Developing Personal Case Studies as a Method for Deepening Lessons in Engineering Leadership

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1   Introduction

As a final assignment in a select graduate program in engineering leadership, The Gordon Engineering Leadership Program (GEL) at Northeastern University, students are tasked to research and develop a case study and prepare a presentation to the class as method for analyzing and assessing leadership skills and characteristics as displayed by historic, contemporary or iconic leaders in engineering and technology.

This paper describes how the program builds awareness of the broad characteristics of leadership leading up to this exercise, enriching the understanding of how leadership emerges and evolves, as a blueprint of a best practice in a nationally recognized curriculum. Included is an overview and structure of the leadership program and brief descriptions of the leadership topics taught in the class, including supporting literature, and outcomes.

2   The Assignment – Personal Case Study

The purpose of the assignment is to give students the opportunity to analyze the leadership approach and philosophies of historic figures and reflect upon how their styles match and contrast with what they've been taught in the classroom, and then share their research with their classmates.

In the program, 14 leadership capabilities are taught and developed through lectures, case study and labs augmented by a weekly guest speaker. Students are introduced to assessment techniques such as Myers-Briggs, Thomas-Kilmann and DISC, taught classic, contemporary and experiential theories on transformational and transactional leadership, sources of power, ethics, followership, leading from the middle, influence without authority, team dynamics and other themes.

With this foundation, vocabulary and awareness of the field of leadership, students are given a "share your leadership story" assignment due at the end of their final semester. They select an engineering leader of interest, someone renown in a field, industry or company for a significant contribution to engineering, and conduct scholarly research on the leader using biographies, autobiographies, history books, television documentaries, movies, interviews or other methods.

2.1   Written Report

The assignment first requires a substantive report in which students analyze their subject using

all of the lenses learned in the class:

- What are the key life events and achievements of this leader? In what ways did they stand out?
- What made them a great engineer?
- What type of organizational climate did they establish and operate in?
- What Myers-Briggs descriptor (ESTP, ENFJ...) do you feel best describes the leader, and why?
- What types of conflicts did they experience and how did they cope with them?
- Based upon the leadership capabilities taught in the program how do they rank?
- What sources of power appear to be the leader's default preferences?
- What surprised you?

2.2 Engineering Leadership Poster

Next the students prepare hand-annotated posters (Figure 1 Engineering Leadership Poster) that are displayed in the corridor and public spaces of the department for a week for view and commentary by faculty, other students and the public.

Figure 1 Engineering Leadership Poster

2.3 Round-table Reflection and Sharing

The assignment continues with each student preparing a set of talking point to "share his or her story". A round-table discussion, facilitated by a randomly chosen student, concludes the exercise. The discussion is recorded, minutes taken and in an after-action review, students reflect on those traits that appear to be common amongst the selected subjects.

We'll return to the results and outcomes of the assignment, but now will describe the program in minor detail to put the exercise in context.

3 Program Background

The mission of the Gordon Engineering Leadership Program (GEL) is to "create an elite cadre of engineering leaders with exceptional abilities to lead engineering teams by providing purpose, direction and motivation to influence others to achieve collective goals."

In prior papers[i] an overview of the complete structure of GEL has been described, including the assessment of industry's need for improvement in engineering leadership and the current impact and consequences of poorly led engineering projects. A representative syllabus and approach to the engineering, product development, technical and scientific content was also presented. Further, the global risk to the competitiveness of companies if this need is not addressed was presented in 2012[ii].

The following sections describe themes that the leadership portion of GEL uses to build leadership and the methods used in analyzing subjects for the case study.

3.1 Self-Team-Stakeholder Pyramid

Realizing Vision, Mission and Stakeholder Goals

Knowlege Skills and Attitudes to Successfully Lead Engineering Teams

Self and Situational Awareness

Figure 2: The Engineering Leadership Pyramid

GEL uses coursework, team activities and labs in the introduction and mastery of the theory and practice of leadership within the framework of a three-level, capability pyramid (Figure 2: The Engineering Leadership Pyramid).

- *Self and Situational Leadership Awareness,* designed to improve self-awareness, develop appropriate confidence and attitudes, and gain an appreciation for the importance of values, integrity, credibility and personal character essential to be an effective leader.
- *Knowledge, Skills and Attitudes to Successfully Lead Engineering Teams,* targeting the development and mastery of best practices in the techniques of setting expectations, organizing and leading a team.
- *Realizing Vision, Mission and Stakeholder Goals,* framing the role and responsibility of the leader to understand and communicate their organization's vision and strategy.

