has value to them and the work they do.
Consequence	None
Relevant Facts	Competitive pressures on price mean that the best engineer is not always chosen for the job. In construction, being the low bid may mean something has been forgotten resulting in shortcuts being taken to minimize losses. In manufacturing and consulting, the price considerations result in situations where the difference is made up in design changes once the customer has committed to a vendor.
Ethical considerations	What is the purpose of the engineering associations? Why is registration important? What images and expectations does the title Engineer carry with it?
Emotional touchstones	In the business world, many clients base their decision on the lowest bidder. Being ethical while competing with other companies for the lowest cost bid can be challenging.
Desired experiences	Consider what it means to be a Professional Engineer and why the title is important. Demonstrate empathy towards someone who is struggling with the value of being an engineer.
Key choices	Choose stories that demonstrate the value of being an engineer.

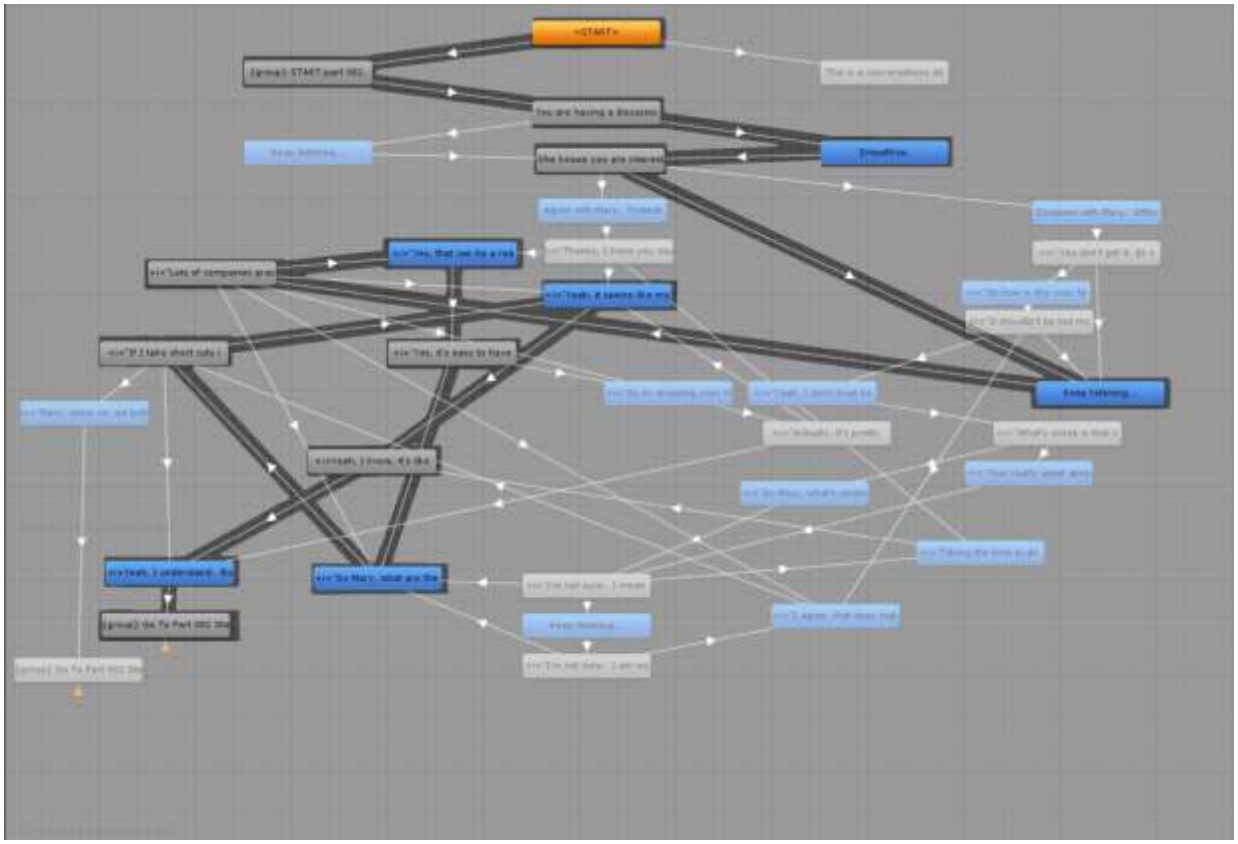

Figure 18: Friendly Conversation — Sample Case — Part 1

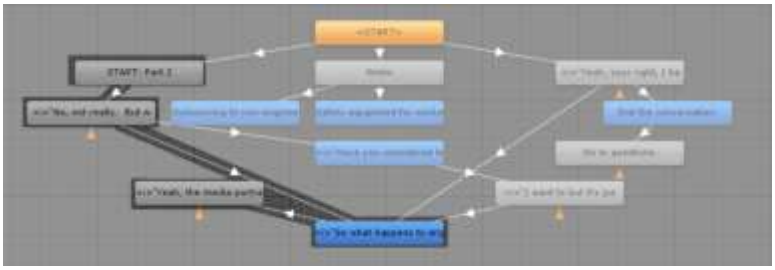

Figure 19: Friendly Conversation — Sample Case — Part 2

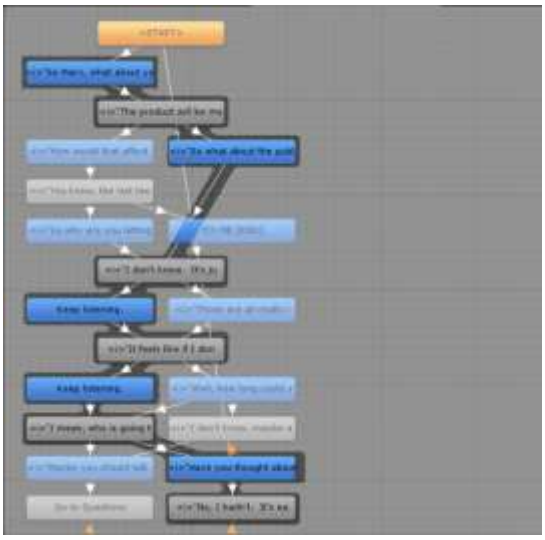

Figure 20: Friendly Conversation — Sample Case — Part 3

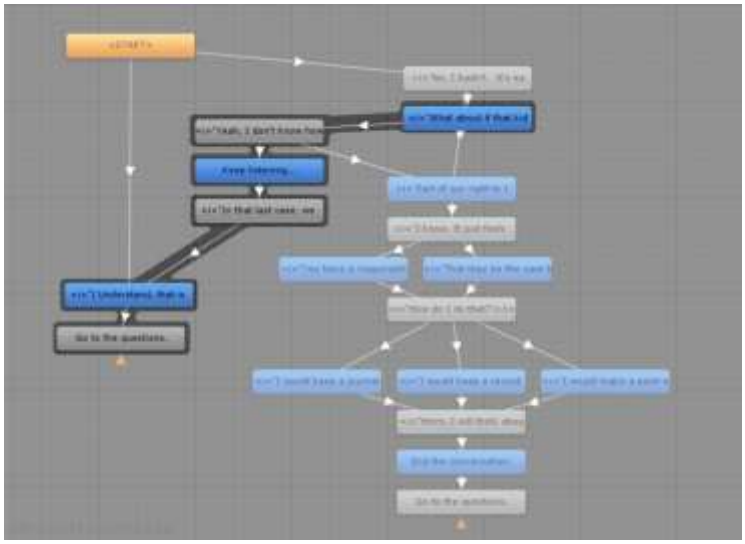

Figure 21: Friendly Conversation — Sample Case — Part 4

Table 17: Friendly Conversation — Sample Path

Conv.	Node	Type	Text	Points
5	3	Narrative	You are having a discussion with your friend Mary who's an engineer at a local manufacturing company. During the conversation, Mary tells you that she feels frustrated because one of the sales reps is trying to blame her for a new customer choosing her competitor's engineering team.	
5	63	Response	Empathise.	
5	44	Narrative	She knows you are interested in Engineering Ethics and says: "Being an ethical engineer and following the association guidelines are putting me out of business. It's raising my costs, making it hard to compete!"	
5	46	Response	Keep listening.	
5	53	Narrative	"Lots of companies practice low balling the development costs and then turn a profit by billing heavily on the design changes. That makes it hard to compete! Even when you are capable, clients seem more interested in the lowest cost than the quality of work."	
5	20	Response	"Yes, that can be a real challenge. Without customers, the company you're working for will disappear quickly. So you're being pressured to compromise, just to protect your job."	Fair(1)
5	55	Narrative	"Yes, it's easy to have principles. But sometimes things like money, family commitments and fear can make it really hard to follow them."	
5	51	Response	"So Mary, what are the costs of taking short cuts?"	Code(1)
5	37	Narrative	"If I take shortcuts in my work, most of the time people won't notice. Software updates are commonplace; electronic devices are often replaced every year. On top of that, no one will die because the voltages are a little off."	
5	14	Response	"Yeah, it seems like most companies are just driven by profit."	
5	60	Narrative	Yeah, I know, it's like here we are, as engineers we are duty bound to protect the public and serve our company. Yet managers and sales reps are only concerned with profit and making themselves look good!"	
5	57	Response	Yeah, I understand. But is that the kind of engineer you want to be?"	Rep(10)
24	9	Narrative	START: Part 2	
24	59	Narrative	"No, not really. But what can I do?"	

Conv.	Node	Type	Text	Points
24	7	Response	"So what happens to the engineering firms that get caught taking shortcuts or not doing the work properly?"	Trust(10)
24	71	Narrative	"Yeah, the media portrays them as heroes. But I think the reality is that they don't stay in business too long. You know now that I think about it when engineering failures hit the news, it often leads to inquiries, lawsuits, and lots of people getting hurt."	
11	72	Response	"So Mary, what about your company?"	Rep(1)
11	62	Narrative	"The product will be more likely to fail. It might not pass testing, and we could end up in a lawsuit."	
11	89	Response	"So what about the public?"	Trust(1)
11	90	Narrative	"I don't know. It's just that I need this job! I have a young family, a new mortgage, and all this responsibility.	
11	91	Response	Keep listening.	
11	92	Narrative	"It feels like if I don't do this, I will lose everything. All that work for nothing and nobody's even going to care!"	
11	93	Response	Keep listening.	
11	94	Narrative	"I mean, who is going to take care of my family?"	
11	10	Response	"Have you thought about what happens if someone gets hurt?"	Trust(10) Rep(10)
11	22	Narrative	"No, I hadn't. It's easy to forget that people sometimes do really stupid things and it's up to us to protect them. I mean, people don't like getting electrocuted when they drop coffee on their computer. But more seriously, if a kid got hurt because I cut corners, I wouldn't feel very good about myself."	
1	5	Response	"What about if that kid had died?"	Rep(-1)
1	23	Narrative	"Yeah, I don't know how I wouldn't know how to live with myself. The problem is, if we don't find ways to keep our costs down, then we don't get hired in the first place. How am I supposed to do the right thing and still be competitive?"	
1	24	Response	Keep listening.	
1	25	Narrative	"In that last case, we started out bidding on a contract, and almost straight out of the gate, the sales rep is hitting me up to lower the price. It seems like every contract; the salespeople keep coming back to me and trying to get the lowest price. While at the same time, the customer keeps wanting to add features with conflicting needs! It's driving me nuts!"	
1	79	Response	"I understand, that is challenging!"	Rep(1)
1	80	Narrative	Go to the questions.	

Table 18: Friendly Conversation — Questions

Conv.	Node	Type	Text	Points
9	2	Narrative	Should an engineer be held responsible for the decisions of a CEO?	
9	5	Response	I don't know.	
9	6	Narrative	What should you do if you're asked to cut project costs in order to get a contract?	
9	25	Response	Ask management to reconsider.	
9	8	Narrative	Your company has difficulty meeting a particularly challenging set of standards imposed by the governmental regulator. Management advises you to design a method to pass inspections without compromising the day to day performance of your product. Do you take on the challenge?	
9	10	Response	No.	
9	15	Narrative	Good job standing by your professional ethics. Think about how you can spin this so that a new employer will see this in a positive light. Hopefully, your next employer will value your professionalism.	
9	17	Response	Okay.	
9	18	Narrative	Did this particular set of questions make you uncomfortable?	
9	19	Response	No.	

11.2.3 Case 3: Construction Site — Workplace Responsibility for Others

This case is built around the questions:

- How do you respond to people doing unsafe work?
- How do you demonstrate professionalism in these situations?

Arc flashes and arc blasts are high-energy arcs and explosions that can occur when proper safety procedures are not followed. An arc flash[105] is an explosive release of energy forming a conductive plasma arc. This arc has extremely high temperatures and produces a blinding bright white light. In commercial situations, the arc flash is often accompanied by an arc blast which

[105] An interesting Youtube video on arc flash rated clothing, YouTube, *Arc flash: How to protect yourself*, https://youtu.be/Ar4UAb3Uwh8, accessed July 20, 2017.

is the shock wave accompanying the explosion. However, in addition to intense light, heat, and explosive force, an arc blast also carries with it the molten metal involved in the short. The severity of the explosion and proximity of the workers and is often fatal. Memorable examples of arc flash and arc blast can be found on YouTube.

As humans, we are often tempted to cut corners under tight timelines and doing so in this context could have very severe consequences. Engineers on a work site have a duty of care[106] to people on the work site, and this case is about dealing with a contractor who is taking shortcuts.

Table 19: Construction Site — Summary

Aspect	Summary
Situation	You discover a tradesperson who is cutting corners on the job site in a manner that could kill him and others around him.
Consequence	Surprising the electrical worker could result in an explosion killing the worker and the player.
Relevant facts	Arc flash and arc blast are high power electrical failures that can kill workers without warning. These hazards are part of the occupational health and safety requirements (CSA Z462-15) for companies, supervisors in Canada.[107] Employers not ensuring the safety of workers can be found guilty of criminal negligence. The key to preventing arc flash[108] and arc blast is following safe work procedures such as not working live, performing proper risk assessments, and following proper lockout-tagout procedures.
Ethical considerations	Duty of Care. Criminal negligence for failing to protect the lives of workers.

[106] This OSPE blog discusses how professional liability is evaluated, https://blog.ospe.on.ca/membership/understanding-professional-liability-for-engineers/, accessed May 31, 2017

[107] This is an article about employer responsibilities in Canada. Canadian eemployer's can receive fines up to $600,000 per offense for failing to protect workers. http://arcadvisor.com/faq/arc-flash-canada, accessed May 31, 2017.

[108] These articles go into the dangers of arc flash and how to prevent it. https://www.complyworks.com/en/blog/2015/01/21/csa-z462-preventing-the-dangers-of-arc-flash-and-shock/, accessed May 31, 2017
http://www.safetyandhealthmagazine.com/articles/12001-avoiding-arc-flash, accessed May 31,2017

Aspect	Summary
Emotional touchstones	People cut corners and may put themselves and others at risk by doing so.
Desired experiences	The situation needs to be handled with firmness and tact to stop unsafe work and resolve conflicts. Awareness of electrical safety issues in the workplace. De-escalating conflict in the workplace.
Key choices	How to stop the contractor without precipitating an explosion. How to resolve the fight that ensues with the tradesperson.