3.2 14 Engineering Leadership Capabilities

Leadership capabilities, also described in prior papers, are derived from the Sloan-MIT Leadership model as described in the articles "In Praise of the Incomplete Leader"[iii] and "Capabilities of Effective Engineering Leaders"[iv], combined with techniques on developing leadership competencies used by the U.S. military.[v,vi,vii,viii] The program uses a polar chart, known within the program as the "spider chart", to both assess leadership capabilities and as a convenient quick reference for the students.
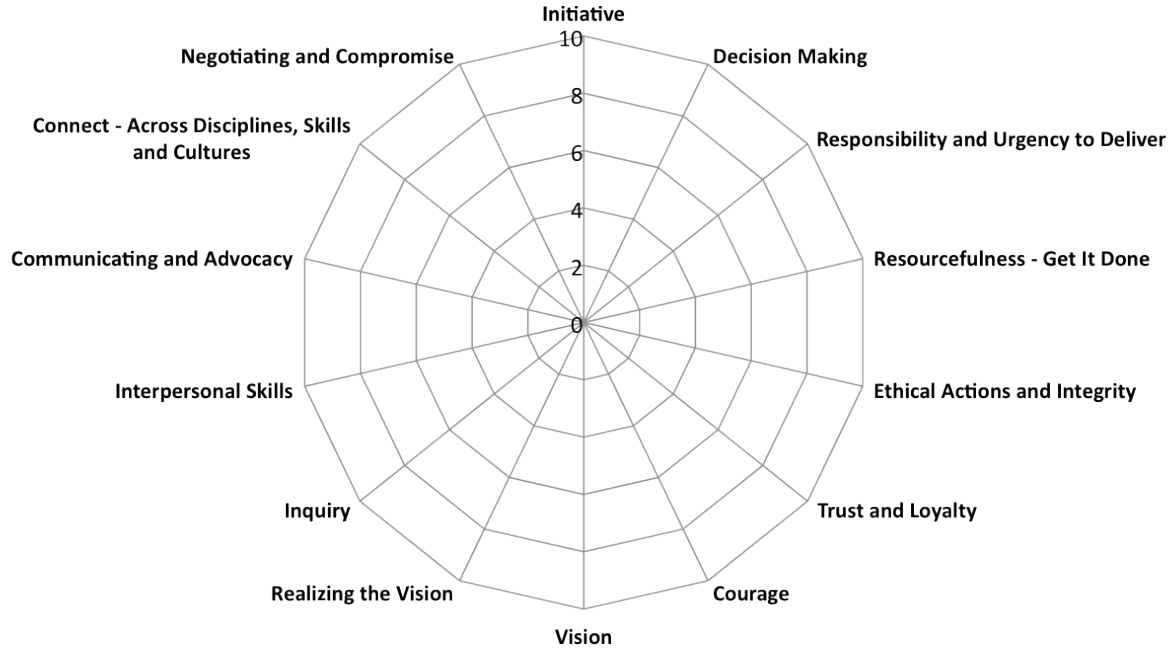
Figure 3: Leadership Capability Polar Chart

These 14 capabilities are developed, periodically assessed, and mastered over the course of the program.   By the time this assignment is given, the students are prepared with a common understanding of how to improve performance in each capability and how to observe it in action.

3.3   Leadership Framework and Framing Definitions

Derived as a group during an introductory workshop, definitions of key framing principles to analyze leadership are also developed.   Representative of the themes developed are:

- Leadership derives from values
- Values are deeply held beliefs about right/wrong, good/bad
- Personal values are implicitly related to choice; they guide decisions by allowing for an individual's choices to be compared to each choice's associated values
- Leadership attributes/attitudes are internal and defining qualities we possess, develop and exercise in our activities and interaction with others
- Leadership is: influencing others by providing purpose, direction and motivation to accomplish a task while improving the organization and its people

- Distinguishing the difference between leadership and management: Leadership deals with people and behavior; management with the science of organizing and planning programs, budgets and systems.

3.4   Organizational, Psychological and Leadership Lenses

The bulk of the leadership curriculum consists of weekly topics introducing both classic and contemporary lenses on leadership.   Through regular exercises, students gain a familiarity with the language associated with and a myriad of conceptual models that have set the foundation for current leadership philosophy and practice.   Most sessions consist of one or more readings, a skill inventory test or case study, followed by a leadership lab and reflection. Labs typically involve an interactive dialog, followed by peer-to-peer, hands-on practice of a task in developing some level of competency in the related topic. Finally, students are asked to look at their own organizations for evidence of both good and poor application of the principles discussed.