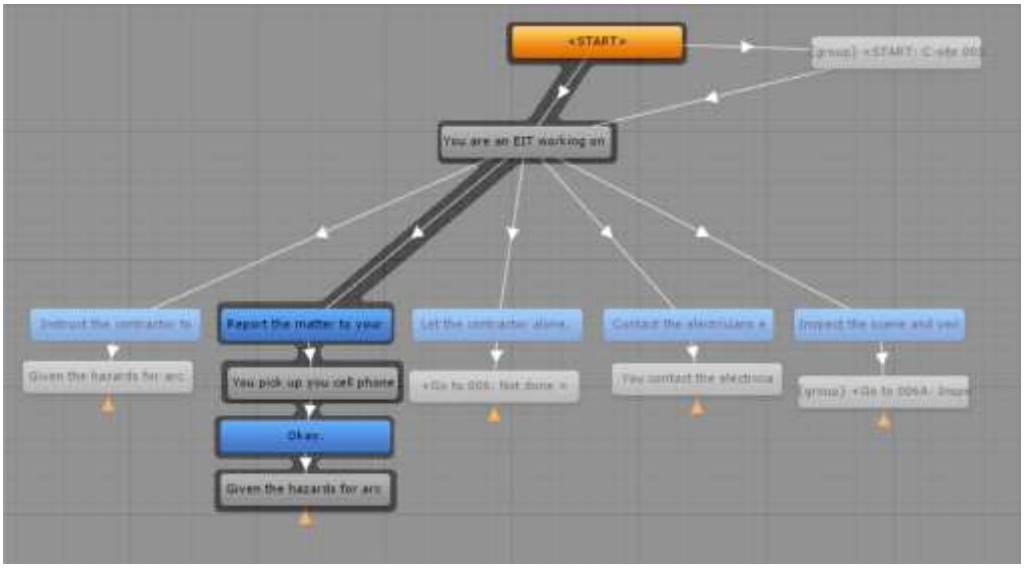

Figure 22: Construction Site — Sample Case — Part 1

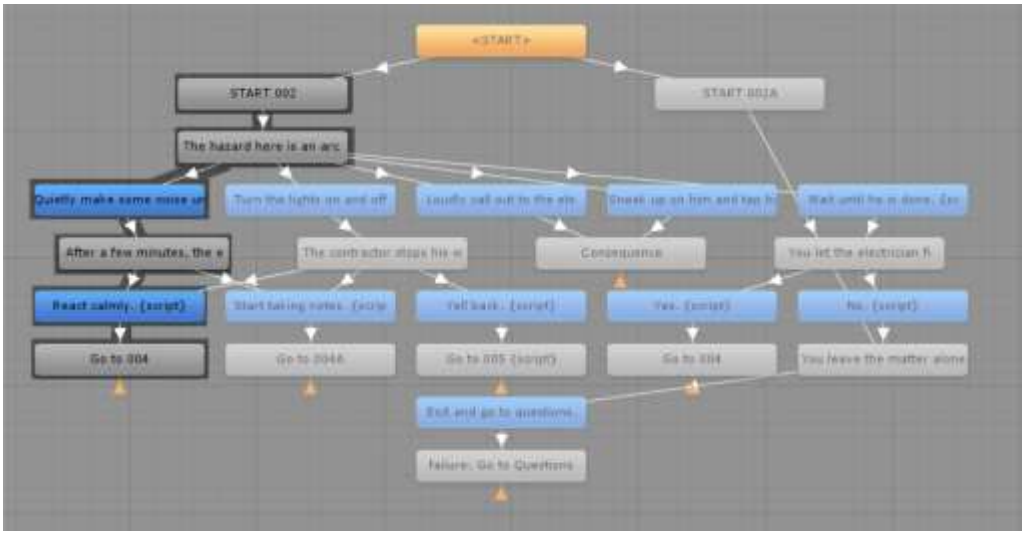

Figure 23: Construction Site — Sample Case — Part 2

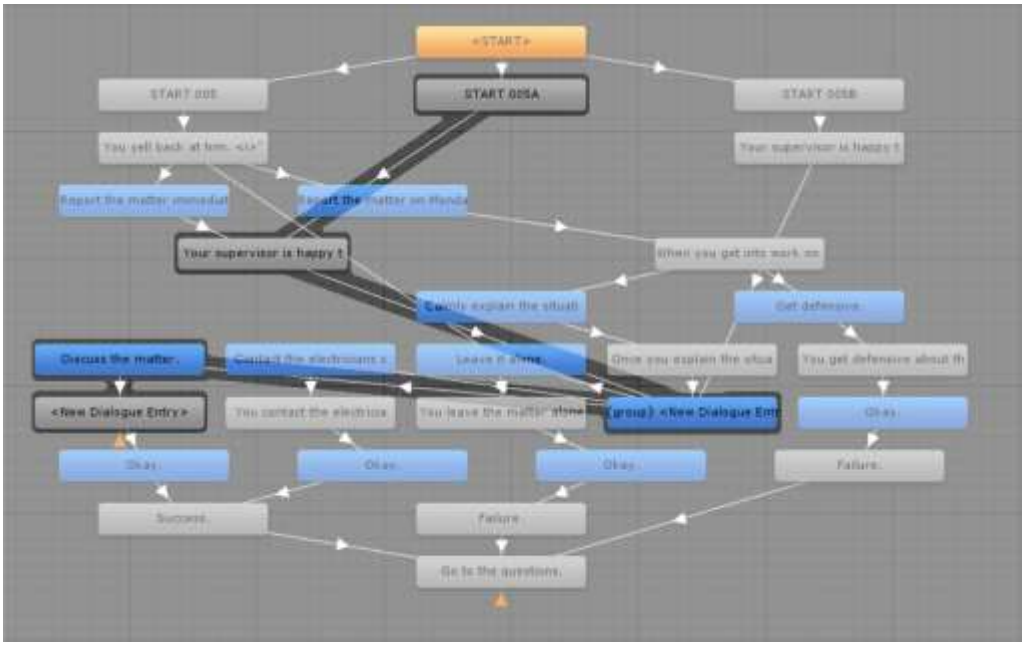

Figure 24: Construction Site — Sample Case — Part 3

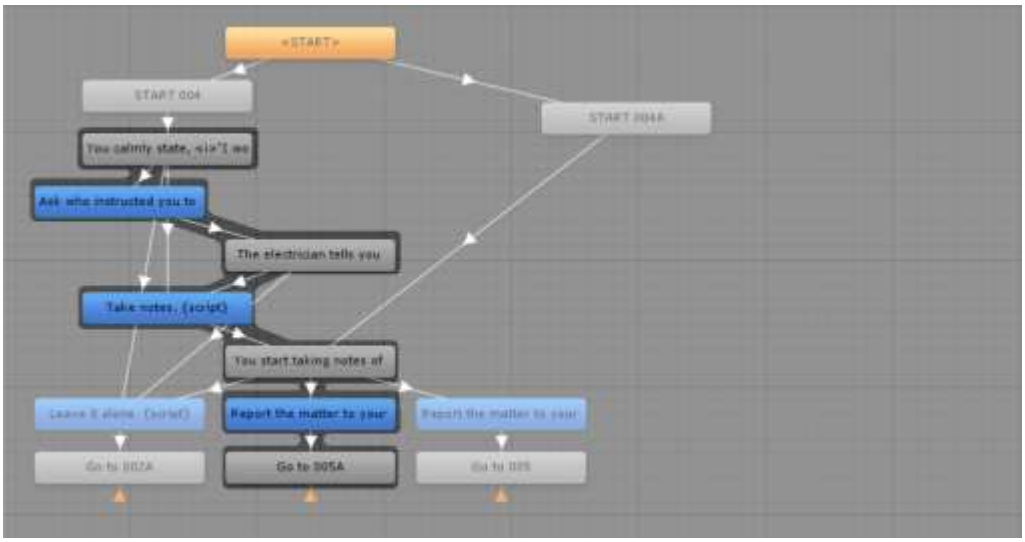

Figure 25: Construction Site — Sample Case — Part 4

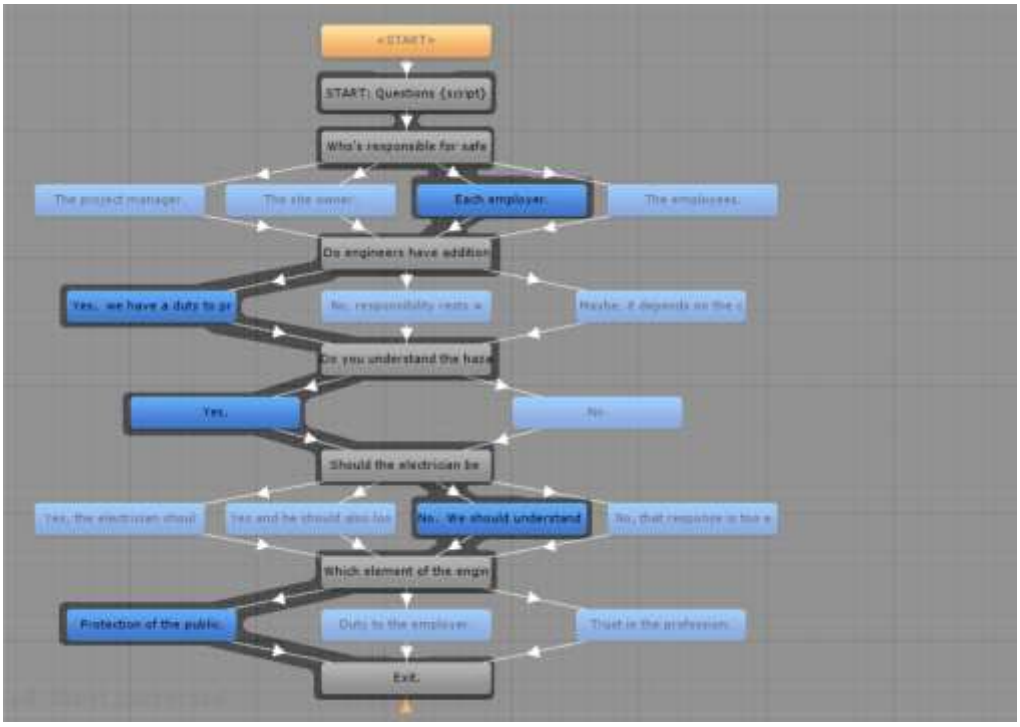

Figure 26: Construction Site — Sample Case — Questions

Table 20: Construction Site — Sample Path — Dialogue Entries

Conv.	Node	Type	Text	Points
43	2	Narrative	You are an EIT working on a construction site. Late Friday afternoon you notice an electrician working in the panel box for the building while it is live. This is a seriously dangerous activity. What do you do?	
43	4	Response	Report the matter to your supervisor.	
43	25	Narrative	You pick up your cell phone to call your supervisor. He instructs you to immediately stop the electrician and find out who he is.	
43	26	Response	Okay.	
43	7	Narrative	Given the hazard for arc blast is caused by shorting high power electrical circuits. How do you want to stop him?	
44	62	Narrative	START 002	
44	7	Narrative	The hazard here is an arc blast caused by shorting out parts in a high power circuit. People can die from this. How do you want to stop the electrician?	
44	9	Response	Quietly make some noise until he acknowledges your presence.	
44	33	Narrative	After a few minutes, the electrician takes notice of you and stops his work. He asks you, " Who are you? What are you doing here? Why did you interrupt me?"	
44	18	Response	React calmly.	
44	19	Narrative	You calmly state: "I work for the engineering firm in charge and I think the work you were doing was unsafe. Who instructed you to work on this panel?"	
53	61	Narrative	START 004	
53	58	Narrative	You calmly state, "I work for the engineering firm in charge and I think the work you were doing was unsafe. Who instructed you to work on this panel?"	
53	63	Response	Ask him, "Who instructed you to work on this panel?"	
53	64	Narrative	The electrician tells you that he is supposed to hook up the power for one of the units in the building, but he could not find the person in charge.	
53	65	Response	Take notes.	
53	21	Narrative	You start taking notes of the situation, and his behaviour. Once he calms down, you calmly get his name and employer information.	
53	28	Response	Report the matter to your supervisor immediately.	
53	30	Narrative	Your supervisor is happy that you stopped the situation and reported the matter to him. The electrician is disciplined and removed from your work site. Do you want to pursue the matter further?	

Conv.	Node	Type	Text	Points
52	63	Narrative	START 005A	
52	30	Narrative	Your supervisor is happy that you stopped the situation, and reported the matter to him. The electrician is disciplined and removed from your work site. Do you want to pursue the matter further?	
52	35	Response	Discuss the matter.	

Table 21: Construction Site — Questions

Conv.	Node	Type	Text	Points
49	33	Narrative	Who's responsible for safety in the workplace?	
49	14	Response	Each employer.	
49	5	Narrative	Do engineers have additional responsibilities in this situation?	
49	6	Response	Yes, we have a duty to protect the public.	
49	7	Narrative	Do you understand the hazards of working live?	
49	8	Response	Yes.	
49	9	Narrative	Should the electrician be barred from this workplace?	
49	20	Response	No. We should understand the situation completely before making this judgment.	
49	11	Narrative	Which element of the engineering act/by-laws/code of conduct is most relevant here?	
49	12	Response	Protection of the public.	
49	1	Narrative	Exit.	

11.2.4 Case 4: Out To Lunch — A Question of Bribery

This case is built around the questions:

- How would an Engineering Intern recognize bribery?
- What are the rewards and consequences for unethical behaviour?
- How can you protect yourself in these kinds of environments?

This case was based on reflection about transparency and making deals with suppliers. Depending on whom you speak with and the context they work in, gifts and kickbacks provided by suppliers for preferential treatment can be considered bribes.[109] [110] [111]

One key influence on this case was the ongoing Charbonneau Commission into corruption in Quebec. The commission revealed widespread political contributions, mafia control of the construction industry, and kickbacks from top engineering firms. Given that Engineering ethics is largely taught through mentoring, the question that formed in my mind was, what would an engineering intern learn if they were working in offices where corruption was commonplace?[112] What behaviours would they learn and would there be anyone there to help them if something was wrong?[113]

Table 22: Out To Lunch — Summary

Aspect	Summary
Situation	In this case, your supervisor/mentor includes you in questionable activities. Complying brings you short-term gains but ultimately leads to problems of corruption down the road.
Consequence	This is a slippery slope case in which it is easy to go along with receiving small gifts or consideration. However, it quickly grows into requests for preferential treatment and inside information.

[109] This page highlights common corruption techniques used in business. http://iacrc.org/procurement-fraud/the-most-common-procurement-fraud-schemes-and-their-primary-red-flags/, accessed May 31, 2017

[110] A UBC law paper on preventing municipal corruption. http://icclr.law.ubc.ca/sites/icclr.law.ubc.ca/files/publications/pdfs/Municipal%20Best%20Practices%20-%20Preventing%20Fraud%2C%20Bribery%20and%20Corruption%20FINAL.pdf, accessed May 31, 2017

[111] An Online Ethics Center (USA) involving questions of transparency and kickbacks.

[112] https://www.theglobeandmail.com/news/politics/quebecs-top-engineering-firms-colluded-on-kickbacks-charbonneau-probe-told/article7831256/, accessed May 31, 2017.

[113] This Globe and Mail article focuses on whistle blowers and their role in the Charbonneau commission. https://www.theglobeandmail.com/news/national/meet-the-five-whistleblowers-praised-for-their-role-in-the-charbonneau-commission/article27467914/, accessed July 16, 2017.

Aspect	Summary
Relevant facts	Many government organizations and private companies have rules against accepting gifts or special consideration. The Charbonneau Commission found widespread corruption in the Quebec construction industry.
Ethical considerations	Bribery, transparency, providing insider information.
Emotional touchstones	Mentoring is an important aspect of success in one's career. The question is, what happens when the people we trust lead us into unethical situations?
Desired experiences	The player should find themselves on a slippery slope so that they think about the unintended consequences of their actions. To consider the perception of illegal activities and the long-term impact of preferential treatment of suppliers.
Key choices	Whom do you trust? What precautions do you take? Where do you draw the line?

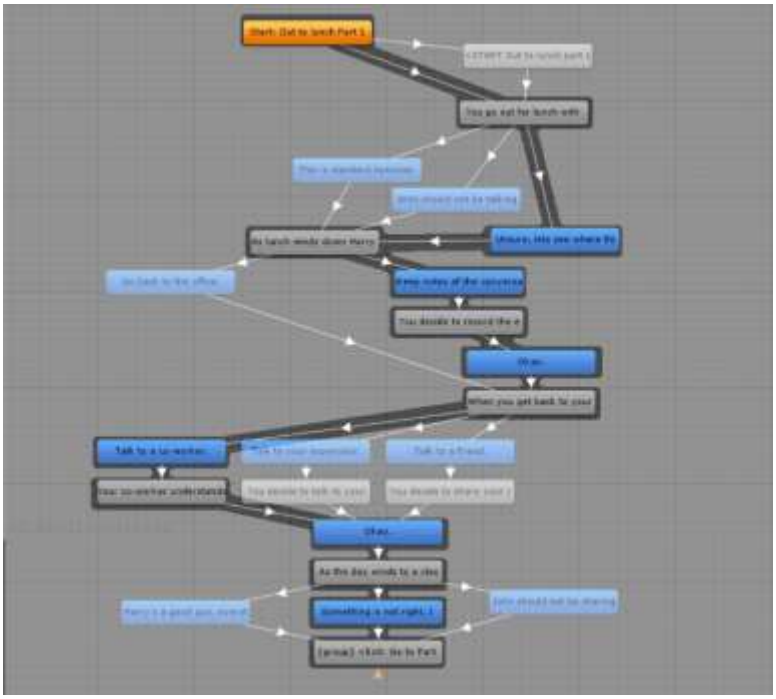

Figure 27: Out To Lunch — Part 1

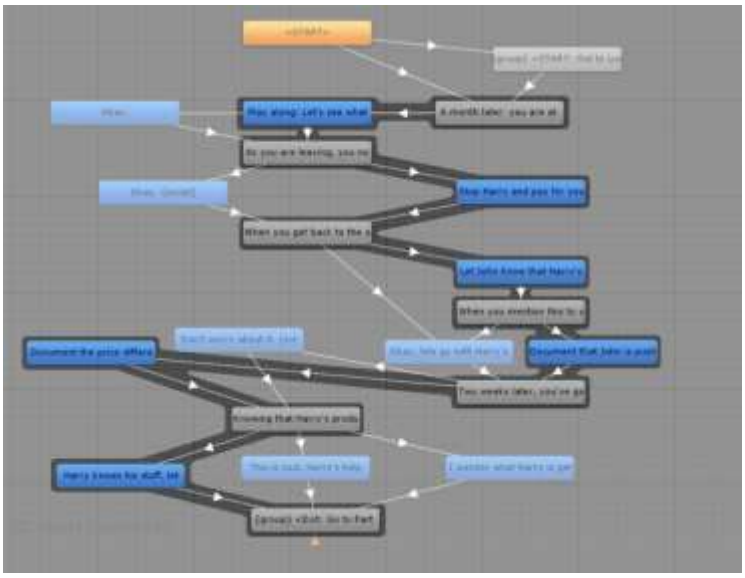

Figure 28: Out To Lunch — Part 2

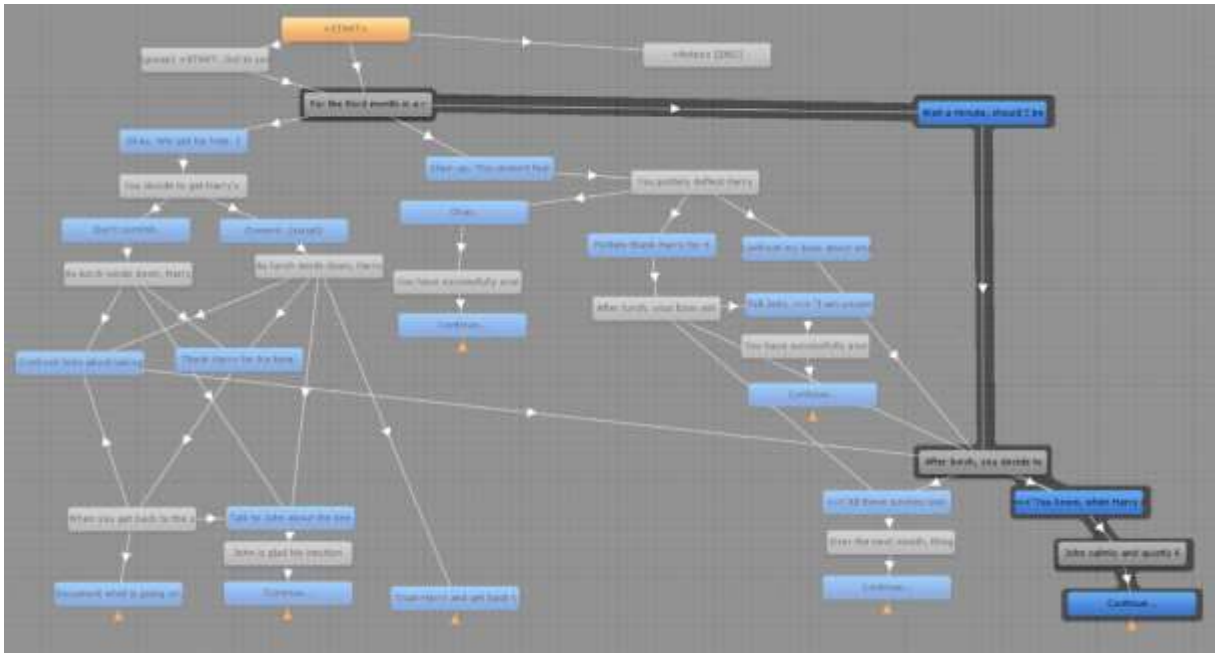

Figure 29: Out To Lunch — Part 3

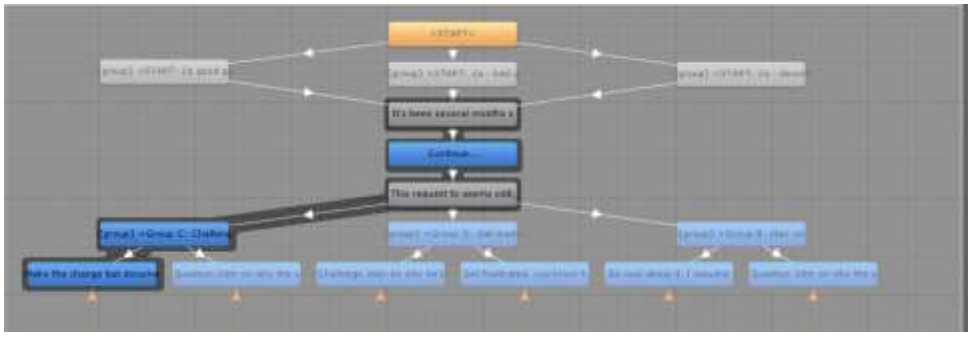

Figure 30: Out To Lunch — Part 4

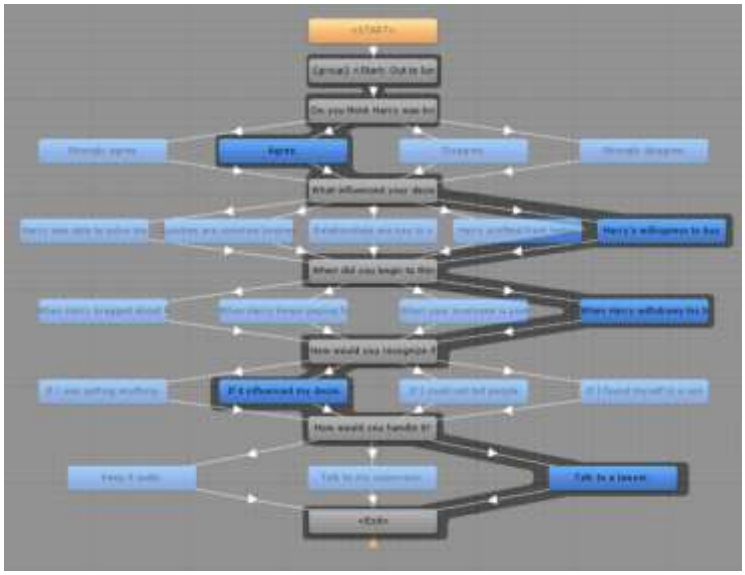

Figure 31: Out To Lunch — Questions

Table 23: Out To Lunch — Sample Path — Dialogue Entries

Conv.	Node	Type	Text	Points
4	1	Narrative	You go out for lunch with John your supervising engineer and Harry, a sales representative for XYZ industries. As lunch progresses, John and Harry start discussing business and how Harry can make them more successful. What's your take on this?	
4	6	Response	Unsure, let's see where this goes.	
4	12	Narrative	As lunch end, Harry extends his arm and suggest that he will pick up the check. Then he turns to you and comments "John thinks highly of you, would you like to join us for lunch next month?"	
4	24	Response	Keep notes of the conversation in a personal journal.	
4	30	Narrative	You decide to record the event in your personal journal.	
4	33	Response	Okay.	
4	20	Narrative	When you get back to your office, something about lunch is still not sitting right with you. You want to talk to someone, but whom?	
4	21	Response	Talk to a co-worker.	
4	28	Narrative	Your co-worker understands, Harry and the boss have a pretty tight relationship. And given a choice, the boss will choose Harry's company even if it means paying a little bit extra. Truthfully though if you need something in a rush, Harry is the guy you want to go to.	
4	31	Response	Okay.	
4	32	Narrative	As the day winds to a close, your thoughts go back to lunch. Given everything that's gone on. What do you think now?	
4	35	Response	Something is not right; I should watch my back.	
23	3	Narrative	A month later you are at lunch with John and Harry again. This time, John encourages you to tell Harry about a problem you have selecting parts for a new project. Harry listens carefully and suggests a part from his product line that will solve your problem easily.	
23	34	Response	Play along: Let's see what I can get out of this.	
23	24	Narrative	As you are leaving, you notice Harry and John having a private conversation during which time Harry once again picks up the check.	
23	35	Response	Stop Harry and pay for your own meal.	Code 10

Conv.	Node	Type	Text	Points
23	23	Narrative	When you get back to the office, John encourages you to check out Harry's suggestion and see how it compares to everyone else. What you discover is that Harry's product is quite good, but it costs more than the competitive products.	
23	36	Response	Let John know that Harry's solution is more expensive.	Rep 1
23	37	Narrative	When you mention this to your John, he recommends going with Harry, because Harry knows his stuff and it will work as promised.	
23	39	Response	Document that John is pushing you to use Harry's product.	Comp 10
23	27	Narrative	Two weeks later, you've got Harry's product, and it works like a charm, right out of the box! But because of the higher price, you are a bit concerned your customer might want you to justify this choice.	
23	28	Response	Document the price difference and reasons for your choice.	Trust 10
23	29	Narrative	Knowing that Harry's product works and will solve the customer's problem. What do you think of Harry as a vendor?	
23	30	Response	Harry knows his stuff, let's talk to him again.	Rep -10
32	3	Narrative	For the third month in a row, you head out for lunch with John and Harry. As you greet Harry, he says "Thanks, PLAYER that little project of yours turned into a real gold mine. Let's go celebrate!" At this point, Harry buys you both a very nice lunch and asks if there is anything else he can help you out with.	
32	36	Response	Wait a minute, should I be doing this?	
32	11	Narrative	After lunch, you decide to confront the matter and John that you do not take bribes. What would you like to say?	
32	45	Response	"You know — when Harry pays for lunch it makes me feel uncomfortable. It's like I'm taking a bribe."	Code 10
32	46	Narrative	John calmly and quietly listens to your concerns and comments, that he understands your feelings and concerns. Over the next few months, you notice you don't get invited out for lunch anymore.	
32	67	Response	Continue …	

Conv.	Node	Type	Text	Points
37	44	Narrative	It's been several months since your lunch with John and Harry, and things have been pretty quiet. But today when John comes back from lunch he asks you to re-evaluate the costs of a project based on using parts from Harry's company XYZ.	
37	45	Response	Continue …	
37	1	Narrative	This request seems odd because you have already found a lower-priced competitor. How do you react?	
37	3	Response	Make the change but document that John specifically told you to do so.	
36	54	Narrative	Although uncomfortable with what is going on, you decide to make the switch.	
36	13	Response	I document the change in my company journal.	Trust -10
35	41	Narrative	START: make the switch.	
35	7	Narrative	Six months later, your supervisor is being terminated. You suspect you will be called upon to justify your choice of Harry's company XYZ as the supplier.	Rep -100
35	9	Response	Play innocent.	Rep -10 Trust -100
35	20	Narrative	This doesn't work. You are terminated.	
35	63	Response	Exit and go to the questions.	