While not exhaustive, the principle topics emphasized in the program are:

- **Behavioral Inventories, Myers-Briggs Type Indicator (MBTI)**[ix], **DISC**[x].   Several topics cover different looks at behavior types and preferences as a method for self-realization and to gain insight into the diversity of personalities leaders face on a team. Two mainstream inventories used are:
  - MBTI types
    - Introversion, Extroversion
    - Thinking, Feeling
    - Sensation, Intuition
    - Judgment, Perception
  - DISC
    - Dominance, Influence, Steadiness, Conscientiousness

- **Transformational/transactional leadership**[xi],[xii].   Using Bernard Bass' text, *Transformational Leadership*, we evaluate and compare the transactional leader, who uses the operational tools of discipline/reward/punishment to drive behavior, with the transformational leader, who goes beyond the day-to-day and focuses on team-building, motivation, setting common goals and prioritizing personal growth of their followers.   Is every great leader transformational?

- **Quinn model of leadership styles**[xiii].   Robert Quinn's model, based upon four different management styles in his Competing Values Framework, is introduced via a skills inventory quiz.   Students discover their own preferred style and both the strengths and weaknesses of each style in different leadership scenarios.
  - Facilitator: facilitates interaction by being process-oriented

- Mentor: shows consideration by being caring and empathetic
- Innovator: envisions change by being creative and clever
- Broker: acquires resources by being resource-oriented and politically astute
- Producer: initiates action by being task-oriented and work-focused
- Director: provides structure by being decisive and directive
- Coordinator: maintains structure by being dependable and reliable
- Monitor: collects information by being technically expert

- **Situational Leadership[xiv].** Using the Hersey-Blanchard *Situational Leadership* Theory different types of leadership styles are shown as necessary and appropriate as a function of the relationship behavior of a follower, i.e., their motivation to do the work or "will", and their ability to do the work, i.e., their competence or "skill".   A good leader needs to be able to adapt their style according to the situation:
    - Delegating: when followers are able, willing and skilled
    - Participating: followers able, unwilling and not skilled
    - Selling style: followers unable, willing and skilled
    - Telling: Followers unable, unwilling, not skilled

- **Coaching, Mentoring and Counseling[xv].** Using a series of popular articles on life-long learning, the role of the leader is looked at from two vantage points.
    - First, the responsibility of the leader to be an active participant, coach and mentor to his followers, including being an emphatic listener[xvi]
    - Second, the responsibility of the leader to seek out their own mentors to ensure that they keep their own skills up-to-date, current and relative

- **Negotiation and Conflict management[xvii],[xviii].**   The Thomas-Kilmann Conflict Styles inventory is coupled with a leading book on negotiation, "Getting to Yes", and the principles of successful conflict identification and resolution strategies are covered.
    - Styles: Competing, Avoiding, Accommodating, Compromise, Collaborating
    - Concepts: Reservation point, BATNA, interested based bargaining

- **Risk taking[xix],[xx].**   Review of literature on embracing appropriate level risk taking as a skill in initiating and driving change and innovation.

- **Storytelling[xxi],[xxii].** Use of storytelling as a leadership tool.
    - Inspiring the organization, setting a vision, teaching important lessons, defining culture and values, explaining who you are and what you believe.
    - The seven elements to turn a good story into a great story: Context, use of metaphors and analogies, appealing to emotion, keeping it tangible and concrete,

include a surprise, use a narrative appropriate for business, and move beyond the story by creating some type of event to enable audience to participate.

- **Sources of power[xxiii].**   French and Raven's *Source of Social Power* lend to a discussion of how leaders derive their sources of power. Which are the most effective?
    - Reward, ability to compensate for compliance
    - Coercion, ability to punish for non-compliance
    - Legitimate, positional authority with right to make demands, expect compliance
    - Expert, from one's superior skill and knowledge
    - Referent, from one's perceived attractiveness, worthiness and respect
    - Informational, resulting from one's possessing knowledge that others want

- **Theory X/Theory Y[xxiv].** Using excerpts from Douglas McGregor's book, *The Human Side of Enterprise*, students expound on the evolution of theories on human motivation and management, from an authoritarian style of leadership to the use of motivation and proactive engagement by moving responsibility to the lower levels of an organization in decision-making.
    - Theory X: Assumes employees are naturally unmotivated and dislike working, hence management must actively intervene to get things done
    - Theory Y: Assumes employees are happy to work, self-motivated and creative and enjoy working with greater responsibility; hence management can apply a more participative style of leadership
    - Concepts: Motivation, Management Style and Control, Work Organization, Rewards and Appraisals, Appropriate application of both styles