Table 24: Out To Lunch — Questions

Conv.	Node	Type	Text	Points
33	3	Narrative	Do you think Harry was bribing John?	
33	4	Response	Agree.	
33	7	Narrative	What influenced your decision most?	
33	29	Response	Harry's willingness to buy lunch.	
33	19	Narrative	When did you begin to think you were being used?	
33	24	Response	When Harry withdraws his help because I am not choosing him.	
33	12	Narrative	How would you recognize if you were being bribed?	
33	14	Response	If it influenced my decision making.	
33	17	Narrative	How would you handle it?	
33	27	Response	Talk to a lawyer.	

11.2.5 Case 5: Bad Software — A Question of Being Pressured to Break Copyright Law

This case is built around the questions:

- How would you respond to pressure from a supervisor to behave unethically?
- How reliable is simulation software?
- How do you convince others to behave more ethically?

A review of Andrews & Kemper (1999, pp. 150 -151) suggests, engineers should use two software packages when doing design to ensure the results are the same and can be trusted. During my time in industry working for a software developer, it was common practice for customers to evaluate the software products in order to assess its validity before purchase. These products ranged from$5000 to $60,000 per seat and it was important for customers to ensure the applications would work in their context. Unfortunately, in a number of some cases, companies would perform the required simulations and return the software at the end of the evaluation period.

Based on interactions with customers, this case frames the challenges an engineer might have if they want to get a second software package to validate their design work and their manager does not want to purchase the product.

Table 25: Bad Software — Summary

Aspect	Summary
Situation	The current design software is producing questionable results.
Consequence	Allowing the company to use software illegally could result in tens of thousands of dollars in settlement fees (in Canada).[114] The Business Software Alliance is an American based organization funded by Microsoft, Adobe, Hewlett-Packard, and others. Its function is to target enterprises using illegal software and take legal action.
Relevant facts	Software piracy is easy to do and common in today's society.[115] [116] Some companies and managers will use illegally-acquired software and turn a blind eye to how it was acquired.[117]
Ethical considerations	Duty to understand, interpret software results. Duty to obey the laws of the land, in this case, copyright.
Emotional touchstones	How do you make engineering judgments when the software tools you rely on are not reliable? How do you gain support to buy better tools and not have management cut corners on you?
Desired experiences	What do you do when you cannot trust your simulation software?
Key choices	What should you do when you question the software package you are currently using? (Andrews & Kemper, 1999, p. 150) Should you use "evaluation" software to validate your work? Can you share the company's intellectual property with outsiders

[114] This article published by Business Software Alliance details their anti-piracy practices and American style persecution of Canadian companies. http://www.itbusiness.ca/news/canadian-firms-pay-170000-to-anti-piracy-group/14816, accessed June 1, 2017.

[115] An news article breaking down the numbers for software piracy and some of the reasons it happens. http://www.itbusiness.ca/news/canada-not-a-pirate-haven-after-all-software-group-says/16724, accessed May 31, 2017.

[116] http://vancouversun.com/news/staff-blogs/confused-about-copyright-in-canada-a-guide-to-recent-changes-in-canadas-internet-piracy-laws-with-video, accessed May 31, 2017

[117] An ItWorldCanada article discussing corporate software piracy numbers. http://www.itworldcanada.com/article/the-steep-price-of-software-piracy-in-canada/14268, accessed May 31, 2017.

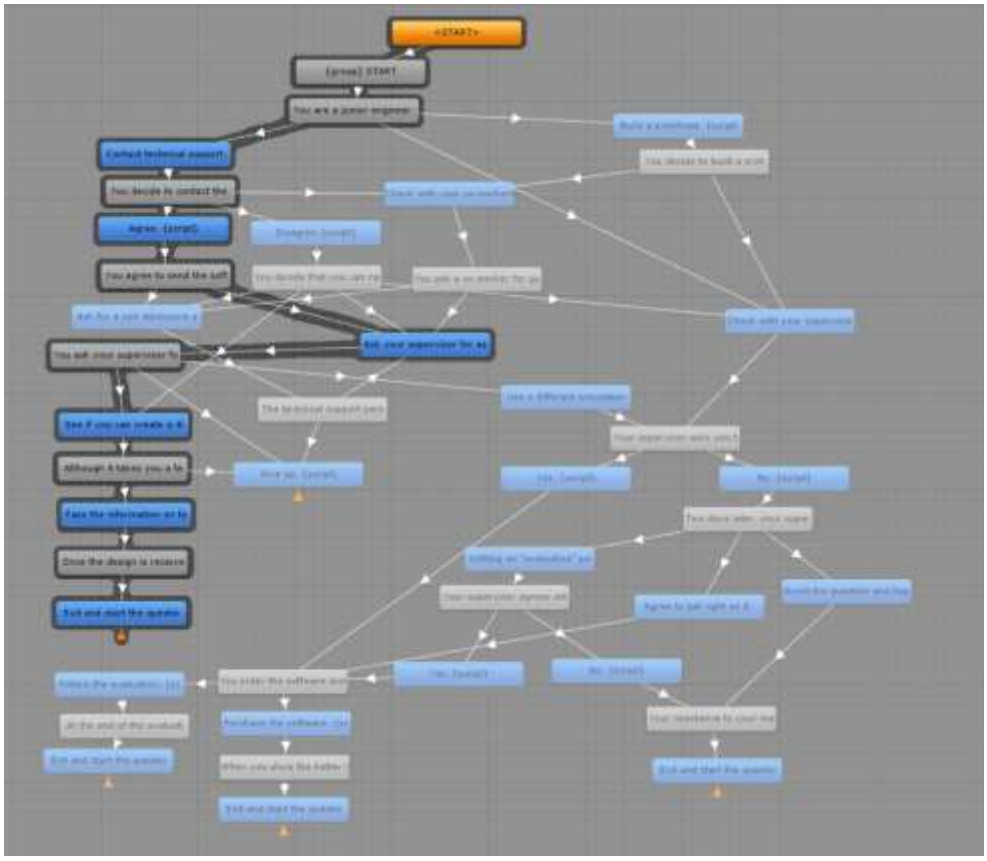

Figure 32: Bad Software — Sample Path

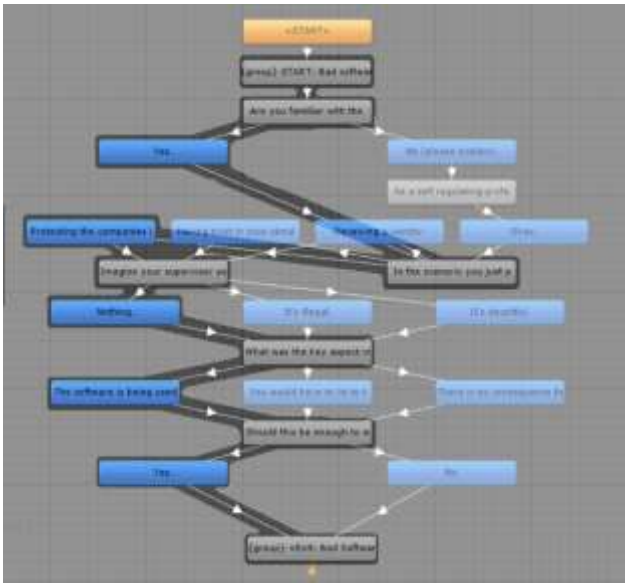

Figure 33: Bad Software — Questions

Table 26: Bad Software — Sample Path — Dialogue Entries

Conv.	Node	Type	Text	Points
46	2	Narrative	You are a junior engineer in a manufacturing company. Your current assignment is to design a sensor that fits within a gearbox. Although you have done this before, the current design is complex enough that nonlinear finite element analysis is required. During the simulation of linear versions of the model, your simulation results are close to your calculations. However, when you introduce a nonlinear material, the results differ substantially from your previous results. In order to keep moving on the project, what would you like to do?	
46	4	Response	Contact technical support.	
46	7	Narrative	You decide to contact the software companies technical support division. They listen to your problem and ask you to send them a copy of your design so they can check it out. Typically, it's just a matter of looking at how you set up the model.	
46	8	Response	Agree.	Comp -10 Rep -10
46	16	Narrative	You agree to send the software company a copy of your files. However, a co-worker overhears your conversation and immediately advises you not to do so. Doing this could make the design public knowledge and release a trade secret. You are strongly advised to speak with your manager.	
46	13	Response	Ask your supervisor for assistance.	Rep 1
46	15	Narrative	You ask your supervisor for assistance. And although like you, he is disappointed with the results, he asks you to create a different model with the same problems. This is important because he doesn't want the sensor design to become public information.	
46	14	Response	See if you can create a different model that has the same problem.	Comp 1
46	18	Narrative	Although it takes you a few attempts, you successfully make a model that creates the same nonlinearity issues you encountered with your design. As far as you can tell, it has to do with numerical round-off and the element size around the corners of your design.	
46	19	Response	Pass the information on to technical support.	Comp 1

Conv.	Node	Type	Text	Points
46	20	Narrative	Once the design is received, technical support confirms your observation and suggests a workaround. You are still not happy with the fix as it leaves your prior work in doubt.	
46	21	Response	Exit and start the questions.	

Table 27: Bad Software — Questions

Conv.	Node	Type	Text	Points
47	2	Narrative	Are you familiar with the requirement for skilled practice?	
47	3	Response	Yes.	
47	5	Narrative	In the scenario, you just played, what was the most pressing engineering ethical issue?	
47	7	Response	Protecting the companies intellectual property.	
47	10	Narrative	Imagine your supervisor asked you to "evaluate" a third party software to ascertain if the results were correct. What is wrong with doing this?	
47	12	Response	Nothing.	
47	15	Narrative	What was the key aspect of your choice?	
47	16	Response	The software is being used for a commercial purpose without paying for it.	
47	21	Narrative	Should this be enough to warrant disciplinary action by your provincial engineering association?	
47	22	Response	Yes.	

11.3 Points Structure

Games typically have two types of scores: status indicators and permanent scores. Status indicators will change frequently throughout the game and typically represent aspects of the character like player attributes, health, and faction status. Permanent scores serve to indicate a player's progress, cumulative experience and relative performance in the game.

Player progress is demonstrated by six status indicators tied to the dimensions of professional practice (Table 28) and a permanent score that demonstrates overall progress in the game. Both the status indicators and permanent scores are arbitrary and included to encourage play rather than be used as assessment tools.

The status indicators were chosen because they highlight different aspects of professional ethics that are important to engineering. As the game progresses, players will find themselves making decisions that affect different aspects of their professionalism or have both good and bad ramifications simultaneously. For example, blowing the whistle may be in the best interest of the public (+100 Trust) while simultaneously destroying the trust of their coworkers (-100 Reputation).

Table 28: Dimensions of Professional Engineering Practice — Status Indicators

Ethics Indicator	Designator	Description
Trust	Trust	Acting in the public interest
Reputation	Rep	In-house peer reputations
Risk	Risk	Risk management
Code	Code	Act, by-law, and code of ethics compliance
Competence	Comp	Technical competence
Fairness	Fair	Fairness with clients and co-workers

The value of status indicator points assigned corresponds to the relative impact of choices measured on a logarithmic scale. Trivial choices have little impact, while significant ones will stay with you for the rest of your career. Trivial, moderate, and significant choices are given values of 10^0, 10^1, and 10^2 respectively. Thus, one bad decision (-10) can wipe out the gains achieved by several smaller ones (+1).

Table 29: Dimensions of Professional Engineering Practice — Scoring Rubric

Description	Points	Scope of impact	Example
Very Bad	-100	Well beyond the player	Destroying evidence
Moderately bad	-10	Primarily the player	Withholding documents
Trivially bad	-1	Easily forgotten	Lying
No impact	0	Assumed behaviour	Doing routine calculations
Trivially good	1	Easily forgotten	Helping others
Moderately good	10	Primarily the player	Proactively solving a problem
Very good	100	Well beyond the player	Encouraging company-wide ethics

Table 30: Dimensions Of Professional Engineering Practice — Scoring Example

Conv. ID	ID	Type	Text	Points
108	25	Narrative	You are working for a farm equipment manufacturer.	
108	4	Response	Talk to the engineer responsible for the previous design.	Code 10
108	8	Narrative	You track down Leo, a retired engineer from the company…	
108	5	Response	Consult my team manager.	Rep 10

Permanent scores are built into games in order to reward the player for exploring and to give them a sense of progress. Unlike status indicators, permanent scores serve to reward players for taking action and demonstrating mastery (Zichermann & Cunningham, 2011) and should never be penalized. Players should always be rewarded for trying new things as every experience is a learning experience which brings the player closer to mastery.

In the context of this game, the permanent points are assigned by calculating the sum of the absolute value of each status indicator change. Thus if the player made a very good decision (+100), with very negative consequences (-100), the assigned points score would be 200 points, In the case of polar decisions like whistleblowing (Table 31), the resulting score would be quite high.

Table 31: Scoring — Whistle Blower Example

Ethics Indicator	Status Change	Points Value	Description
Trust	+100	+100	This is in the public's best interest
Reputation	-100	+100	Destroys trust with coworkers
Risk	-100	+100	This act could destroy the engineer's career
Code	+100	+100	Code of ethics puts protection of public interest first
Competence	0	0	Depends on circumstances
Fairness	0	0	Depends on circumstances
Points (sum)		+400	$\sum\lvert status\ indicator\ changes\rvert$

A reasonable criticism of this point scheme is that rewards undesirable behaviour and may send the message that unethical play is good. A value proposition encountered in many first-person shooters. But the key to recognize is that a high score in permanent points, means that players have consistently chosen items which had strong ethical implications. In Table 31, the very high score in is the result of pitting one value scheme against another. The player is choosing to protect the public over his or her personal reputation and career. Hopefully, this is not a decision player's have to make in real life -- rather one they only encounter in a virtual world.

11.4 Summary

Ethical dilemmas are choices in which the outcomes are unknown, and the correct direction is unclear because of the presence of "right" answers or conflicting success criteria. This chapter examined the motivation and experiences underlying the five cases. The highlighted paths through each case dialogue and associated text were chosen to provide a meaningful context.

Key points:

- The game has almost 700 dialogue entries spread over 5 cases.
- The cases focus on the non-technical day to day experiences an engineer could encounter.
- There are no "right" answers, only choices and consequences.
- Scoring is based on themes found within the *National Guidelines on the code of ethics* (Table 3 p.56) reflecting protecting the public interest (trust), affect the engineers reputation (rep), demonstrate an ability to manage risk (risk), compliance with the code of ethics (code), technical competence (comp) and fairness to others (fair).

12 Design Review

"After all, the only way to tell if a game is any good is to play it."[(Hirumi, Appelman, Rieber, & Van Eck, 2010b) used with permission]

In order to assess whether the project accurately represented professional engineering, Professional Engineers in Manitoba were asked to serve as playtesters in order to assess the validity of the cases and identify areas for improvement. This chapter looks at the recruitment of playtesters, game coverage, survey results, and lessons learned. Overall, the feedback from playtesters constructive and their comments inferred a need for this type of training experience to complement the existing methods of preparing for the National Professional Practice Exam.

12.1 Recruitment and Participant Retention Rates

During the summer of 2016, two cohorts of Engineers and Engineering Interns were recruited to test the game through the Engineers Geoscientists Manitoba (EGM) email newsletter (June 30, 2016, and August 9, 2016). This recruitment method was chosen because it targeted engineers in the province who were invested in the engineering profession while providing anonymity for engineers who did not wish to participate. The engineers who responded took the time to read, consider, and act upon the Engineers Geoscientists Manitoba newsletter.

Table 32: Playtester Actions

Step	Action	Common Timelines
1	Read Engineers Geoscientists Manitoba email newsletter.	Start
2	Indicate interest via email.	<1 day
3	Review, sign and return an informed consent form.	7 days
4	Receive a download key from the researcher.	7 days
5	Download the program.	14 days
6	Play the game.	30 days
7	Complete a survey and locate the game generated log files.	30 days
8	Email the researcher the data.	30 days

In order to provide meaningful and manageable feedback, a goal of testing the game with 10 to 20 Engineers was set. As people expressed interest, this goal was expanded to include Engineering Interns because they were part of the games target audience and their focus on preparing for the National Professional Practice exam was considered valuable. Upon review of the surveys, 5 of the 16 participants who completed all (31%) were Engineering Interns.

The key challenge in recruitment and retention was the time involved. Even though most respondents replied within hours of the EGM newsletter being sent out, the process of moving from expressing interest to having completed consent generally took one week. After the participants had downloaded the game, getting feedback generally took about another month. The reason for these long delays is that playtesters had to demonstrate informed consent (Table 32 steps 1-4), download the game (step 5), find time to conscientiously play the game (steps 6)), and provide feedback (steps 7-8).

The 16 playtesters who completed the survey and submitted their log file responses provided feedback to make informed judgements about how the cases reflected engineering practice and areas in which they could be improved. The additional e-mail feedback also reflected a positive evaluation of the game and its application as a learning environment. It made playtesters reconsider what it meant to be an engineer and they felt that others could benefit from the same experience.

Table 33: Participant Retention Rates

Status	Cohort		Notes
	1	2	
Interested	19	14	Most participants replied on the day the newsletter came out.
Consent received	18	12	Written consent via email was sufficient.[118]
Download completed	16	8	Based on download keys.
Some feedback received	13	6	Volunteers who submit some feedback.
Complete:	11	5	Surveys and log files received.

[118] ENREB is the University of Manitoba Education and Nursing Research Ethics Board to which Engineering is assigned. It is the board of jurisdiction for ethics approval in this project.

Of the 33 volunteers who expressed interest (Table 33), 24 downloaded the software and 19 of those provided feedback on the game. The initial drop from 33 to 24 (27% drop) is directly attributable to the involved consent process required for ethics approval. Despite the respondents indicating their interest within hours of the EGM newsletter being distributed, consent took several days of back and forth emails.

Basing the feedback numbers on the 24 participants who actually downloaded the game, 19 (79%) provided feedback, 16 (66%) completed the survey. By comparison, articles from the American Journal of Pharmacology Education, SurveyGismo and FluidSurveys all indicate these response rates are quite reasonable.

In his editorial on research reliability (Fincham, 2008) set a target response rate of 80% and noted that E-mail response rates of 25-30% were to be expected without follow up phone calls and in-person visits.

The SurveyGizmo[119] posting entitled "3 Ways to Improve Your Survey Response Rates", suggests that typical response rates are 30-40% for internal surveys and 10-15% for external ones. The article also points out that 85% response rates can be achieved through well-constructed surveys given to a motivated audience.

The FluidSurveys[120] posting *Response Rate Statistics for Online Surveys -- What Numbers Should You be Aiming For?* Revealed similar numbers, their average response rate for email

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[119] SurveyGizmo posting entitled "*3 Ways to Improve Your Survey Response Rates*". https://www.surveygizmo.com/survey-blog/survey-response-rates/, last accessed Sept 10, 2017

[120] FluidSurveys posting entitled "*Response Rate Statistics for Online Surveys -What Numbers Should You be Aiming For?*" http://fluidsurveys.com/university/response-rate-statistics-online-surveys-aiming/, last viewed September 10, 2017.

surveys was 24.8% and suggested that internal employee surveys could reach as high 90% with the right motivation and incentives.

Given that motivation, connection with the results, and reward schemes are all important factors in driving survey response, the fact that volunteers who were not receiving rewards reached a completion rate of 48% mark infers that they saw value in providing meaningful feedback.

12.2 Coverage

To assess the level of playtesting coverage, the 64 log file submitted by the playtesters were analyzed. Of these, 6 were rejected because they contained just the header data created when players launched the game. In the remaining 58 files, the number of nodes viewed ranged from a minimum of 8 to a maximum of 784. Across all files, 9245 nodes were recorded resulting in 577 unique entries. And while not all nodes were viewed, it is reasonable to expect that the unviewed dialogue nodes could likely be culled off and the functional testing nodes removed.

Table 34: Playtesting Coverage

Node type	Nodes Viewed	Total Nodes	Coverage
Gameplay Dialogue	553	781	70%
Functional Testing	24	94	26%
Total	577	875	66%

12.2.1 Design Review -- Purpose and Scope

The motivation for the design review is to solicit outside feedback in order to asses if the game is on or off target in meeting its design goals and to then identify areas of improvement.