- **Culture and Climate[xxv].**   Explores the impact that the natural forces of culture and climate have on an organization, particularly those attempting to go through transformational change.
    - Components of culture: Values, beliefs, myths, traditions, norms
    - Components of climate: Leadership, organizational structure, history, standards of accountability and behavior, communication, rewards, organizational connectedness, vision and strategy, trust and commitment

- **Followership[xxvi],[xxvii].** Mellinger' s "The Ten Rules of Good Followership" emphasizes that in order to lead; you must first be a good follower.   The role of followership is also discussed using the classic Harvard Business School Case, "The care and feeding of monkeys".
    1. Don't blame your boss for an unpopular decision or polity; your job is to support
    2. Fight with your boss if necessary; but do it in private
    3. Make the decision then pass it by the boss; use your initiative

4. Accept responsibility whenever it is offered
5. Tell the truth and don't quibble
6. Do your homework: give your boss all the information needed to make a decision
7. When making a recommendation, remember who will have to implement it
8. Keep your boss informed on what's going on at all times
9. If you see a problem, fix it
10. Put in more than an honest day's work, but don't ever forget the needs of your family.

- **Politics[xxviii],[xxix].** Company politics is frequently seen as a necessary evil, versus something that naturally exists and needs to be treated as part of the environment and context in which one leads. Students are presented scenarios and tools to analyze the political nature of their businesses and teams.
  o Political mapping: Introducing the way of looking an organization through difference lenses, as proposed by Ancona and Kohan in *Managing for the Future*, students use the political lens to map out stakeholder and team member positions on their master's project
  o Harvard Business School case: "Thomas Green: Power, Office Politics and a Career in Crisis" which describes the challenges a new employee faces when confronting company politics

- **Power and Influence[xxx],[xxxi].**
  o From John Kotter's, *Power and Influence,* methods for when one does not have positional authority on developing reserves of "unofficial" power and influence to achieve goals, reduce conflict and gain cooperation
  o Case from Cohan and Bradford, *Influence Without Authority,* covers the lifetime story of an influential leader, Nettie Seabrooks, within a company in which she never had management responsibility

- **Ethics[xxxii][xxxiii],[xxxiv].** This topic explores the concept of ethics from a moral framework in leadership and as part of the social contract that engineers have with society
  o Components of Moral Analysis: Conscience, Degree of Freedom, Intention, Ends sought, Means employed, Consequences
  o Looking at the code of ethics for your profession (for example IEEE) and become familiar with what's stated
  o Using the Challenger Space Shuttle Disaster, can we better understand the influence of organizations under stress to dismiss or ignore vital input?

- **Leader as Visionary[xxxv],[xxxvi],[xxxvii].** And, finally, leadership considered visionary, either in words or deeds.

- o Analyzing Martin Luther King's, "I Have a Dream" speech students assess the power of language to articulate a vision
- o From *The Creative Leader*, key attributes of visionary leaders:
    - ▪ Openness, imagination, persistence, conviction
    - ▪ Sensitive, good at making predictions, conceive the future
    - ▪ Can be eccentric i.e., Van Gogh, Steve Jobs, Thomas Edison
- o From Simon Sinek's TED talk, the golden circle model and mapping an inspirational leader in moving from Why? How? What?

4   Assessment method

With the key elements of this part of the program now explained, let's return to the assignment. As noted, students are expected to select either a past or current engineering leader as their subject. They are encouraged to select someone in either their field, perhaps the founder of their company, or someone else that they think will be interesting. They nominate their leader for approval at the beginning of the semester, along with a detailed description of how they plan to conduct their research.

At a minimum, their paper and presentation must answer the questions posed earlier in this paper, but student are encouraged to expand as they see fit and most do:

- What are the key life events and achievements of this leader? In what ways did they stand out?
- What made them a great engineer?
- What type of organizational climate did they establish and operate in?
- What Myers-Briggs descriptor (ESTP, ENFJ...) do you feel best describes the leader, and why?
- What types of conflicts did they experience and how did they cope with them?
- Based upon the leadership capabilities taught in the program how do they rank?
- What sources of power appear to be the leader's default preferences?
- What surprised you?

5   Outcomes

Excerpts from selected papers and posters are included at the end of this paper.

To date, reports on over 120 different leaders have been studied and archived. Subjects have ranged from Sir Isaac Newton to Thomas Edison, Grace Hopper to Steve Jobs, Elon Musk (of SpaceX fame) to Ratan Tata (founder of the Tata Group), from distant history to pulled from today's headlines, local and international, male and female, from every type of engineering discipline and industry. A major contribution, over 3 years, is the growing library of case studies on leaders analyzed.