In the two subsequent questions, the word *valid* is chosen because it is assumed that this project will be refined and improved after this thesis and the questions are asking, are the foundations upon which this project is built reasonable and leading to the desired learning outcomes.

The first question is, are the cases themselves valid representations of the dilemmas encountered in engineering? As the cases were designed to meet the learning outcomes of recognizing, appraising, and reacting to ethical situations that surround engineering practice, it is important

that the stories, decisions, and outcomes written in the cases reasonably represent engineering practice as seen by practicing professionals. If the cases seem realistic and make sense -- then they are considered valid at the case level and reasonably represent non-technical aspects of engineering practice and professionalism.

The second question is, is the method of using a non-linear dialogue valid? This question reflects on the underlying methodology. The assumption was that the use of stories, non-linear dialogue, and putting players into a protagonist role would create a positive learning environment which caused players to reflect on their professional responsibility and what it means to be an engineer. If both the cases themselves and the questions that follow causes reflection, then the method can be considered valid.

Assuming the cases are accurate, and the method causes reflection, the next question is, is the game working? Based on the literature, the assumption here is that a video game *can* be a very effective learning environment. However, glitches, layout, language, instructional design choices, along with the foundational design choices can prevent this from happening.

As a developer, it is challenging to see the game from the player's perspective, because you already understand the game mechanics, what is supposed to be going on, and the behaviours you expect of players. Thus, the question that needs to be asked of the players, is what is going on for them, detracting from the environment and how can it be improved?

The effectiveness of the game, is then a subjective assessment of how the combination of the cases, method, and game mechanics work together to create a learning environment and an acknowledgement of the detractors which move players out of the magic circle.

12.3 Survey Questions

A nine-question survey was distributed with the game to assess; the playtesters familiarity with the Engineers Geoscientists Manitoba code of ethics (Questions 1-2), whether or not the method is valid (Questions 3-6), and what improvements need to be made (Questions 7-9).

As a development tool, the survey served to confirm if the cases being presented were in fact authentic. Did they represent engineering practice and did they cause players to consider their professional responsibility?

Table 35: Survey Questions

	Survey Question
1	Are you an engineer?
2	Are you familiar with the Act, By-laws, and Code of Ethics that govern Engineering in Manitoba?
3	In your opinion, do the cases seem realistic?
4	Did the cases cause you to think about your professional responsibility?
5	In your opinion, did the questions and answers make sense?
6	Did the questions cause you to think more about the case?
7	Are there any glitches in the software?
8	Do you have any recommendations for improvement?
9	Any other feedback that you feel is valuable?

Questions 1-2 served to qualify the playtesters and validate that they were familiar with Manitoba's Act, Bylaws, and Code of Conduct. Although each participant met these criteria, the lack of this experience base would have made the playtesters comments suspect and caused them to be rejected from the design review.

Questions 3-6 focus on ensuring that the game content is authentic. Were the cases realistic and representative of real-world practice? The answers here will lead to improved narrative and choices in future games.

Questions 7-9 asked playtesters to take a critical look at the program as a whole and recommend improvements. This feedback is important because it helps identify which problems are most affecting the player experience, reducing engagement, and compromising the effectiveness of the experience.

Despite its brief nature, the consistency of responses and specific references to in-game dialogue, allowed for clear trends to be identified and corrections to be made. Although some questions could be improved in future surveys to encourage further depth, none of the responses were inconsistent with the questions being asked.

Questions about engagement, retention, and transfer were not addressed in this survey for three reasons. First, game design is an iterative process, so engagement was not assumed. Second, playtesters were evaluating the game rather than playing it. Their reasons for participating were different from future players. Third, the key value of the survey was to assess is this design progressing in the right direction. For future researchers wanting to investigate player engagement, dialogue coverage with greater statistical confidence, the use of analytics (Section **Error! Reference source not found.**) is highly encouraged.

A total of sixteen surveys received and each question was analyzed in three ways; first by classifying the responses as yes/no or partial, second by encoding the responses and looking at themes which appeared three or more times, and third by looking at the responses as a whole and considering what lessons could be learned.

12.4 Question 1: Are You An Engineer?

The purpose of this question was to classify playtesters as Engineers, Engineering Interns or members of the public. For this question, there were ten Professional Engineers, one Retired Engineer, five Engineering Interns, and no members of the public. These numbers make sense because the email newsletter was distributed to members of the Engineers Geoscientists Manitoba (EGM) and the specific language in the announcement specified engineers.

Table 36: Question 1 Survey Results

	Yes	Partial	No
Engineers	10	1	0
Interns	5	0	0
Total	15	1	0

12.4.1 Themes

In these responses, 3/4 of the playtesters included whether they were a Professional Engineer (7) or an Engineering Intern (5). The remaining four respondents simply indicated yes and were counted as Professional Engineers. An interesting note is that all five of the engineering interns identified themselves with the old titles of "Engineer-in-Training" (3 times) or a "Member-in-Training" (2 times) rather than Engineering Intern.

12.4.2 Interpretation

In order to obtain a range of meaningful feedback, a target of 10 to 20 knowledgeable people was set. This target was reached with 33 people expressing interest and 16 people playing the game and providing survey feedback. The fact that nearly one-third of the playtesters were Engineering Interns was an unintended advantage for this project because they are part of the target audience and their responses are more likely representative of their peers than engineers who have been practicing for quite some time.

12.4.3 Lessons Learned

While many of the respondents simply answered yes, several answers demonstrated that the differentiation between an Engineer and a Professional Engineer was prevalent in the minds of participants. Adding the word professional to the question would alleviate this confusion.

12.5 Question 2: Are You Familiar with the Act, By-laws, and Code of Ethics that Govern Engineering in Manitoba?

The objective of this question was to assess the level of prior knowledge of the playtesters with the act, by-laws, and code of ethics. Given the audience, it was assumed that Engineers would answer yes, Engineering Interns would answer partially, and members of the public would answer no. However, the feedback indicated that Engineering Interns felt that they knew the act, by-laws, and code of ethics very well, whereas Engineers expressed more general familiarity with the topic. These results make sense because the Engineering Interns are required to study the act, by-laws, and code of ethics in preparation for their professional practice exam (Association of Professional Engineers and Geoscientists of Alberta, n.d.). It is a topic that Engineering Interns need to pay attention to.

Table 37: Question 2 Survey Results

	Yes	Partial	No
Engineers	7	4	0
Interns	4	1	0
Total	11	5	0

12.5.1 Themes

The two themes that appeared in the answers were either yes or somewhat. Of the Professional Engineers who responded that they were somewhat aware of the act, by-laws, and code of ethics, most articulated that they had a passing familiarity with the content. One respondent, in particular, replied: "Mostly. I studied them and know the gist of them, but I do not have them all committed to memory." [Playtester 30 — Engineer]

12.5.2 Interpretation

Based on feedback recommendations, I suspect the strong response from Engineering Interns is tied to their focus on writing the National Professional Practice Exam which requires them to study the act, by-laws, and code of ethics for their province. In contrast, the Professional Engineers would likely have integrated these behaviours into their professional practice and long forgotten the specific wording used in these documents. As two of the Engineers responded; "Somewhat familiar – it's been years since I read them." [Playtester 24 — Engineer] and "Familiar, but not obviously not as much as I had thought." [Playtester 17 — Engineer].

12.5.3 Lessons Learned

Interestingly, the lower degree of familiarity identified by some of the Engineers suggests that there is a need for ethics training and refreshers beyond students and Engineering Interns. This kind of project could also serve as an interesting way to refresh Professional Engineers about the role of the association and their professional responsibility in a non-threatening way.

12.6 Question 3: In Your Opinion, do the Cases Seem Realistic?

The key challenge in this project was to create cases that were representative of professional engineering practice and could reasonably occur in the workplace. The feedback was generally favourable but also indicated the potential for improvement. All but one participant felt that the case studies were realistic. However, five playtesters identified that they had trouble understanding the cases due to a simplified situation and insufficient context.

Table 38: Question 3 Survey Results

	Yes	Partial	No
Engineers	6	4	1
Interns	3	2	0
Total	9	6	1

12.6.1 Themes

Of the respondents that answered positively, five responded with a simple "yes," and the remaining four used longer answers. Of the six who responded with partial yeses, the comments indicate a lack of depth and detail in the cases. The one playtesters who answered “no” did not give any feedback for improvement in this question. The feedback from two playtesters in particular clearly articulates the need for more detail:

> Realistic-ish. I’m sure similar issues come up regularly, but the ‘right’ and ‘wrong’ won’t usually be so cut and dry. In this case, I understand it has to be relatively obvious, and it can’t take too long to arrive at the outcome and questions portion. [Playtester 30 — Engineer]

> The cases are representative of possible issues an engineer may encounter. I found it difficult to understand the scenario completely to make appropriate decisions. There needed to be more detail in the overall situation for an appropriate judgement. The context was difficult to relate to. [Playtester 16 — Engineering Intern]

12.6.2 Interpretation

One of the key challenges in this project was making sure the cases were representative of engineering practice. Having 15 of the 16 volunteers agreeing that the cases are realistic is very encouraging. However, the criticism that the cases need additional context, details, and depth implies that further refinement is required in order to move from a prototype to a functional game.

12.6.3 Lessons Learned

Engineering is quite a diverse field and, although the players are willing to play along in these game situations, they still want the context, the details, and a greater understanding of the situation in order to make a decision. Engineers are critical thinkers, and that aspect should be more thoroughly examined.

12.7 Question 4: Did The Cases Cause You to Think About Your Professional Responsibility?

All the respondents answered yes to this question, with the most positive comments reflecting that the cases were eerily familiar, brought forward real issues, and generated thought about how ethics applied to daily work.

Table 39: Question 4 Survey Results

	Yes	Partial	No
Engineers	11	0	0
Interns	5	0	0
Total	16	0	0

12.7.1 Themes

While ten participants answered with just a "yes" answer. The six remaining comments indicated the cases were well chosen and very representative of the profession. The following quotes are representative of the feedback received:

> Yes. Several of the scenarios were eerily familiar. [Playtester 28 — Engineer]

> The cases brought forward real issues in our profession. It makes you aware that the issues are not localized but seen through many industries. I commonly think of my responsibility to the public, employer, and environment. [Playtester 16 — Engineering Intern]

> The strongest aspect of this game was generating thought about how ethics apply to daily work experience. [Playtester 13 — Engineer]

12.7.2 Interpretation

Each of the playtesters was a Professional Engineer or an Engineering Intern who volunteered to try this game and give their honest feedback. Based on the six positive comments and supporting yeses, it is reasonable to assume the game is achieving its core purpose — to get players thinking and reflecting upon engineering ethics.

12.7.3 Lessons Learned

One of the key purposes of ethics education is to spark the moral imagination of participants and cause purposeful consideration of their choices and the consequences thereof. Given the unanimous "yes" response to this question and level of constructive feedback received strongly infers success in this element of the design.

12.8 Question 5: In Your Opinion, did the Questions and Answers Make Sense?

This question revealed that more work needs to be done on the question portion of the game. Feedback from playtesters identified that the questions need to be cleaned up, have dependencies added, and include more divergent options.

Table 40: Question 5 Survey Results

	Yes	Partial	No
Engineers	1	9	1
Interns	2	3	0
Total	3	12	1

12.8.1 Themes

In both cohorts, the playtesters found that some of the questions did not line up well with the cases. Based on comments by the first group, the generic (repetitive) questions were removed from each case. Thus a softening in the responses can be seen between the two groups. Overall, the important theme in these responses is that all the questions need to be more connected to the player's dialogue path in order for them to make sense. Furthermore, comments about the out to lunch and bad software cases reveal the playtesters are frustrated by the answers and would like options.

> The first couple questions made sense but then the secondary questions didn't seem to help me understand the ethical considerations. They seem to be too repetitive without providing any additional information. After a while, I just want to get past these questions to get to the next case (it felt like voicemail jail), and the answers had no consequential outcome to the score for the game. It just seemed that the game was capturing data without providing any benefit. [Cohort 1, playtester 1 — Engineer]

> In the software case, the original statement asked me to evaluate a software but didn't imply that it was downloaded illegally.… So then when subsequent questions implied that I had downloaded the software illegally for the purposes of evaluation, I wasn't sure how to respond. [Cohort 1, playtester 4 — Engineer]

> In particular, when I would indicate "no" to the question "Have you ever experienced a situation like this?" the questions continued as if I had indicated "yes." [Cohort 1, playtester 13 — Engineer]

> Most of the questions made sense except in the "Lunch/Bribe" case study … Answers were too black and white, but not detailed enough as this is a very gray area (in terms of the topic). There are relationships and standard business practices that can be made without a violation of code. [Cohort 2, playtester 33 — Engineering Intern]

> Yes. [Except] for "Bad Software." I found I had to redo that one a second time as I misinterpreted it the first time through before I really understood what was going on. On my first read, I thought the case study was going was to illustrate the potential dangers of misunderstanding FEA solutions and using bad results to make important design decisions. That's where I thought it was going at first so I made some decisions I normally wouldn't have. I realize it's a game and there's no real wrong answer, it's all for learning. Still, I think that angle on the story would have made for possibly a more effective case study on the realities of engineering error.

> Either way, it was still well done. Hope that makes sense. [Cohort 2, playtester 34 — Engineer]

12.8.2 Interpretation

There were two key problems with the questions used. First, for the first group, two sets of in-game reflection questions were being asked for each case. The first set was case-specific, while the second set related to the act, by-laws, and code of ethics. After one playtester in the first cohort described the questions as "it felt like voicemail jail," the questions about the act, by-laws, and code of ethics were removed and evaluations. This change caused the responses generated by the second cohort to be softer and less negative.

In both cohorts, the questions at the end of each case were not tied to the specific paths players had taken, this resulted in several participants in both cohorts feeling confused or asked questions about problems they had not encountered.

12.8.3 Lessons Learned

Despite the apparently critical responses to this question, the feedback was very valuable, desirable, and in line with the objectives of a design review. The responses clearly demonstrated areas for improvement and gave clear direction as to why those changes were important. Going forward, cleaning up and the questions and adding release conditions[121] is the most important improvement to be made. It will improve the game flow and makes the player's actions more meaningful.

Although these changes have not been implemented, they are listed in the recommendations (Chapter 13). The two reasons for not making these changes were; (1) doing so would compromise the feedback provided as the game would no longer represent what was tested (2) adding release conditions to the game adds a level of dependency between the questions and the

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[121] One way to make sure that questions are applicable to all players is to tie them to the choke points in the program. That way, the questions would be tied to one or two nodes that all players would have to pass through. Alternatively, the questions could be tied directly into the cases themselves.

cases that are hard to track. Any changes in the conversation ID's, node ID's, or node text can invalidate the release condition without warning. Thus adding this functionality significantly increases the complexity of maintaining the software.[122]

12.9 Question 6: Did the Questions Cause You to Think More About the Case?

Playtesters generally responded "yes" to this question, but the more verbose response identified that the first set of questions got them thinking about the case, whereas when those questions were repeated, they added little value. Overall, the feedback revealed that the questions were an essential part of the thinking and reflection process and needed to be carefully considered in order to cause meaningful reflection.

Interestingly, the questions after each case were originally included to get a better sense of how the playtesters were responding to the cases. Yet it turned out, that the questions were as important to the learning experience as the cases themselves. The question caused players to reflect on the cases and explicitly consider their professional responsibilities. This makes sense given the importance of reflection and metacognition in learning.

Table 41: Question 6 Survey Results

	Yes	Partial	No
Engineers	7	3	1
Interns	4	0	1
Total	11	3	2

12.9.1 Themes

Seven respondents simply answered "yes" while one answered "no." In longer responses, a continuation of the theme that the questions could be improved existed. Two respondents cited

[122] If the game were being rebuilt from scratch, the questions could be tied into the Dialogue System, quest and inventory databases. This would be easier to maintain than restrictions based on which nodes had been chosen/displayed in previous conversations. However, the complexity of doing so would likely merit rewriting the engine instead of trying to fit it in with the existing code base.

the act, by-law, or code of ethics item that corresponded to each choice. Three of the respondents from the first group also identified the questions as having little-added value after the first case.

12.9.2 Interpretation

The feedback in this question ties closely with Question 5 in that the first group of playtesters identified questions as having diminishing value. However, after the number of questions was reduced, the playtesters identified that a greater connection to the act, by-laws, and code of ethics would be valuable.

12.9.3 Lessons Learned

Players see the questions as an integral part of the game, but they wanted those questions to be short, focused, and have good feedback.

12.10 Question 7: Are There Any Glitches in the Software?

The responses to this question were broken down into 33 sub-responses and encoded based on four dominant themes; interface problems (14 times), crashes/resets the dialogue system (8 times), spelling/grammar (6 times), and dialogue discontinuity (5 times).

Table 42: Question 7 Survey Results

	Yes	Partial	No
Engineers	11	0	0
Interns	5	0	0
Total	16	0	0

12.10.1 Themes

One of the key reasons for engaging playtesters at this stage of development was to identify the most important areas for improvement. The responses to this question were in line with those from Question 8 and Question 9, and from these, it is apparent that the interface reliability, dialogue errors, and grammar are the three areas most needing improvement.

The key problems in the interface identified by the playtesters were the back button behaving unreliably (6 times), the interface buttons occasionally locking up the software (3 times), and four points in the program where selecting a dialogue choice forced the dialogue to close down or return to the initial selection screen (8 times). The remaining errors were unique cases where the playtesters identified spelling/grammar or logic errors throughout the dialogue (11 times).

The interface errors were addressed between the first and second cohorts, while the grammar and spelling errors were addressed for the Thesis submission. The four points where the dialogue crashed were left alone because fixing them would change the underlying structure of the game away from what had been tested.

Before changing the underlying dialogue further, a better fix would be to rewrite the front end of the software to address these concerns along with the ones raised in Questions 8 and 9.

12.10.2 Interpretation

The problems identified in this question tie back to the use of two asset packages in the game. The first was the back button which was included as the result of friendly feedback early on in the development cycle. The implementation of this functionality was written by Tony Li at Pixel Crushers on request, but the fundamental logic of this workaround contravenes the logic commonly used in role-playing games. In short, using the back button was in conflict with the way the *Dialogue System* was designed. While it actually worked, it was never without problems. The second was the use of a *Game Jam Template*[123] that managed title screens, menu options, and much of the interface logic. The pairing of this the game manager with the designed interface caused conflicts because they were designed with different intents in mind. Given how

[123] Game Jam Menu Template, https://www.assetstore.unity3d.com/en/#!/content/40465, accessed July 24, 2017. The Pixel Crusher add-on to this template is no longer available.

the *Game Jam Template* and *Dialogue System* back button were integrated into the project, the easiest solution would be to remove these asset packages and rewrite the front end.[124]

12.10.3 Lessons Learned

The solution to both problems was to disable or minimize the role each of these modules played in the program. Between the first and second groups of playtesters, the back button and several of the *Game Jam Template* functions were disabled.

The first lesson learned was to consider the effect of a design change closely because the unintended consequences may well overshadow the desired change. Reflecting on the addition of a back button, it ran counter to the intended design of the *Dialogue System* and caused many of the first playtesters to complain. When it was removed, no one complained. However, the underlying problem was not the need to go back but the desire to have more insight and feedback when making choices.

The second lesson is that the more third-party components that are brought into a design, the more chances for failure and unintended interactions that exist. The *Game Jam Template* has worked reasonably well in testing, but the requirements of this module and the complexity of the game caused problems to appear in testing that did not exist when it was being built. Minimizing the interaction of the *Game Jam Template* removed most of the user problems.

12.11 Question 8: Do You Have Any Recommendations For Improvement?

This was an open-ended question to encourage playtesters to identify any aspect of the game they wished. While many of the same themes existed from Question 7, the responses to this question added depth and new feedback to be considered.

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[124] In 2017, Pixel Crushers released a new *Dialogue System Menu Framework* independent of the *Game Jam Template*, http://www.pixelcrushers.com/download/5724/, accessed July 24, 2017.

Table 43: Question 8 Survey Results

	Yes	Partial	No (blank)
Engineers	10	0	1
Interns	5	0	0
Total	15	0	1

12.11.1 Themes

While many of the answers to this question extended responses to Question 5 and Question 8, three new recommendations emerged for improving the program. The first was to clarify the specific text in certain nodes, ensuring that the players could understand and predict the consequences of their choices. The second recommendation was to include more divergent options so that players could find alternative solutions to the problems presented. The third recommendation was to provide better feedback to players throughout the game. Many playtesters found the points bar too simplistic and would have preferred contextual feedback on how their decisions related back to the act, by-laws, and code of ethics.

12.11.2 Interpretation

The feedback on clarifying the text, including more divergent options, and changing the points bar leads me to conclude that the players are looking for more depth, facts, and feedback in the choices they're making. Engineers are trained to look for the facts, the details, and consider the consequences. This additional depth could be created by; adding more dialogue, creating a visual novel by adding graphics to the story, providing context-sensitive information about the act, by-laws, and code of ethics for each node, or providing feedback on good/bad choices after they are made. Of these, adding dialogue is the most straightforward, but adding graphical elements will improve the game overall and should be easy to implement within the existing *Dialogue System* framework. Providing context-sensitive feedback about the quality of player choices would likely require restructuring the program as a whole.

12.11.3 Lessons Learned

As this thesis has grown and developed, I have come to appreciate two expressions from the game development community; (1) "test early, test often," and (2) "the player is always right, the player is never right."

In this question, thirty different recommendations for improvement were made. These ranged from changing colours to help address colour blindness, the logic that didn't make sense, to thoughts on the displaying attribute scores. As a whole, this feedback indicates that improving the feedback on attribute scores would make the game substantially better.

Some players feel the points bar doesn't work, but without testing, it would have been impossible to know that — hence the recommendation to "test early, and test often." The earlier in the design phase a change needs to be made, the easier it is.

The idea that "the player is always right" acknowledges that the players know what they experienced — however "the player is never right" also reminds us that the players do not know what is going on behind the scenes. They do not know how the game is programmed. Thus, player feedback should be acknowledged and considered, but the designer has to make informed decisions about what is best for the game.

The playtesters identified grammar, the points display, and controls as problems, but overall, they are requesting more information, more clarity, and more feedback.

12.12 Question 9: Any Other Feedback That You Feel Is Valuable?

Responses to this question were the most encouraging because many playtesters took the time to offer encouragement, articulate the value of this research, while offering generic suggestions for improvement.

Table 44: Question 9 Survey Results

	Yes	Partial	No (blank)
Engineers	10	0	1
Interns	4	0	1
Total	14	0	2

12.12.1 Themes

Two themes existed in the answers to this question. The first theme was to continue on the themes of questions 7 and 8, the second theme which is focused on here, was to offer encouragement and validation of the project. The Engineers and Engineering Interns, who

played this game, recognized the value in experiencing common, real-world aspects of engineering ethics.

> This could certainly be useful to give people a more real-world (as opposed to theoretical) understanding of the ABC {Act, Bylaws, and Code of Ethics], but would need more fine-tuning and a good method of giving feedback. [Playtester 15 — Engineering Intern]

> I think the scenarios are good. I like the scenario with the sales team pressuring engineers to do things. It is a very common issue, where managers and sales groups pressure engineers to do things they are uncomfortable with. There is always a way to do business with ethical business practices; it is just up to the leadership to set that tone. The scenario with XYZ industries was also very accurate to the industry. Business meetings and having lunch to me and many people is not a bribe though. Also, if John were to buy lunch and they switched every month would that not make that situation less of a conflict. One interesting issue was that the product recommended worked. In many cases, I have sourced products in designs because of the quality of the product. Typically quality and cost are directly associated and if you are of that mindset, using a product that does a great job and is reliable and has good support is a no-brainer if the cost impact is similar to another product. I was surprised to see the engineer was also let go, even though the product did the job. The only issue to me was that he had accepted several free lunches. [Playtester 16 — Engineering Intern]

> I would be willing to do another round of testing on future revisions or more thorough testing following a script. [Playtester 28 — Engineer]

> I think this game may help some people learn ethics and prepare for the PPE — it is by no means a replacement for reading and understanding the Act, By-laws, or Code of Ethics documents. In order to be truly useful as a study tool more case studies should be added and ideally each case study should be followed by a blurb

> discussing the important aspects of the Act, By-laws, and Code of Ethics to ensure the player fully understand each of the issues presented and the expected outcome of the questions portion. [Playtester 30 — Engineer]

> Keep up the good work. I see this kind of thing being very useful in Universities as well as in Professional Development. This kind of education is always useful no matter your experience or skill level. Well done! [Playtester 34 — Engineer]

12.12.2 Interpretation

One-third of the playtesters offered encouragement and support. This is really significant because, despite testing a prototype product with all its warts and faults, the Engineers and Interns involved saw merit and value in this research.

12.12.3 Lessons Learned

The idea of using an interactive narrative as a teaching method is valid. It offers new ways to connect engineers with their profession and opens up new modes of learning and sharing experiences. The practice of Engineering is about more than applying science to solve technical problems. It is also about the challenges of demonstrating trustworthiness, gaining the respect of your peers, and living by a code of ethics. This method may not lead to a grade in a classroom, but it allows different and important aspects of the engineering profession to be explored.

12.13 Additional Feedback:

In addition to the survey, most of the playtesters also had comments in their attached email. In following with the encouraging answers from Question 9, these two quotes summarize the types of positive feedback playtesters included in their emails.

> "Overall I thought the scenarios were much more applicable as compared to the standard testing from the PPE exam. Issues like software piracy and advanced simulation is a more modern approach for sure." [Playtester 16 — Engineering Intern]

> "The situations and detail in this game are very interesting. I believe you have selected a set of situations that is somewhat representative across the engineering profession. The 6 parameters with regards to the qualities to be maximized by an engineer highlight an appreciation for complexity in the profession as advancing one parameter can reduce another." [Playtester 22 — Engineer]

12.14 Summary

Table 45 captures the key feedback from the survey questions. As a whole this project appears to be on the right track but needs further work. The feedback on the cases was generally positive, however as expected in a design review, numerous detailed and specific points were raised on how to improve the cases, program interface, and feedback mechanisms.

Table 45: Key Playtester Feedback

Question	Key Feedback
1	All the playtesters were Professional Engineers or Engineering Interns.
2	All the playtesters were familiar with the act, by-laws, and code of ethics.
3	The cases were realistic and could be improved with great context and detail about the engineering problems involved.
4	Causing reflection is the strongest aspect of this thesis. It should be enhanced and reinforced in subsequent work.
5	Going forward the questions should be improved by creating stronger ties to the specific dialogue player have encountered.
6	The questions add value by facilitating reflection. They are essential to the learning experience. However, too many questions create resentment.
7	The software menu system is buggy and should be rewritten.
8	Improve the point system and include more transparent ties to the act, by-laws and code of ethics.
9	This research project serves a need within the engineering community.

13 Recommendations for Future Work

During the design review, the most imperative question was do the cases seem realistic, are they authentic and representative of professional practice. With that goal met, the game can be refined to improve the data collection processes, provide deeper assessment, and improve gameplay.

In order to move this game towards commercialization, enhancing the data collection methods, assessment, and game experience should be considered. Each of the eight recommendations below would move this game closer to a minimally viable product.

13.1 Analytics

Since the game was originally developed in 2015, *Unity* has added analytic tools into the game engine and embraced using analytics as a core element of game design. This allows new projects to easily gather information on new installs, daily active users, sessions per users, and time spent in the application.[125] However, doing so requires COPPA compliance and protection of user data.[126] [127]

Furthermore, using analytics may create challenges in obtaining ethics approval as the data may no longer be collected in a transparent manner or with sufficient safeguards to protect the identity of participants.

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[125] Unity Analytics Overview, https://docs.unity3d.com/Manual/UnityAnalyticsOverview.html. Accessed May 6, 2019.

[126] Before integrating analytics into a game, Unity recommends consulting a lawyer to understand the legal requirements involved. https://support.unity3d.com/hc/en-us/articles/213227926-Can-Unity-provide-guidance-on-drafting-a-Privacy-Policy-for-users-of-a-game-that-employs-Unity-Analytics-, Accessed July 3, 2017.

[127] Data collection and web analytics falls under The Personal Information Protection and Electronic Documents Act (PIPEDA), https://www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/the-personal-information-protection-and-electronic-documents-act-pipeda/, Accessed July 3, 2017.

13.2 Assessment

Evidence-centred design, and stealth assessment are predicated on having a clear understanding of what is being assessed, and embedding game mechanics to generate evidence that can be used to classify a learner's bias and progress.

By analyzing log files, and considering the metrics and measurements outlined in 8.5 human evaluators can identify patterns that indicate a player's level of focus, skill, and persistence. These patterns can then be used to train neural networks to automatically assess learners which provides value to regulators and instructors tasked with teaching engineering ethics.

This change has the potential to greatly improve academic rigour and open up research opportunities for use in classroom environments. While the framework of the game can be easily adapted, doing so is not a trivial task given the game was originally conceived to be an optional, self-selected experience.

13.3 Multiple Perspectives

An important aspect of understanding ethical dilemmas is considering cases from multiple viewpoints. An interesting goal for players, would be to incorporate challenges where the players tried to emulate a specific ethical perspective. For example, instead of being an engineering intern, what if the player was a company owner, customer, financier, or member of the investigation committee.

This change would require extending the dialogue database and adding game mechanics to track which perspective was the player was being challenged with. Adding more dialogue is easy, while adding in-game mechanics would require extending the code base to include methods of tracking the desired perspective.

13.4 Multiplayer

A very effective way to raise the engagement levels in video games is through multiplayer play.[128] Playing with others provides a sense of social connection, encourages collaboration and/or competition with others, and provides a sense of status through publicly visible achievements. These social aspects make multiplayer games are more engaging and compelling than traditional stand-alone games.

However, this change redefines the game and adds significant technical complexity as multiplayer games are substantially harder to create and manage. The complexities of asynchronous interactions between players, network latency, and data hosting would all need to be considered.

13.5 Improved Dialogue and Question Mechanics

Three improvements could be made in the dialogue and reflections questions, (1) prune the dialogue trees, (2) utilize release conditions and (3) add more feedback.

The first dialogue improvement would be to prune the dialogue trees and include more choke points. Doing so would significantly reduce the complexity and make the conversations much easier to manage. The exponential growth caused by having five options quickly became confusing and difficult to manage.

The second dialogue improvement would be to improve the connection between game choices and the reflection questions, answers could be tagged with release conditions, preventing them from being shown until certain nodes have been visited, quests completed, or attribute scores obtained. However, this approach requires caution because it makes the program fragile by introducing a significant level of dependency between the nodes that is not easily tracked.

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[128] This page highlights some of the causes of video game addiction, http://www.techaddiction.ca/why_are_video_games_addictive.html, Accessed July 3, 2017.

The third dialogue improvement would be to add more feedback for players on their decision and how they relate to the Act, Bylaws, Code of Ethics. Doing so, would help players feel more in control, deepen the learning experience, and increase their perception of value.

13.6 Gender Parity, English as an Additional Language, and Accessibility

In Manitoba, gender equity, and racial equity are important societal considerations. Given the open-ended nature of the game, and the development platform – future researchers could easily expand the scope of the game to include additional experiences such as gender equity, challenges for immigrants, and aboriginal culture in the workplace. Though changes in the core dialogue, the inclusion of conditional statements, or through the use of localization, subsequent researchers should be able to:

- Arbitrarily or randomly change the gender of characters in the code.
- Rename characters to have more ethnically diverse names.
- Include additional information in the cases to enhance accessibility.

Furthermore, through the use of analytics, deviations in player responses caused by these changes could be easily tracked without sacrificing the anonymity of the players involved.

13.7 Improve the Interface

Based on playtester feedback, the interface needs to be enhanced. Doing so should provide the players with more information, feedback, and control of the game. This version of the game was a prototype designed to get feedback on using a game to teach engineering ethics. Moving forward, creating a more polished look and feel is desirable. Ideally this refinement would include: (1) creating a visual novel, (2) changing how attribute scores are displayed, (3) including rewards and trophies for achievers.

13.8 Mobile

The final recommendation is to enable mobile devices, which is easy in the current version of Unity. The three considerations in doing so are (1) supporting touch controls, (2) data storage, and (3) app store requirements. Touch controls should be easy to implement as the game already

works on touchscreen monitors. Data storage would be easy to implement as only the player's current state and list of nodes viewed needs to be recorded. Porting the game to the mobile platforms will require work to meet Android and Windows specifications, but instructions are available on the *Unity* website.[129] [130]

[129] Instructions for compiling Unity apps for use with Apple iOS, https://unity3d.com/learn/tutorials/topics/mobile-touch/building-your-unity-game-ios-device-testing, accessed July 4, 2017.

[130] Instructions for compiling Unity apps for use with Android operating systems, https://unity3d.com/learn/tutorials/topics/mobile-touch/building-your-unity-game-ios-device-testing, accessed July 4, 2017.

14 Concluding Remarks

The goal of this thesis was to: *Identify what is involved in creating a video game to teach Canadian engineering ethics — and then build a prototype for evaluation.* To this end, three milestones were reached, (1) information on instructional design, video game design and engineering ethics were all explored, (2) a video-game was created, (3) Professional Engineers and Engineering Interns validated the work and gave recommendations for improvement.

Based on the literature review, sustained interaction, narrative and dialogue are very effective ways to develop an emotional connection with the characters in a game. Combining emotional connection with day to day ethical situations that could reasonably happen to the players is how the fabric of this game creates a learning environment. This is different from most of other engineering ethics games reviewed which were designed for assessment and used in a classroom environment.

Finding alternative ways to teach engineering ethics is important to the engineering profession as a whole and augmenting the existing professional practice material through the use of a video game is feasible, timely, and well supported by the research on game-based learning.

14.1 The Key Lesson Learned

A guiding belief in this project was that good games allow players to choose their course of action and that playing in a malicious or cynical manner can be intentional on the part of the player. In many regards, testing the system in this manner can create learning opportunities as useful and powerful as following a prescribed code of ethics. As discussed in chapter 9, the challenge was orchestrating a learning environment in which the fabric of the game, its procedural rhetoric allowed the learning outcomes to be met, regardless of the manner in which players progressed through the game.

Throughout the design review, it was apparent that work needs to be done to move this project from a research prototype to a production grade game. However it is also apparent that the original goals of investigating the design parameters and building a working prototype have been met. The Professional Engineers and Engineering Interns who evaluated this game consistently

saw merit in what was being done and offered encouragement about its value as a learning experience for early-career engineers.

14.2 Credit to the Community

Ethics is a challenging field in which answers to dilemmas are largely based on personal experience and the values of those involved. Trying to create realistic, meaningful experiences cannot be done in isolation because it favours one way of thinking about problems that may, in fact, be quite the opposite of what the players expect.

The most important aspect of this thesis was a supportive community. The feedback of the playtesters, discussions with Engineers Geoscientists Manitoba staff, and feedback from members of the advisory committee, were all essential to the development process.

Huge credit and thanks are due to each of the playtesters in this thesis — these volunteers took the time to help a fellow engineer and see the game for the learning experience it could be. They committed a serious amount of time to play the game, reflected on the experience, and provided meaningful feedback. Several engineers, in particular, assisted me above and beyond my expectations. They helped by reviewing the early designs, critiquing the case studies, and even proofreading the entire dialogue for the game. Ethics, education, and video game design are all complicated subjects and without a community supporting this project the Canadian Engineering Ethics Game would not have been possible.

14.3 Concluding Remarks

Engineering Ethics is an important aspect of professional practice in Canada. It is the basis upon which the trust of the public, clients, and peers is built. Over the last ten years, high profile events like the Charbonneau Commission and Elliot Lake mall collapse have put that trust into question.

This project furthers the academic understanding of professional engineering practice and creating an epistemic learning environment. Conducting the design review was an important step in this process becaused it ensured the game was authentic and representative of real engineering practice. Based on the feedback of playtesters, the game was successful in reaching

the goal of creating authentic (ill-defined, multifaceted problems, that are representative of real-world practice) because the cases were "eerily familiar," and "brought forward real issues." and generated "thought about how ethics apply to daily work experience."

Appendices

A1. Glossary

Agency

A player's ability to impact and control the gameplay through their actions and the consequences thereof. When a player's choices significantly affect the plot, they are considered to have a high degree of agency. Conversely, a low agency situation exists when the game forces an outcome on players regardless of their actions.

Agôn

Ancient Greek adopted by Roger Caillois in 1958 to categorize games as being based on competition and skill. Examples would include chess, poker, and cribbage.

Alea

Latin term for the game of dice that was adopted by Caillois to categorize games as being based on chance and randomness. Examples would include lottery tickets, slot machines, and child's card game War.

Andragogy

The methods and practice used in the teaching of adults. Mirrors the term pedagogy, which is the practice and method of teaching children. Andragogy emphasizes self-directed, experiential learning which allows adults to express their opinion and integrate prior knowledge.

Applied Ethics

Ethical studies characterized by the act of making decisions and choosing which course of action to take in a moral or ethical dilemma. Ethical models such as Utilitarian or Kantian ethics can be used to aid decision making but will themselves lead to different right answers

Assessment-centred Environments

Using formative and summative assessment to identify and address gaps in the student's knowledge. This environment is important when grades and credentialing are important aspects of the learning environment. (Bransford, Brown, & Cocking, 2000, p. 140)

Canadian Engineering Accreditation Board (CEAB)

An arm of Engineers Canada responsible for the accreditation of Engineering programs in Canada.

Code of Ethics

In Canada (except Quebec), the right to title and practice are governed by self-regulating bodies. These bodies are governed by their act, by-laws, and code of ethics. Engineering Ethics are the duties and behaviours expected of an Engineer by his or her peers by virtue of being an Engineer and compliance with these expectations is an ongoing component of licensure in Canada.

The key difference between Canada, the United States, and the UK, is that in Canada, failure to act in accordance with the code of ethics can result in disciplinarily acts, restrictions on professional practice, and licence removal.

Conceive Design Implement Operate (CDIO)

A teaching model developed by Ed Crawley at MIT in the late 1990s which focuses on hands-on, experiential learning for engineering students.

Digital Game-Based Learning (DGBL)

Video game environments expressly designed for learning.

Educational Data Mining (EDM)

Automated collection and monitoring of player data in educational settings to gain insight into instructional practices, student learning, and engagement. In video games, this can be real-time stealth assessment of individual players, analysis of log files, and player usage data.

Efficacy

The effectiveness or capacity to produce a specific desired result. In video games, this term describes a player's ability to take actions that produce the desired outcome.

Endogenous Value

Having value that comes from within the system. In games, this means the experience is meaningful, interesting, and fun to people playing the game. Without endogenous value, players will become bored, disinterested, and will leave the game permanently. With video game based learning, this aspect is important because the person selecting/purchasing the software may not be the person playing the game.

Engineering Ethics

The rules, standards, and expected behaviours that guide the actions of Engineers in professional practice. In Canada, each province and territory have their own act, by-laws, and code of ethics which for the most part are very similar.

Ethics

The field of ethics refers to how *societies* evaluate the concepts of right and wrong. It is then subdivided into metaethics, normative ethics, and applied ethics.

Evidence Centered Design

Coined by Robert J. Mislevy, Evidence Centered Design is the approach of designing educational environments to provide statistical evidence of learning that is consistent with the intended subject matter and knowledge. The key to evidence-centred design, is the focus on evidentiary reasoning and statistical analysis of the learner's performance.

Gamification

The process of applying game concepts like points and reward structures to a game, website, or learning experience to enhance retention of users.

Game-Based Learning

Game-based learning environments embed curriculum and learning activities into the game mechanics. Thus as players pass through the game, they are both learning the curriculum and demonstrating proficiency at it. Game-based learning environments have the potential for offering personalized learning experiences, just in time teaching, reduced test anxiety, and more memorable experiences.

Kantian Ethics (Deontological)

An ethical model based on having rules (maxims) that everyone must follow and that we would want people to us. The key drawback of this method is that it focuses on the intent and means rather than the ends being obtained.

Knowledge-centred Environments

Focuses on the understanding, knowledge transfer, and learning skills required to perform the task. This environment should be combined with learner-centred and assessment-centred environments. (Bransford, Brown, & Cocking, 2000, pp. 136-137)

Learner-centred Environments

Focuses on the existing conceptual and cultural knowledge, skills, and attitudes that learners have when coming to a course and developing them further. These environments focus on the person, not the skills needed to function. (Bransford, Brown, & Cocking, 2000, p. 136)

Magic Circle

Huizinga's magic circle is an articulation of the idea that games have a unique play space defined by the game and its participants. Inside the game, the rules provide meaning and context for a player's actions. For example, kicking a ball into a net in the real world can be interpreted as scoring a goal. Alternatively, within the magic circle of a game (rules, meanings, interpretation of actions) a person can transform their identity and reality by playing through their avatar. In this capacity, they can become knights, assassins, puppet masters or even gods.

Mimicry

Mimicry describes games and simulations that imitate the real world. An example would be *Dungeons and Dragons* or *Live Action Role Play* where players roleplay characters in a fantasy environment. Mimicry and ilinx represent one continuum of game design.

Ilinx

Ilinx describes games that alter a player's perception of reality (vertigo). Mimicry and ilinx represent one continuum of game design. American McGee's video game *Alice* is a good example of reality warping in a video game because of its dreamlike story, movement system and combat.

Ludic

Playful behaviour, spontaneous playfulness, lively and full of fun. For example, ludic interfaces are playful interfaces.

Ludus

Ludus is the Latin term for game (see paidia). The use of the term is attributed to sociologist Roger Caillois and has been adopted in many areas of game studies. The base of lud or ludo is used to refer to play involving rules, goals and structure. The following common game-design terms use ludo as a root:

- Ludology — the study of games and play.
- Ludophile — a person who loves games.
- Ludological — an adjective form used to add the study of games to other words.
- Ludography — a list of games someone has worked on.

Metaethics

General principles — Philosophical/Academic study of the underlying basis where ethical principles come from.

Morality

Often confused with ethics, morality refers to an *individual's* sense of right and wrong whereas ethics refers to *society's* sense of right and wrong. Typically these assessments are learned at home and school during childhood and pre-teen years.

Normative Ethics

Evaluation framework — Philosophical/Academic study to quantify how society evaluates right and wrong (norms). The Ethical theories found within normative ethics include Deontological Ethics, Teleological Ethics, and Virtue Ethics.

Paidia

Paidia is a term coined by Caillois for play that involves exploration or player driven structure. This type of play is seen in sandbox style games and toys such as Minecraft and Lego. Paidia and ludus form a continuum from spontaneous, unstructured play to rule-bound, goal-focused play.

Philosophical Ethics

The study of moral philosophy (normative ethics and metaethics).[131] Philosophical ethics works to study the ethical decisions of others in order to classify and analyze the underlying thinking. Philosophical ethics is tied to *understanding* a situation and the thinking that governed the decisions made. *(Sensemaking)*

Problem-Based Learning (PBL)

A teaching technique that focuses on having students solve ill-structured problems with multiple solutions, the goal of which is to have students combine practical skills with theory and research. (Savery, 2006)

Professional Ethics

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[131] http://www.yale.edu/darwall/Phil361.html

The application of professional standards and behaviours to decision making (applied). Doctors, lawyers, and engineers all have codes of conduct that govern the behaviour of members by virtue of their involvement in the profession. And although Professional ethics may be similar between professions, a core piece is that professional ethics apply to members within a profession and NOT to those outside of it.

Public Interest

According to the Engineering and Geoscientific Professions Act, Public interest refers to the concern, convenience, and well-being of the public at large.[132] The association is expected to act in the public interest (well-being) by promoting skill and competence in its members and advocate in cases where the public interest, well-being or convenience is at risk.

Science and Engineering Ethics (SEE)

A broader classification of engineering ethics that can be used in literature searches. Often used as a keyword in papers on engineering ethics.

Serious Games

Video games designed for purposes other than entertainment (serious as compared to fun). Serious games seek to combine the fun of video games with instructional content. Done well, learning is seamlessly integrated with the game, while still being fun and engaging.

Stealth Assessment

This term was coined by Valerie Shute, to describe integrated testing and evaluation that does not interfere with gameplay. Implementation of this required training a neural network to recognize patterns in a player's actions from which competence, persistence, and problem-solving could be measured. Stealth assessment is tied closely to evidence-centred design, in that

[132] http://web2.gov.mb.ca/laws/statutes/ccsm/e120e.php Accessed Nov 6, 2016.

having clear educational goals and behavioural evidence of competence allows for testing to be integrated into game design.

Utilitarian Ethics (teleological)

An ethical model which focuses maximizing the common good. Its key drawbacks are that it allows for deception, pain, and suffering to be inflicted upon a small group for the common good and that the assessment of satisfaction (good) is often reduced to a monetary calculation.

A2. Source Control GIT

Both *Unity* and the *Dialogue System* are complex and involved software packages. With each of these packages, you are constantly modifying the project in a manner that cannot be easily undone. It is good practice to use a source control program like GIT, SVN, or Plastic SCM to maintain a working copy of the program which can be easily differentiated with the modified code.

GIT is a very popular source control program. However, it is designed for small text files (code) rather than large binary files such as sound are graphics. Although it may be useful to store assets such as sound, video, and textures within the GIT repository, they cause the repository to become bloated. This bloating is caused because every time a binary file is changed, the entire file is added to the repository. Git Large File Storage (LFS) replaces the binary files within the database with pointers to the file in question. This allows you to version large gigabyte-sized files in an external database in order to perform faster fetching and cloning operations.

Information and Best practices for GIT and GIT-LFS can be found at the following websites:

- http://kleber-swf.com/the-definitive-gitignore-for-unity-projects/, accessed May 16, 2017
- https://www.visualstudio.com/en-us/docs/git/manage-large-files, accessed May 16, 2017
- http://www.strichnet.com/using-git-with-3d-games/, accessed May 16, 2017
- https://thenappingkat.azurewebsites.net/unity-gamming-unity-and-git/, accessed May 16, 2017
- https://stackoverflow.com/questions/17888604/git-with-large-files, accessed May 26, 2017
- https://git-lfs.github.com/, accessed May 26, 2017
- https://github.com/git-lfs/git-lfs/wiki/Tutorial, accessed May 26, 2017

A3. Complete Dialogue for the Case Studies

The content of this section is a corrected version of the dialogue text (769 nodes out of 781) for the cases within the game — dialogue surrounding the game testing (94 nodes), and control (12 nodes) have been omitted. The corrections specifically address feedback from playtesters on spelling and grammar.

Table 46: Complete Case Dialogue

Conv.	Node	Type	Text	Points
1	0	Response	START	
1	5	Response	"What about if that kid had died?"	Rep -1
1	22	Narrative	"No, I hadn't. It's easy to forget that people sometimes do really stupid things and it's up to us to protect them. I mean, people don't like getting electrocuted when they drop coffee on their computer. But more seriously, if a kid got hurt because I cut corners, I not sure I could live with myself."	
1	23	Narrative	"Yeah, I don't know how I wouldn't know how to live with myself. The problem is, if we don't find ways to keep our costs down, then we don't get hired in the first place. How am I supposed to do the right thing and still be competitive?"	
1	24	Response	Keep listening.	
1	25	Narrative	"In that last case, we started out bidding on a contract, and almost straight out of the gate, the sales rep is hitting me up to lower the price. It seems like every contract; the salespeople keep coming back to me and trying to get the lowest price. While at the same time, the customer keeps wanting to add features with conflicting needs! It's driving me nuts!"	
1	79	Response	"I understand, that is challenging!"	Rep 1
1	80	Narrative	Go to the questions.	
1	125	Response	"Part of our right to title is responsibility to carry insurance. When we screw up, people can get hurt!"	Code 1 Trust 1
1	126	Narrative	"I know. It just feels like I am a commodity item here. And when something goes wrong, I'll be the first person they will replace."	

Conv.	Node	Type	Text	Points
1	127	Response	"You have a responsibility to protect the public, and if the company is pressing you, then you need to protect yourself."	
1	128	Narrative	"How do I do that?"	
1	129	Response	"I would keep a journal."	
1	130	Response	"I would keep a record of your calculations."	
1	131	Response	"I would make a point of defending my costs better so they couldn't pressure me."	
1	132	Narrative	"Hmm, I will think about that. Thanks."	
1	133	Response	End the conversation.	
1	134	Narrative	Go to the questions.	
1	139	Response	"That may be the case, but you still need to protect yourself."	
4	0	Response	Start: Out to lunch Part 1A.	
4	1	Narrative	You go out for lunch with John your supervising engineer and Harry, a sales representative for XYZ industries. As lunch progresses, John and Harry start discussing business and how Harry can make them more successful.\nWhat's your take on this?	
4	2	Response	This is standard business practice.	
4	6	Response	Unsure, let's see where this goes.	
4	7	Response	John should not be talking about company business with Harry.	
4	12	Narrative	As lunch winds down Harry reaches out and offers to pick up the check. Then he turns to you and comments "John thinks highly of you, would you like to join us for lunch next month?"	
4	18	Narrative	START Out to lunch part 1A	
4	19	Response	Go back to the office.	
4	20	Narrative	When you get back to your office, something about lunch is still not sitting right with you. You want to talk with someone, but whom?	
4	21	Response	Talk to a co-worker.	
4	22	Response	Talk to your supervisor.	
4	23	Response	Talk to a friend.	
4	24	Response	Keep notes of the conversation in a personal journal.	
4	25	Narrative	You decide to talk to your supervisor about lunch. He tells you not to worry about it, he and Harry go way back. Harry has gotten him out of a few jams with customers, and now he often asks Harry's opinion on things when planning contracts.	

Conv.	Node	Type	Text	Points
4	28	Narrative	Your co-worker understands, Harry and the boss have a pretty tight relationship. And given a choice, the boss will choose Harry's company even if it means paying a little bit extra. Truthfully though if you need something in a rush, Harry is the guy you want to go to.	
4	29	Narrative	You decide to share your reservations about lunch with a close friend. During the conversation, you come across three points.\n 1. Are you reading too much into this?\n 2. What is your companies policy on lunch with suppliers?\n 3. Do you have your facts straight or are you just assuming things?	
4	30	Narrative	You decide to record the event in your personal journal.	
4	31	Response	Okay.	
4	32	Narrative	As the day winds to a close, your thoughts go back to lunch. Given everything that's gone on. What do you think now?	
4	33	Response	Okay.	
4	34	Response	Harry's a good guy; everything is all right.	
4	35	Response	Something is not right; I should watch my back.	
4	36	Response	John should not be sharing business information with Harry.	
4	37	Narrative	{group} Exit: Go to Part 1B.	
5	0	Response	START	
5	3	Narrative	You are having a discussion with your friend Mary who's an engineer at a local manufacturing company. During the conversation, Mary tells you that she feels frustrated because one of the sales reps is trying to blame her for a new customer choosing her competitor's engineering team.	
5	9	Narrative	{group} START: part 001.	
5	13	Narrative	"Thanks, I knew you would understand. You know last week, the sales guy pressures me to cut the design costs by 20% so he can get the design contract. This week, purchasing comes back and says the parts are too expensive. It's really getting under my skin!"	
5	14	Response	"Yeah, it seems like most companies are just driven by profit."	

Conv.	Node	Type	Text	Points
5	19	Narrative	This is a conversation about priorities and expectations:\n —What constitutes a good engineering decision.\n —What constitutes a good management decision.\n —What are the roles of an engineer in these situations.\n — Engineers are expected to inform others of the consequence of their actions\n — Engineers are expected to understand the context, standards and safety requirements of the situation\n — Engineers are expected to create products that work as expected	
5	20	Response	"Yes, that can be a real challenge. Without customers, the company you're working for will disappear quickly. So you're being pressured to compromise, just to protect your job."	Fair 1
5	37	Narrative	"If I take shortcuts in my work, most of the time people won't notice. Software updates are commonplace; electronic devices are often replaced every year. On top of that, no one will die because the voltages are a little off."	
5	44	Narrative	She knows you are interested in Engineering Ethics and says:\n"Being an ethical engineer and following the association guidelines are putting me out of business. It's raising my costs, making it hard to compete!"	
5	45	Response	Keep listening.	
5	46	Response	Keep listening.	
5	47	Response	Agree with Mary. Protecting the public raises your costs.	Rep 1 Code -1
5	48	Response	Disagree with Mary. Although the short-term costs may be higher. The long-term benefits should be worth it.	Rep -1 Comp 1
5	49	Response	"Taking the time to do be diligent in the design takes more time. A time when you could be working on other projects."	Rep 1
5	50	Narrative	"You don't get it, do you. Last week, the sales guy pressured me to cut the design costs by 20% so he can get the design contract. This week, purchasing comes back and says the parts are too expensive! And now that it's come full circle, the sales rep is blaming me because the customer went to our competitor!"	
5	51	Response	"So Mary, what are the costs of taking short cuts?"	Code 1

Conv.	Node	Type	Text	Points
5	53	Narrative	"Lots of companies practice low balling the development costs and then turn a profit by billing heavily on the design changes. That makes it hard to compete! Even when you are capable, clients seem more interested in the lowest cost than the quality of work."	
5	54	Response	"I agree, that does make it hard."	
5	55	Narrative	"Yes, it's easy to have principles. But sometimes things like money, family commitments and fear can make it really hard to follow them."	
5	56	Response	"So by dropping your initial costs, you are hoping to build more business? How do your customers feel about footing the bill for all the design changes?"	Trust 10 Rep 1
5	57	Response	Yeah, I understand. But is that the kind of engineer you want to be?"	Rep 10
5	58	Narrative	"Actually, it's pretty common. So I think the customers expect it. It's like a game we play with each other. We give them a quote, then they try and drive the cost down. We come to an agreement on the terms, and then we jack the price up when design changes occur. I mean, look at these government projects that are millions of dollars over budget. If they had just been honest at the beginning the project would never have been built."	
5	60	Narrative	Yeah, I know, it's like here we are, as engineers we are duty bound to protect the public and serve our company. Yet managers and sales reps are only concerned with profit and making themselves look good!"	
5	62	Narrative	{group} Go To Part 002 Start Here	
5	63	Response	Empathise.	
5	64	Response	"So how is this your fault?"	Rep 1
5	65	Narrative	"It shouldn't be but my managers breathing down my neck because this is the third contract this month and the sales reps are blaming me."	
5	66	Response	"Yeah, I don't trust sales reps either."	Rep 1
5	67	Narrative	"What's worse is that now I've heard a rumour that the sales manager is trying to get the boss to fire me."	
5	68	Response	"So Mary, what's causing the lost sales?"	Rep 1
5	69	Narrative	"I'm not sure. I mean my time estimates are bang on and the stuff I make works. The only thing I can think of is that I am not as fast as the other engineers."	

Conv.	Node	Type	Text	Points
5	70	Response	"Your really upset about this any idea why?"	
5	71	Narrative	"I'm not sure. I am working as fast as I can, but I refuse to cut corners on our designs. We are designing products to the customer's specification, I spend a lot of time checking my work."	
5	72	Response	Keep listening.	
5	73	Response	"Mary, come on, we both know you can't do that. If something goes wrong, it's the end of your career."	Comp 10
5	74	Narrative	{group} Go To Part 002 Start Here	
9	0	Response	START	
9	2	Narrative	Should an engineer be held responsible for the decisions of a CEO?	
9	3	Response	Yes.	
9	4	Response	No.	
9	5	Response	I don't know.	
9	6	Narrative	What should you do if you're asked to cut project costs in order to get a contract?	
9	7	Response	Perform the request.	
9	8	Narrative	Your company has difficulty meeting a particularly challenging set of standards imposed by the governmental regulator. Management advises you to design a method to pass inspections without compromising the day to day performance of your product. Do you take on the challenge?	
9	9	Response	Yes.	
9	10	Response	No.	
9	11	Response	Take on the job and then blow the whistle.	
9	12	Narrative	<color=orange>Not withstanding whistleblower protection, this is not going to serve you well. You should look for a more proactive solution to this situation. </color>	
9	14	Narrative	<color=orange>You should remember this. If the cover-up is discovered, You will likely be held responsible. The corporation and media will likely hang you out to dry. \n\nUnlike management engineers have a duty to the public beyond the interests of the company. \n\nSo take some time and get this directive in writing. (This may help.) </color>	
9	15	Narrative	Good job standing by your professional ethics. Think about how you can spin this so that a new employer will see this in a positive light. Hopefully your next employer will value your professionalism.	
9	16	Response	Yes.	

Conv.	Node	Type	Text	Points
9	17	Response	Okay.	
9	18	Narrative	Did this particular set of questions make you uncomfortable?	
9	19	Response	No.	
9	20	Response	Very much so, I've lived it.	
9	21	Response	Not at all, situations like this don't come up for me.	
9	22	Narrative	{group} Exit and return to start.	
9	23	Narrative	{group} Start: Friendly conversation questions.	
9	24	Response	Refuse.	
9	25	Response	Ask management to reconsider.	
9	29	Response	I don't care! I'm going to do it anyway!	
9	30	Narrative	As a result of your decision, you get fired. And allegations are made against you in the media as an engineer. After a long and financially crippling legal battle, you realize that you have been blacklisted and will never work as an engineer again. Good luck with your new career. \nEngineers are expected to protect the public AND be faithful to their employers. \n <color=orange>The best solution is to find a way to convince management to do the right thing.</color>	
11	0	Response	START	
11	10	Response	"Have you thought about what happens if someone gets hurt?"	Trust 10 Rep 10
11	22	Narrative	"No, I hadn't. It's easy to forget that people sometimes do really stupid things and it's up to us to protect them. I mean, people don't like getting electrocuted when they drop coffee on their computer. But more seriously, if a kid got hurt because I cut corners, I wouldn't feel very good about myself."	
11	62	Narrative	"The product will be more likely to fail. It might not pass testing, and we could end up in a lawsuit."	
11	70	Response	"How would that affect you?"	Rep 1
11	72	Response	"So Mary, what about your company?"	Rep 1
11	73	Narrative	"You know, the last lawsuit we were involved in really took a toll on the company. Having our records scrutinized. Management is looking for someone else to blame. It was hell. Personally, I think it would probably destroy my reputation and put my career in jeopardy."	
11	89	Response	"So what about the public?"	Trust 1

Conv.	Node	Type	Text	Points
11	90	Narrative	"I don't know. It's just that I need this job! I have a young family, a new mortgage, and all this responsibility.	
11	91	Response	Keep listening.	
11	92	Narrative	"It feels like if I don't do this, I will lose everything. All that work for nothing and nobody's even going to care!"	
11	93	Response	Keep listening.	
11	94	Narrative	"I mean, who is going to take care of my family?"	
11	95	Response	"Maybe you should talk to the association?"	Rep 1
11	121	Response	"Those are all really important things. But if it's it just money, you can go elsewhere."	Rep -10
11	122	Response	"Well, how long could you last if you lost your job?"	Rep -1 Risk 1
11	123	Narrative	"I don't know, maybe a few weeks. I would definitely need to get EI. And if I did, would anyone want to hire me?"	
11	124	Narrative	Go to Questions	
11	144	Response	"So why are you letting people pressure you? I think you should remind them of the consequences of failure."	Trust 1 Rep 1
11	145	Response	FIX ME	
13	0	Response	START	
13	2	Narrative	{group} Start: ESD Scenario 003.	
13	8	Narrative	This case is about suspecting a design change and following up with it.\n Questions: \n 1) The engineer should have known or ought to have known.\n 2) Non-engineers are making decisions based on cost. \n 3) People coming in afterward and changing the design. \n Notes:\n Servicing of combine harvesters is typically done at home.\n One solution is to have a technician visit the existing customers and do a retrofit.	
13	26	Narrative	There is a hazard, and you know it. If it can be shown that this is something you should have known about, then the company is definitely at risk. In a lawsuit, your work could reveal the companies negligence. How would you like to proceed?	
13	27	Response	Talk to the companies legal department.	Comp 10 Rep -10
13	28	Response	Use the argument that this is new information.	
13	29	Response	Talk to the head of marketing.	Rep -10 Comp 1 Trust -1

Conv.	Node	Type	Text	Points
13	32	Response	Look at when the change was made.	
13	33	Narrative	If it was made (recently, i.e. 2 years) then it's a smaller group to fix.	
13	34	Narrative	If it's been that way for 10 years, then it probably not going to be a problem (volume of success).	
13	35	Response	Does that put your choice in a grounding system into question?	
13	36	Narrative	Can you design a retrofit for the existing machines?	
13	37	Narrative	Can you use a different material?	
13	38	Narrative	Question: \n —Do you drop it? \n —Do you push legal and potentially get fired? \n —Do you convince somebody it is the right thing to do? \nConsequences: \ n drop it — if something goes wrong, you're on record as knowing that something could go wrong. Knew or ought to have known. \n\nGo public — start a new (non-engineering career). \n\nPush legal — double jeopardy. (Ford — they knew and chose to take the risk) \n\nConvince higher-ups … tread carefully; it could cost you your job. \n\n\n\nQuestion — did you do what should be done? Can you live with yourself. \n\nQuestion — if this happened to you. Can you work in this environment. \n (If you get the reputation as a hard-ass, how long is it going to take) \n\nDo you want to work elsewhere. (resign)	Developer comments
13	39	Response	Shortchanging the customer is profitable.	
13	40	Response	What's the cost to the company if there is a problem?	
13	41	Response	Are their consequences to the companies reputation if the flaw is found? Can you fix it so that the company looks good?	
13	42	Narrative	You decide to speak with legal about the matter. The company lawyer acknowledges your work for the company but reminds you that your employment contract includes a non-disclosure clause. He politely asks you to keep the matter confidential while he addresses the matter with senior management.	Rep -10 Risk -10 Code 100

Conv.	Node	Type	Text	Points
13	43	Narrative	You try and make an appointment with the head of marketing, but he doesn't acknowledge your emails. Once you finally get through to him, he listens to your idea and recommends you go through the proper channels.	Rep -10 Risk -10
13	44	Narrative	New Dialogue Entry	
13	45	Narrative	You explain the risks to the VP. There is a hazard that the company is liable for, and now that you know about it, you are responsible for it. The VP seems to need a little more convincing, how would you like to continue?	
13	46	Response	Bury your notes.	Trust -100
13	47	Response	Talk to senior management.	Code 10 Comp 10 Rep 10
13	48	Narrative	You arrange a meeting with the VP of the company and explain your concern about how the combines could have a problem with grain dust.	
13	50	Narrative	NOTES Question: —Do you drop it? —Do you push legal? —Do you convince somebody it's the right thing to do? Consequences: Drop it — if something goes wrong, you're on record as knowing that something could go wrong … Knew or ought to have known. Go public — start a new (non-engineering career). Push legal — double jeopardy. (Ford — they knew and chose to take the risk) Convince higher-ups … tread carefully; it could cost you your job. Question — did you do what should be done? Can you live with yourself? Question — if this happened to you. Can you work in this environment? (If you get the reputation as a hard-ass, how long is it going to take before your unemployable) Do you want to work elsewhere (resign)?	Trust -100 Rep 100 Risk -10 Code -100
13	51	Narrative	{group} Go to Questions	
13	52	Response	Exit.	
13	53	Response	{group} New Dialogue Entry	
13	54	Response	Discuss the original design (with grounding).	Comp 10
13	57	Response	Point out the risks.	
13	58	Response	Appeal to corporate responsibility.	

Conv.	Node	Type	Text	Points
13	59	Response	Sell the idea as caring for the safety of your customers.	
13	60	Narrative	You decide to bury your notes. But in talking to your friends, they point out that is the same as destroying evidence and now you could be found guilty of unprofessional practice. \n This is likely to give you more problems than just acknowledging the problem and seeking out a solution.\n <color=orange>Would you like to rethink your solution?</color>	
13	61	Response	Yes.	
13	62	Response	No.	
13	63	Narrative	CONSEQUENCE: unprofessionalism award.	
13	64	Response	Discuss the risks.	Comp 10
13	65	Narrative	You try and convince the VP that the corporation should take responsibility for resolving this problem. Unfortunately, the VP supports your manager's decision that you are blowing the problem out of proportion.	
13	66	Response	Exit.	
13	67	Response	Should you go public (blow the whistle)?	
13	68	Narrative	Which risk is more challenging?	
13	69	Response	The financial risk to the company.	
13	70	Response	The personal risk to me and my career.	
13	72	Narrative	<color=orange>As an engineer, you are expected to look out for the public. \n\nADVICE: keep your records, let the corporation manage the risk. They are liable either way. \n\nWith your records you can legally show that you have followed the proper course of action. You have informed the corporation and recommended they fix it. </color>	
13	73	Response	Leave the company.	Rep 10 Risk 10
13	74	Response	Blow the whistle.	Risk 100 Rep -100
13	75	Response	Return to work.	Risk -10
13	76	Narrative	You have decided to cut ties with the corporation. You should prepare to see them in court.	
13	77	Response	Exit.	
13	78	Narrative	You decide to leave the company. You will need to maintain your records this could come back to haunt you.	
13	79	Response	Exit.	

Conv.	Node	Type	Text	Points
13	80	Narrative	Your confidence in the company is shaken, but you can live with it. You should keep your records to protect yourself.	
13	81	Response	Exit.	
13	82	Narrative	<color=orange>You suspect your reputation may take a huge hit if you report this \n\nADVICE: keep your records, let the corporation manage the risk. They are liable either way. \n\nWith your records you can legally show that you have followed the proper course of action. You have informed the corporation and recommended they fix it. </color>	
13	83	Narrative	The VP likes your idea and takes it to the marketing department.	
13	84	Response	Exit.	
13	85	Narrative	You point out the explosion risk caused by grain dust and sparks, and the VP takes you very seriously. They arrange a meeting with the lawyer and agree to implement a recall and your solution.	Trust 10 Comp 10 Rep 100
13	87	Narrative	{group} Start: ESD Scenario 003A	
13	88	Narrative	{group} Go to Questions	
13	89	Narrative	{group} Go to Questions	
13	90	Narrative	{group} Go to Questions	
13	91	Narrative	{group} Go to Questions	
13	92	Narrative	{group} Go to Questions	
13	93	Narrative	{group} Go to Questions	
13	94	Response	Exit.	
13	95	Narrative	{group} Go to Questions	
13	96	Response	Exit.	
13	97	Narrative	{group} Go to Questions	
14	0	Response	START	
14	4	Response	"I think engineers have a duty to protect the public."	Trust 10
14	61	Narrative	"Why would you say that?"	
14	101	Response	"Well virtually every code of engineering ethics puts protection of the public first."	Code 1
14	103	Narrative	"I thought the association was just an old boys club. "	
14	104	Response	"No, the association is there to protect the public. And by doing so, protect us. Our reputation as professionals depends on us being trustworthy."	Code 10 Trust 10
14	105	Response	"Yeah, I think a lot of people think that."	
14	106	Narrative	"Can you think of an example?"	
14	107	Response	"Think about the Toyota and Volkswagen cases a few years back."	
14	108	Narrative	"What about them?"	

Conv.	Node	Type	Text	Points
14	109	Response	"Well Toyota had their brakes fail under certain conditions. And instead of issuing a recall, they tried to deny there was a problem."	Comp 1
14	110	Response	"In the Volkswagen case, they were caught cheating on the emissions tests."	Comp 1
14	111	Narrative	"Well, what does that have to do with me?"	
14	112	Response	"Well think about the pressures those engineers must have been under. Just like you, they were probably being pressured by someone more concerned about profit than about protecting the public."	Rep 10
14	113	Response	"Imagine that you were the engineer responsible for that. In both those cases, the companies publicly blamed the engineers. What makes you think someone is going to have your back?"	Trust 1 Rep 1
14	114	Narrative	"I get your point!"	
14	117	Narrative	{group} check this	
14	142	Response	End the conversation.	
14	143	Narrative	{group} Go to questions.	
15	0	Response	START	
15	18	Response	"What happens when companies neglect safety?"	Code 1
15	65	Response	"Do you want that to happening to you?"	Rep 1
15	66	Response	"Sure it's easy to take shortcuts! But what happens when things go bad?"	Trust 10
15	67	Narrative	"Yes, but I work in a manufacturing company, not as a consultant. I don't deal with the public."	
15	68	Response	"Okay, but you still call yourself an engineer."	Rep 10
15	74	Response	"Is that worth it?"	Rep 1 Trust 1
15	77	Narrative	"Well, most of the time, nothing happens. But you know if we miss something on a combine or a tractor, some people could really get hurt. Remember the Toyota brake scandal. If that was us, the company might never recover."	
15	78	Response	"If you knew your design had caused the brakes to fail. Could you live with yourself?"	Code 10
15	81	Narrative	"It's unfortunate, in a lot of these situations, the people in control (the CEO's) are not the same as the people responsible (the engineers). We see that so often with companies saying they didn't know their decisions would hurt people."	

Conv.	Node	Type	Text	Points
15	87	Response	"Yes, that's about it. To make matters worse, the person doing it who did the final inspection wasn't even an engineer. He had his licence revoked and was having another engineer sign off on his work."	Comp 1 Trust 1 Rep 1
15	88	Response	"And when the building collapsed, it was the engineer they put the blame on!"	Rep -1 Code 10
15	98	Response	"But if someone gets hurt, it could be worse."	Trust 1 Rep 1
15	120	Narrative	{group} Goto F Conv 002-69	
15	140	Response	End the conversation	
15	141	Narrative	{group} Go to questions.	
18	0	Response	START	
18	63	Response	"Think about that case in Elliot Lake a few years back where the mall collapsed."	Comp 10
18	82	Narrative	"Oh yeah, that one. Didn't it become a crown inquiry?"	
18	83	Response	"Yes it did. In fact, the inquiry determined it was negligence on the part of the owners and a consultant representing himself as an engineer that led to the collapse. "	Comp 1
18	84	Narrative	"No! What happened?"	
18	85	Response	"The parking facility on top of the mall needed expensive repairs. Instead of making the owners do this, the consultants proposed a series of cheaper and less effective repairs.	Code 1 Trust 1 Rep 1
18	86	Narrative	"So the owners neglected the maintenance and put peoples lives at risk because doing the right cost too much money?"	
18	99	Response	"The building changed hands a number of times. And each of the owners ignored the effects of corrosion caused by leaks in the parking garage floor (on top of the mall)."	Trust 1 Comp 1 Rep 1
18	100	Narrative	"That's horrible. How could that have been allowed to happen?"	
18	115	Response	"Yes it did! They found it was negligence, poor maintenance and low-cost solutions that led to the collapse."	Comp 1
18	116	Response	"I don't recall all the details, but I think the engineer responsible was letting his partner use his seal."	Code 1
18	118	Response	"Think about that case in Elliot Lake a few years back where the mall collapsed."	Comp 10
18	119	Narrative	{group} Node 005A	

Conv.	Node	Type	Text	Points
18	135	Narrative	"That's not right. You should never let someone use your seal."	
18	136	Response	"It gets worse."	
18	137	Response	"Well, the Argo mall was the centre of economic activity in the town. Nobody wanted to see it close."	Comp 1 Trust 1
18	138	Narrative	"Really?"	
23	0	Response	START	
23	3	Narrative	A month later you are at lunch with John and Harry again. This time, John encourages you to tell Harry about a problem you have selecting parts for a new project. Harry listens carefully and suggests a part from his product line that will solve your problem easily.	
23	18	Narrative	{group} START: Out to Lunch Part B	
23	22	Response	Okay.	
23	23	Narrative	When you get back to the office, John encourages you to check out Harry's suggestion and see how it compares to everyone else. What you discover is that Harry's product is quite good, but it costs more than the competitive products.	
23	24	Narrative	As you are leaving, you notice Harry and John having a private conversation during which time Harry once again picks up the check.	
23	25	Response	Okay.	Code -10
23	26	Response	Okay, let's go with Harry's solution.	Risk 1
23	27	Narrative	Two weeks later, you've got Harry's product, and it works like a charm, right out of the box! But because of the higher price, you are a bit concerned your customer might want you to justify this choice.	
23	28	Response	Document the price difference and reasons for your choice.	Trust 10
23	29	Narrative	Knowing that Harry's product works and will solve the customer's problem. What do you think of Harry as a vendor?	
23	30	Response	Harry knows his stuff, let's talk to him again.	Rep -10
23	31	Response	This is cool, Harry's helping me and it's making me look good.	Risk 1
23	32	Response	I wonder what Harry is getting out of this?	Comp 1
23	33	Narrative	{group} Exit: Go to Part 1C	
23	34	Response	Play along: Let's see what I can get out of this.	
23	35	Response	Stop Harry and pay for your own meal.	Code 10
23	36	Response	Let John know that Harry's solution is more expensive.	Rep 1

Conv.	Node	Type	Text	Points
23	37	Narrative	When you mention this to your John, he recommends going with Harry, because Harry knows his stuff and it will work as promised.	
23	39	Response	Document that John is pushing you to use Harry's product.	Comp 10
23	40	Response	Don't worry about it.	Risk 1
24	0	Response	START	
24	7	Response	"So what happens to the engineering firms that get caught taking shortcuts or not doing the work properly?"	Trust 10
24	9	Narrative	START: Part 2	
24	15	Response	Safety equipment for workers costs money.\n	
24	19	Narrative	Notes: You should not see this This is a conversation about priorities. What constitutes a good engineering decision? What constitutes a good management decision? What are the roles of an engineer in these situations? — Engineers are expected to inform others of the consequence of their actions — Engineers are expected to understand the context, standards and safety requirements of the situation — Engineers are expected to create products that work as expected	
24	21	Response	Outsourcing to non-engineers creates unsafe situations. If I have to compete with manufacturing in China or India.\n	
24	59	Narrative	"No, not really. But what can I do?"	
24	69	Narrative	"Yeah, you're right, I hadn't thought about it that way."	
24	71	Narrative	"Yeah, the media portrays them as heroes. But I think the reality is that they don't stay in business too long. You know now that I think about it when engineering failures hit the news, it often leads to inquiries, lawsuits, and lots of people getting hurt."	
24	75	Response	End the conversation.	
24	76	Narrative	Go to questions.	
24	96	Response	"Have you considered leaving?"	Rep 1
24	97	Narrative	"I want to, but it's just not financially feasible right now. I've got my car, my house, my student loans. If I stop working, I lose it all."	
32	0	Response	START	

Conv.	Node	Type	Text	Points
32	3	Narrative	For the third month in a row, you head out for lunch with John and Harry. As you greet Harry, he says "Thanks [lua(return Actor.Player.Name)] that little project of yours turned into a real gold mine. Let's go celebrate! "\nAt this point, Harry buys you both a very nice lunch and asks if there is anything else he can help you out with.	
32	5	Narrative	When you get back to the office, you discuss lunch and Harry's offer with a co-worker. She doesn't say much, except that you should watch your back because it might look like your being bribed. What should you do?	
32	9	Response	Clam up: This doesn't feel right.	Code 1
32	10	Narrative	John is glad his intuition about you is right. You're going to get things done. Over the next few months, you are assigned the role of project lead and enrol in the companies management training program.	Risk 10 Rep 10
32	11	Narrative	After lunch, you decide to confront the matter and John that you do not take bribes.\n What would you like to say?	
32	12	Narrative	As lunch winds down, Harry picks up the check and offers to sit down with you and discuss what products you will likely need during the course of the project. That way he has lead time to talk with his suppliers and make sure everything goes smoothly for you.	
32	18	Narrative	{group} START: Out to Lunch part 1c.	
32	20	Response	Continue …	
32	22	Response	Okay, let's get his help.	Code -10
32	35	Response	Commit.	Code -10
32	36	Response	Wait a minute, should I be doing this?	
32	38	Response	Don't commit.	
32	39	Narrative	As lunch winds down, Harry picks up the check, he thanks you for your business and ask you to let him know if you change your mind.	
32	40	Narrative	Notes	
32	41	Narrative	You politely deflect Harry's inquiries and comment that although his help was really appreciated, you've got nothing on your plate right now. Harry acknowledges your statement, and replies, "That's okay, you've got my number. Call me when you need my help."	
32	42	Response	Okay.	
32	43	Response	"All these lunches look like bribes! What are you thinking!"	Rep -10 Code 10

Conv.	Node	Type	Text	Points
32	44	Response	Talk to John about the benefits of working with Harry.	Rep 10 Code -10
32	45	Response	"You know — when Harry pays for lunch it makes me feel uncomfortable. It's like I'm taking a bribe."	Code 10
32	46	Narrative	John calmly and quietly listens to your concerns and comments, that he understands your feelings and concerns. Over the next few months, you notice you don't get invited out for lunch anymore.	
32	51	Narrative	Over the next month, things between you and John get tenser and then seem to die down.	
32	52	Response	Confront John about taking bribes.	Risk 10
32	54	Response	Thank Harry for his time.	
32	55	Response	Politely thank Harry for his offer of assistance.	Rep 1
32	56	Response	Confront my boss about what is going on.	Rep -10 Code 10
32	57	Narrative	After lunch, your boss asks you, "Why were you playing coy with Harry, is something wrong?"	
32	58	Response	Tell John, "I am uncomfortable with Harry knowing what I am working on."	
32	59	Narrative	You have successfully avoided taking bribes. However, it now looks like you're eating lunch alone.	
32	60	Narrative	You have successfully avoided taking bribes. However, it now looks like you're eating lunch alone.	
32	61	Response	Document what is going on. You might need it.	
32	62	Response	Continue …	
32	63	Narrative	You decide to get Harry's help on a new contract that you are working on. Its success could make or break your career with the company. Harry listens and suggests that if you make them your supplier of choice on the project, then he will personally make sure things go as smoothly as possible.	
32	64	Response	Trust Harry and get back to work on the project.	
32	65	Response	Continue …	
32	66	Response	Continue …	
32	67	Response	Continue …	
33	0	Response	START	
33	1	Narrative	{group} Start: Out to lunch questions.	
33	2	Response	Strongly agree.	
33	3	Narrative	Do you think Harry was bribing John?	
33	4	Response	Agree.	
33	5	Response	Disagree.	
33	6	Response	Strongly disagree.	

Conv.	Node	Type	Text	Points
33	7	Narrative	What influenced your decision most?	
33	8	Response	Was Harry able to solve my problems?	
33	9	Response	Lunches are common business practices.	
33	10	Response	Relationships are key to success in business.	
33	11	Response	Harry profited from helping me out.	
33	12	Narrative	How would you recognize if you were being bribed?	
33	13	Response	If I was getting anything of real value in return.	
33	14	Response	If it influenced my decision making.	
33	15	Response	If I could not tell people what I had just done.	
33	16	Response	If I found myself in a conflict of interest.	
33	17	Narrative	How would you handle it?	
33	19	Narrative	When did you begin to think you were being used?	
33	21	Response	When Harry bragged about how much he made off me.	
33	22	Response	When Harry keeps paying for lunch.	
33	23	Response	When everyone is pointing you to use Harry.	
33	24	Response	When Harry withdraws his help because I am not choosing him.	
33	25	Response	Keep it quiet.	
33	26	Response	Talk to my supervisor.	
33	27	Response	Talk to a lawyer.	
33	28	Narrative	Exit	
33	29	Response	Harry's willingness to buy lunch.	
35	0	Response	START	
35	2	Response	Continue …	
35	7	Narrative	6 months later, your supervisor is being terminated. You suspect you will be called upon to justify your choice of Harry's company XYZ as the supplier.	Rep -100
35	9	Response	Play innocent.	Rep -10 Trust -100
35	10	Response	Resign.	Rep -100
35	11	Response	Hide the evidence.	Rep -10 Trust -100
35	12	Narrative	You hide the evidence but suspicion surrounds you in the office. You begin to look for work elsewhere.	
35	20	Narrative	This doesn't work. You are terminated.	
35	22	Narrative	You resign in the middle of an internal scandal. Your former employer is now looking for evidence of a cover-up.	Rep -100
35	30	Response	Exit and go to the questions.	
35	41	Narrative	START: make the switch.	
35	44	Narrative	{group} START: I am cool.	
35	45	Narrative	{group} START: Why the switch?	

Conv.	Node	Type	Text	Points
35	47	Narrative	You make the switch John is asking for. He's a good friend and supporting him has helped your career so far.	
35	48	Narrative	You ask John	
35	49	Response	"Why the switch? I thought Harry was bidding high to avoid suspicion?"	
35	50	Response	"Why the switch? I thought you liked the contract I worked out."	
35	51	Narrative	John agrees, your recommendation was good. Unfortunately, he has suspicions about the new supplier's ability to deliver on time. In order to meet all the project deadlines, Harry would be a better choice.	
35	52	Response	Make the switch.	
35	53	Response	Continue questioning.	
35	54	Narrative	John says, "Good, I am glad you see it my way. See you at lunch tomorrow."	
35	55	Narrative	John tells you that senior management has taken an interest in his current project and they want to minimize delays and ensure the project comes in ahead of schedule. Harry has promised to deliver if we can make it worth his while.	
35	56	Response	Continue …	
35	57	Response	"We both know how important this contract is, now let's do this."	
35	58	Narrative	Harry delivers above expectation, as promised the goods arrive on site without any delays or complications. Senior management is thrilled with your ability to deliver the project on time. However, the project costs have risen significantly.	Rep 100
35	59	Response	Continue …	
35	60	Narrative	{group} START: Switch without documenting it.	Risk 100
35	61	Response	Pull out my documentation.	Code 10 Trust 10 Rep 10
35	62	Narrative	You pull out your documentation showing when you were instructed to use XYZ. The company provides your notes to the police.	
35	63	Response	Exit and go to the questions.	
35	64	Response	Exit and go to the questions.	
35	65	Response	Exit and go to the questions.	
36	0	Response	START	
36	13	Response	I document the change in my company journal.	Trust -10
36	14	Response	I make the switch and document the change in my private journal.	Trust -10 Rep -10

Conv.	Node	Type	Text	Points
36	15	Narrative	When asked for clarification your manager explains that he and XYZ have worked together extensively. He trusts the quality of their work and their professionalism. The competitors, however, have failed to deliver and left him hanging on certain projects.	
36	45	Narrative	{group} START: 2c — document the request.	
36	46	Narrative	{group} START: 2c — question motivation.	
36	54	Narrative	Although uncomfortable with what is going on, you decide to make the switch.	
36	55	Response	I make the switch and do not document it.	Code -10 Trust -10 Rep -10
37	0	Response	START	
37	1	Narrative	This request seems odd, because you have already found a lower priced competitor. How do you react?	
37	2	Response	Be cool about it. I assume John has a good reason.	
37	3	Response	Make the change but document that John specifically told you to do so.	
37	4	Response	Get frustrated; you know how to do your job.	
37	5	Response	Challenge John on why he's changed his mind. Stick with your decision unless he gives you a specific reason.	
37	6	Response	Question John on why the sudden switch.	
37	41	Narrative	{group} START: 2a good guy.	
37	42	Response	{group} Group C: Challenge the decision	
37	43	Response	{group} Group D: Get mad	
37	44	Narrative	It's been several months since your lunch with John and Harry, and things have been pretty quiet. But today when John comes back from lunch he asks you to re-evaluate the costs of a project based on using parts from Harry's company XYZ.	
37	45	Response	Continue …	
37	46	Response	{group} Group B: play nice	
37	49	Response	Question John on why the sudden switch.	
37	50	Narrative	{group} START: 2a — bad guy.	
37	51	Narrative	{group} START: 2a — document it.	
38	0	Response	START	
38	4	Response	Frustrated. I know how to do my job. Yet if I don't follow his instructions I will probably be out of work.	

Conv.	Node	Type	Text	Points
38	15	Narrative	When asked for clarification your manager explains that he and XYZ have worked together extensively. He trusts the quality of their work and their professionalism. The competitors, however, have failed to deliver and left him hanging on certain projects.	
38	16	Narrative	About 3 months into the project the supplier you chose is late on a shipment and causing your company to miss the promised delivery date of the product. If you do not resolve this situation, you expect to lose your job.	
38	17	Response	Ask XYZ (Harry) for help.	Rep -10
38	25	Response	Ask your supervisor for help.	Rep -10
38	26	Narrative	Swallowing your pride. You call on company XYZ. Sometimes the lowest cost vendor is not the best.	
38	27	Narrative	Swallowing your pride, you talk to your supervisor. He tells you that the reason XYZ gets his business is that they take care of their clients. When you contact XYZ, they agree to help out at a reasonable price given the short notice. Sometimes the lowest cost vendor is not the best.	
38	28	Response	Continue …	
38	35	Response	Tactfully suggest that an outsider this may look like taking bribes.	
38	36	Narrative	Your supervisor assures you everything is above board. XYZ is widely known for quality service and a favourite in the industry.	
38	38	Response	Don't make the switch.	
38	39	Response	Take my suspicions to senior management.	
38	40	Narrative	Your supervisor is terminated, and a new manager is brought in. However, you now have the feeling that you and your department are always being closely watched.	Rep -10
38	47	Narrative	{group} START: Get mad.	
38	50	Response	Continue …	
38	52	Narrative	{group} START: Question.	
38	53	Response	I understand. Being able to trust our suppliers is critical to the success of our business.	
38	54	Narrative	Feeling angry and frustrated with John, you refuse to change the specification. He backs down, and the next day you are called into the vice presidents office to resolve the matter.	

Conv.	Node	Type	Text	Points
38	55	Narrative	The Vice President backs your decision that unless the situation truly warrants it, you are expected to use the lowest cost vendor. John is unhappy about the decision because he believes XYZ (Harry's company) is a better and more reliable choice.	Rep 10
38	56	Response	Continue …	
38	57	Response	Let the Vice President know about John and Harry's lunchtime meetings.	
38	58	Narrative	The Vice President thanks you for bringing this to her attention. The matter will be resolved after an internal investigation.	Rep -100
38	59	Response	Continue …	
38	60	Response	Ask XYZ (Harry) for help.	Rep -10
38	61	Narrative	Harry no longer works for XYZ. The new sales rep is eager to help you, but cannot get the supplies you need right away. After a few days, he is able to deliver, but the parts cost nearly double the original amount.	
38	62	Response	Continue …	
38	65	Response	Continue …	
43	0	Response	START	
43	1	Narrative	{group} START: C-site 001.	
43	2	Narrative	You are an EIT working on a construction site. Late Friday afternoon you notice an electrician working in the panel box for the building while it is live. This is a seriously dangerous activity. What do you do?	
43	3	Response	Instruct the contractor to stop immediately.	Comp 10
43	4	Response	Report the matter to your supervisor.	Comp 10 Rep 10
43	5	Response	Let the contractor alone; he knows what he is doing.	Comp -10 Rep -10 Trust -10
43	6	Response	Contact the electrician's employer.	Comp 1 Rep -1
43	7	Narrative	Given the hazard for arc blast is caused by shorting high power electrical circuits. How do you want to stop him?	
43	8	Response	Inspect the scene and verify your assumptions.	Comp 10
43	25	Narrative	You pick up your cell phone to call your supervisor. He instructs you to immediately stop the electrician and find out who he is.	
43	26	Response	Okay.	
43	45	Narrative	You contact the electrician's supervisor. He asks you to stop the electrician immediately. They will reschedule the electrical work with your supervisor.	

Conv.	Node	Type	Text	Points
43	62	Narrative	{group} Go to 006A: Inspect the job site	
43	63	Narrative	Go to 006: Not done	
43	64	Narrative	Given the hazard for arc blast is caused by shorting high power electrical circuits. How do you want to stop him?	
44	0	Response	START	
44	7	Narrative	The hazard here is an arc blast caused by shorting out parts in a high power circuit. People can die from this. How do you want to stop the electrician?	
44	9	Response	Quietly make some noise until he acknowledges your presence.	Comp 10
44	10	Response	Turn the lights on and off.	Comp 1
44	11	Response	Loudly call out to the electrician to stop.	Comp -10
44	12	Response	Sneak up on him and tap him on the shoulder.	Comp -10
44	13	Response	Wait until he is done.	Comp -10
44	14	Narrative	Boom your dead.	
44	15	Narrative	The contractor stops his work and angrily starts yelling at you. "Who the hell are you! What do you think you are doing!"	
44	16	Response	Yell back.	Rep -10
44	17	Narrative	You yell back at him. "Working live is unsafe! I'm going to report you!"	Rep -10
44	18	Response	React calmly.	Rep 1 Comp 1
44	19	Narrative	You calmly state: "I work for the engineering firm in charge and I think the work you were doing was unsafe. Who instructed you to work on this panel?"	
44	20	Response	Start taking notes.	Comp 10
44	22	Narrative	You let the electrician finish. Do you want to confront him now?	Comp -10
44	23	Response	Yes.	Comp 1
44	24	Response	No.	Comp -10
44	33	Narrative	After a few minutes, the electrician takes notice of you and stops his work. He asks you, " Who are you? What are you doing here? Why did you interrupt me?"	
44	59	Narrative	You leave the matter alone. However, the electrician has an accident at a different work site killing himself and two other workers. During the subsequent investigation, your incident with him comes to light.	
44	60	Narrative	failure: Go to Questions	
44	62	Narrative	{group} START 002	

Conv.	Node	Type	Text	Points
44	63	Narrative	You start taking notes of the situation, and his behaviour. Once he calms down, you calmly get his name and employer information.	
44	64	Narrative	You calmly state, "I work for the engineering firm in charge and I think the work you were doing was unsafe. Who instructed you to work on this panel?"	
44	65	Narrative	{group} START 002A	
44	66	Response	Exit and go to questions.	
45	0	Response	START	
45	38	Narrative	You contact the electrician's supervisor. He informs you that the electrician you reported no longer works for their firm. Following safe work procedures are a requirement for them.	
45	45	Narrative	You contact the electrician's supervisor. He asks you to stop the electrician immediately. They will reschedule the electrical work with your supervisor.	
45	46	Response	Continue …	
45	47	Narrative	You gently stop the electrician from working and tell him you have arranged to reschedule the work.	
45	48	Response	Follow up with your supervisor.	
45	49	Response	Follow up with the electrical contractor.	
45	54	Narrative	success Go to Questions	
45	57	Narrative	Your supervisor is happy that you stopped the situation and reported the matter to him. The electrician is disciplined and removed from your work site. Do you want to pursue the matter further?	
45	58	Narrative	START 003	
45	59	Response	Exit	
46	0	Response	START	
46	1	Narrative	{group} START	
46	2	Narrative	You are a junior engineer in a manufacturing company. Your current assignment is to design a sensor that fits within a gearbox. Although you have done this before, the current design is complex enough that nonlinear finite element analysis is required. During the simulation of linear versions of the model, your simulation results are close to your calculations. However, when you introduce a nonlinear material, the results differ substantially from your previous results. In order to keep moving on the project, what would you like to do?	
46	4	Response	Contact technical support.	

Conv.	Node	Type	Text	Points
46	5	Response	Build a prototype.	Comp 1 Trust 1 Code 1 Rep -1
46	6	Response	Check with your supervisor.	
46	7	Narrative	You decide to contact the software companies technical support division. They listen to your problem and ask you to send them a copy of your design so they can check it out. Typically, it's just a matter of looking at how you set up the model.	
46	8	Response	Agree.	Comp -10 Rep -10
46	9	Response	Check with your co-workers about how to proceed.	
46	10	Response	Disagree	Comp 1
46	11	Narrative	You decide that you cannot let the technical support people see your design because it is proprietary. But you still have the problem.	
46	12	Response	Ask for a non-disclosure agreement with the software vendor.	Comp 1
46	13	Response	Ask your supervisor for assistance.	Rep 1
46	14	Response	See if you can create a different model that has the same problem.	Comp 1
46	15	Narrative	You ask your supervisor for assistance. And although like you, he is disappointed with the results, he asks you to create a different model with the same problems. This is important because he doesn't want the sensor design to become public information.	
46	16	Narrative	You agree to send the software company a copy of your files. However, a co-worker overhears your conversation and immediately advises you not to do so. Doing this could make the design public knowledge and release a trade secret. You are strongly advised to speak with your manager.	
46	17	Narrative	The technical support person you are dealing with says he is not authorized to sign such an agreement. It would have to go through corporate legal.	
46	18	Narrative	Although it takes you a few attempts, you successfully make a model that creates the same nonlinearity issues you encountered with your design. As far as you can tell, it has to do with numerical round-off and the element size around the corners of your design.	
46	19	Response	Pass the information on to technical support.	Comp 1

Conv.	Node	Type	Text	Points
46	20	Narrative	Once the design is received, technical support confirms your observation and suggests a workaround. You are still not happy with the fix as it leaves your prior work in doubt.	
46	21	Response	Exit and start the questions.	
46	23	Narrative	You ask a co-worker for guidance, and he reminds you that the company designs are proprietary and that you will need a non-disclosure agreement along with your supervisor's approval.	
46	24	Narrative	You decide to build a prototype of the sensor and find that as you suspected the simulation results are not valid! As this could substantially impact the design, you decide to bring the matter to your supervisor's attention.	
46	25	Response	Give up.	Rep -10
46	26	Narrative	Your supervisor asks you to get an evaluation copy of another package and use it to generate a second solution. However, the software company specifies that you cannot use the evaluation software for design purposes. Do you arrange for an "evaluation" copy anyway?	
46	27	Response	Yes.	Code -10 Comp 10
46	28	Response	No.	Code 10 Rep -10
46	29	Narrative	Two days later, your supervisor stops by your desk to see the new simulation results. Since you have not acquired the software, what do you say?	
46	30	Response	Getting an "evaluation" package is wrong. As a condition of evaluation, you are not allowed to use the software for product design.	Code 1 Rep 1
46	31	Response	Avoid the question and hope your supervisor doesn't notice.	Rep -10
46	32	Response	Agree to get right on it.	Code -10 Rep -10
46	33	Narrative	You order the software and run the simulations. The "evaluation" package is producing results more in line with what you expect.	
46	34	Response	Purchase the software.	Code 10 Comp 10 Rep 10
46	35	Response	Return the evaluation.	Code -10 Rep -10

Conv.	Node	Type	Text	Points
46	36	Narrative	When you show better results to your supervisor, you ask for permission to do the right thing and purchase the better package. It has shown it's worth and already proven valuable.	
46	37	Response	Exit and start the questions.	
46	38	Narrative	At the end of the evaluation period, you return the software. The software salesman asks you why?	
46	39	Response	Exit and start the questions.	
46	40	Narrative	Your supervisor agrees with your point and suggests, if the "evaluation" copy works out, then they will buy the software. Is that good enough?	
46	41	Response	Yes.	Rep 1
46	42	Response	No.	Rep -10
46	43	Narrative	Your resistance to your manager's instructions is taken badly. You are taken off the project and terminated shortly thereafter.	
46	44	Response	Exit and start the questions	
46	45	Response	Use a different simulation package.	Comp 10
47	0	Response	START	
47	1	Narrative	{group} START: Bad software questions.	
47	2	Narrative	Are you familiar with the requirement for skilled practice?	
47	3	Response	Yes.	
47	4	Response	No (please explain).	
47	5	Narrative	In the scenario, you just played what was the most pressing engineering ethical issue?	
47	6	Narrative	As a self-regulating profession, engineers have the responsibility to practice within the limits of their skill and ability. As an engineer, you have a responsibility to understand the quality of simulation results you are working with and the consequences of errors in those simulations.	
47	7	Response	Protecting the companies intellectual property.	
47	8	Response	Having trust in your simulation results.	
47	9	Response	Deceiving a vendor.	
47	10	Narrative	Imagine your supervisor asked you to "evaluate" a third party software to ascertain if the results were correct. \nWhat is wrong with doing this?	
47	11	Response	Okay.	
47	12	Response	Nothing.	
47	13	Response	It's illegal.	
47	14	Response	It's deceitful.	
47	15	Narrative	What was the key aspect of your choice?	
47	16	Response	The software is being used for a commercial purpose without paying for it.	

Conv.	Node	Type	Text	Points
47	17	Response	You would have to lie to the software manufacturer to get it.	
47	18	Response	There is no consequence for downloading software off the internet.	
47	19	Narrative	{group} Exit: Bad Software quest is a success	
47	20	Narrative	Question: Is it illegal. Depends on the licence agreement In the case of XXX, it said it was for evaluation purposes only. When we found out a customer from YYY was evaluating the software, we stopped it.	
47	21	Narrative	Should this be enough to warrant disciplinary action by your provincial engineering association?	
47	22	Response	Yes.	
47	23	Response	No.	
49	0	Response	START	
49	1	Narrative	Exit.	
49	2	Narrative	START: Questions	
49	3	Narrative	Who's responsible for safety in the workplace?	
49	4	Response	The project manager.	
49	5	Narrative	Do engineers have additional responsibilities in this situation?	
49	6	Response	Yes, we have a duty to protect the public.	
49	7	Narrative	Do you understand the hazards of working live?	
49	8	Response	Yes.	
49	9	Narrative	Should the electrician be barred from this workplace?	
49	10	Response	Yes, the electrician should be barred from this work site.	
49	11	Narrative	Which element of the engineering act/by-laws/code of conduct is most relevant here?	
49	12	Response	Protection of the public.	
49	13	Response	The site owner.	
49	14	Response	Each employer.	
49	15	Response	The employees.	
49	16	Response	No, responsibility rests with the individual contractors.	
49	17	Response	Maybe, it depends on the contract.	
49	18	Response	No.	
49	19	Response	Yes and he should also lose his licence.	
49	20	Response	No. We should understand the situation completely before making this judgment.	
49	21	Response	No, that response is too extreme.	
49	22	Response	Duty to the employer.	
49	23	Response	Trust in the profession.	

Conv.	Node	Type	Text	Points
52	0	Response	START	
52	17	Narrative	You yell back at him. "Working live is unsafe! I'm going to report you!"	
52	27	Response	Leave it alone.	
52	29	Narrative	You leave the matter alone. However, the electrician has an accident at a different work site killing himself and two other workers. During the subsequent investigation, your incident with him comes to light.	
52	30	Narrative	Your supervisor is happy that you stopped the situation, and reported the matter to him. The electrician is disciplined and removed from your work site. || Do you want to pursue the matter further?	
52	32	Narrative	Failure.	
52	35	Response	Discuss the matter.	
52	36	Response	Contact the electrician's supervisor.	
52	37	Narrative	New Dialogue Entry	
52	39	Response	Report the matter immediately.	
52	40	Response	Report the matter on Monday morning.	
52	41	Narrative	When you get to work on Monday, your supervisor calls you in about a complaint from the electrical contractor.	
52	42	Response	Calmly explain the situation.	
52	43	Response	Get defensive.	
52	44	Narrative	Once you explain the situation, your supervisor calms down. He suggests that you try to avoid screaming matches in the future.	
52	51	Narrative	You get defensive about the situation and are fired because of unprofessionalism. In retaliation, you contact the provincial workplace health and safety office and report the matter. They launch a full investigation into your company and its contractors.	
52	52	Response	Okay.	
52	53	Narrative	Failure.	
52	55	Narrative	You contact the electrician's supervisor. He informs you that the electrician you reported no longer works for their firm. Following safe work procedures are a requirement for them.	
52	56	Narrative	Success.	
52	57	Narrative	Your supervisor is happy that you stopped the situation, and reported the matter to him. The electrician is disciplined and removed from your work site. Do you want to pursue the matter further?	
52	62	Narrative	START 005	

Conv.	Node	Type	Text	Points
52	63	Narrative	START 005A	
52	64	Narrative	START 005B	
52	66	Response	{group} New Dialogue Entry	
52	67	Response	Okay.	
52	69	Response	Okay.	
52	70	Narrative	Go to the questions.	
52	71	Response	Okay.	
53	0	Response	START	
53	21	Narrative	You start taking notes of the situation, and his behaviour. Once he calms down, you calmly get his name and employer information.	
53	27	Response	Leave it alone.	Comp -100 Trust -100 Rep -100
53	28	Response	Report the matter to your supervisor immediately.	Code 10 Comp 10 Rep 10
53	29	Narrative	You leave the matter alone. However, the electrician has an accident at a different work site killing himself and two other workers. During the subsequent investigation, your incident with him comes to light.	
53	30	Narrative	Your supervisor is happy that you stopped the situation and reported the matter to him. The electrician is disciplined and removed from your work site. Do you want to pursue the matter further?	
53	40	Response	Report the matter to your supervisor on Monday morning.	Rep 10 Trust -10
53	41	Narrative	When you get to work on Monday, your supervisor calls you in about a complaint from the electrical contractor.	
53	58	Narrative	You calmly state, "I work for the engineering firm in charge and I think the work you were doing was unsafe. Who instructed you to work on this panel?"	
53	61	Narrative	START 004	
53	62	Narrative	START 004A	
53	63	Response	Ask him, "Who instructed you to work on this panel?"	Comp 1 Rep 1
53	64	Narrative	The electrician tells you that he is supposed to hook up the power for one of the units in the building, but he could not find the person in charge.	
53	65	Response	Take notes.	Comp 10
54	0	Response	START	
54	1	Narrative	{group} START 006A: Inspect the job site	

Conv.	Node	Type	Text	Points
54	2	Narrative	{group} Start 006B: Leave the contractor alone.	
54	4	Narrative	You decide to inspect the scene and verify your assumptions. While doing so, you quietly walk around the room to see who is working and what he is doing. Once the electrician notices you, he puts down his tools and asks if he can help you.	
54	7	Narrative	Let the contractor be; he knows what he is doing.	
54	8	Response	Continue …	
54	9	Narrative	You notice three things. One, his jacket is from a subcontractor you know. But you don't recognize this person. Two, the breaker for this room is located elsewhere in the building. And it should be locked right now. And three, as far as you can tell, he is very careful.	
54	10	Response	Contact your supervisor.	Rep 10
54	11	Response	Confront the electrician.	Rep -10
54	12	Response	Stop him from working.	Comp 10
54	13	Narrative	You really should stop this guy, because what he is doing is unsafe. If he had shut down and tagged out the panel properly, it would be okay. What do you want to do?	
54	14	Narrative	{group} Go to 004	
54	15	Narrative	{group} Go to 005A	
54	16	Response	Continue …	
54	17	Narrative	{group} Go to 002	
108	0	Response	START	
108	1	Narrative	{group} Start: ESD Scenario.	
108	2	Response	Investigate further because I am not sure this is actually a problem.	Comp 10
108	4	Response	Talk to the engineer responsible for the previous design.	Code 10
108	5	Response	Consult my team manager.	Rep 10
108	6	Narrative	You decide to investigate further and learn that no reports of explosions have been reported on the existing equipment. However, your initial suspicions were right. Under the correct conditions, grain dust will explode. Furthermore, grain exiting a PVC tube can cause the spark necessary.	
108	7	Narrative	Your team manager is interested in what you have found and wants you to make sure the current system is grounded. He directs you not to worry about the existing product as there have been no problems before.	

Conv.	Node	Type	Text	Points
108	8	Narrative	You track down Leo, a retired engineer from the company and project lead for the previous combine design. He informs you that his design had a grounding wire inside the tube to minimize static charge and sparking. If that design change has occurred, it happened after he left the company.	
108	9	Narrative	Questions:\n 1) The engineer should have known or ought to have known?\n 2) Non-engineers making decisions based on cost?\n 3)People coming in afterward and changing the design? \nNotes:\n Servicing combines is typically done at home.\n One solution is to have a technician, visit the existing customers and do a retrofit.	
108	10	Response	Continue my investigation.	Comp 10
108	11	Response	Talk to other people in the company.	Rep 10
108	12	Narrative	You discover from the company records that several years back, the engineering department was tasked with reducing the costs of the combine. These along with several other cost-cutting measures were approved by the Vice President. However, neither he nor the engineer who suggested the changes are with the company.	
108	13	Response	Push for a recall on the existing combines.	Trust 10 Code 10
108	14	Response	Based on the lack of problems, assume the engineer and VP knew what they were doing. Anyways it's the companies problem.	Trust -10
108	15	Narrative	You decide to collect reactions from your peers. And although they think your arguments have merit, they don't want to oppose the current manager.	
108	16	Response	Go investigate the company records.	Comp 10
108	17	Response	Give up.	Trust -10 Comp -100

Conv.	Node	Type	Text	Points
108	18	Narrative	NOTES: Look at when the change was made. If it was made (recently, i.e. 2 years) then it's a smaller group to fix. If it's been that way for 10 years, then it probably not going to be a problem (volume of success). Does that put your choice in a grounding system correct? Can you design a retrofit for the existing machines? Can you use a different material? Questions: Do you drop it? Do you push legal (get fired)? Do you convince somebody it's the right thing to do (tread carefully)? Consequences: Drop it — if something goes wrong, you're on record as knowing that something could go wrong. Knew or ought to have known. Go public — start a new (non-engineering career). Push legal — double jeopardy (Ford — they knew and chose to take the risk). Convince higher-ups -- tread carefully; it could cost you your job (And it won't be because of this). Even if you fix it, there are consequences to the company's reputation if the flaw is found. Alternative (Best solution) Can you fix it so that the company looks good? Question: Did you do what should be done? Can you live with yourself? Question: If this happened to you: Could you work in this environment (If you get the reputation as a hard-ass, how long is it going to take)? Do you want to work elsewhere (resign)? Is shortchanging the customer is profitable? What is the cost to the company if there is a problem?	
108	19	Narrative	{group} Go to ESD 003A	
108	22	Narrative	{group} Go to questions	
108	25	Narrative	You are working for a farm equipment manufacturer. As part of the engineering team, you are responsible for designing the next generation of combines. During testing, you notice that the existing design uses a PVC liner in its pipe that generates a lot of static electricity. What do you want to do?	

Conv.	Node	Type	Text	Points
108	27	Narrative	{group} Go to ESD 003	
110	1	Narrative	{group} Start: ESD Questions	
110	2	Response	START	
110	3	Response	Yes.	
110	5	Narrative	Do you think the company should have listened to the junior engineer?	
110	6	Response	No.	
110	7	Narrative	As a junior engineer, should you inform the companies VP of a hazard even if your engineer team does not?	
110	8	Response	Yes.	
110	9	Response	No.	
110	10	Narrative	Can you see a company terminating the junior engineer in a case like this?	
110	11	Response	Yes.	
110	12	Response	No.	
110	16	Narrative	{group} Go to general questions.	

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