This exercise has proven to be powerful, enlightening and revealing. By analyzing a leader from the perspective of what they've learned in the course, students begin to appreciate the diversity of how leadership emerges and that most leaders, while successful, are not superhuman. At some point in their lives they weren't very different than our students.

During the round-table discussion, as common themes emerge, they are logged for reflection. Many leaders faced some handicap, challenge, flaw or shortcoming that they nevertheless were able to overcome. It's these traits that frequently differentiate the great from the good leader. The capabilities that come up as universal include:

- Vision – the desire to do something of meaning, have a purpose and the ability to articulate it
- Urgency – getting things done faster and better than thought possible
- Initiative – ability to frame a plan and get things started
- Resilience – the ability to spring back when facing difficult obstacles and the probability of success seems low
- Perseverance – steadfastness in keeping focus on the big picture
- Tenacity – stubborn determination to never let go, never quit, never accept failure
- Expertise – striving to be the best and demanding the best
- Inspiration – able to influence others to follow them

Also revealing is the observation that a few renowned leaders did not always behave in a pure and virtuous manner. Traits such as blind ambition, rivalries and competition or even personal weakness, sometimes led to a path where ethical or moral choices appeared at odds with good values. For example, Thomas Edison's competition with Nicolas Tesla on creating a standard for electrical power distribution led to the demonstration of electricity as a means of executing prisoners. When constructing the Brooklyn Bridge, over 20 workers were killed due to lax safety standards. Some leader behaviors and addictions hint at a degree of hypocrisy between their public persona and private lives.

Equally powerful is the discussion on what led leaders to make those decisions and whether the compromises made were necessary. Do they diminish the leader's stature or reputation?

6   Summary and Conclusion

The Gordon Engineering Leadership Program at Northeastern University is enthusiastic about sharing any of the techniques or approaches with other institutions involved in engineering leadership development. The background material and use of it on a semester long assignment is an example of a best practice and it is hoped that the description and framework can be of use by other leadership programs.

In summary, as a final assignment in a select graduate program in engineering leadership, students are tasked to research and develop a case study and prepare a presentation to the class as method for analyzing and assessing leadership skills and characteristics as displayed by historic, contemporary or iconic leaders in engineering and technology.

The result is a richer understanding of leadership as demonstrated by historical and contemporary figures and is an example of a best practice in a nationally recognized curriculum.

7   Samples from Students

Excerpts from papers and examples of the posters presented in class provided the background for rich discussion on all of the leadership topics introduced in the program.

7.1   Paper excerpt – Clarence "Kelly" Johnson

"For this assignment I selected Clarence L. 'Kelly' Johnson (1910-1990). Kelly was named Vice President of Advanced Development Projects in 1958, leading Lockheed's famed Skunk Works organization in the design and manufacturing of many airplanes that changed the course of aviation history. *Aviation Week and Space Technology* ranked Johnson 8th on its list of the top 100 'most important, most interesting, and most influential people' in the first century of aerospace

He was a very strong team leader and able to deliver seemingly impossible tasks under budget and on time. Kelly went through several transformations over the course of his career. He appeared to initially be an ISTJ (Introvert, Sensing, Thinking, Judging) as an extremely bright student, very dedicated to his science, but also very quiet.

He passionately valued learning and knowledge

He retained his staunch beliefs in education and research, but his day-to-day life became less about doing the hard calculations and more about inspiring and influencing the people on his team and external stakeholders.

Kelly relied on two main sources of power. The one he used predominantly was expert power. As he rose through the ranks at Lockheed, Kelly gained and would often use legitimate power especially in his days when in forming the Skunk Works.

Kelly created an organizational climate unlike any other at the time. The Skunk Works was an extremely efficient and prolific group of people. The organization relied on a few very capable and very dedicated individuals working on cross functional teams to accomplish designs and builds that previously would have taken hundreds of people and thousands of man hours. He located manufacturing and design physically next to each other in the same building so that as soon as a drawing was created it could be given to production to figure out the best way to build it. The relatively flat organizational structure kept his team nimble and reactive. Rewards came based upon demonstration of excellence, hard work and acting as a team"

7.2   Paper Excerpt – Elon Musk

"Elon Musk was born in South Africa to an Electrical Engineer and a model. He created his first program at age 12 and sold the code for his first video game for $500. He loved comic books, and like the super heroes he read about, he wanted to save the world.   He co-founded X.com, which became PayPal and helped found or develop companies like LinkedIn, YouTube and Yelp, credited with the re-emergence of consumer focused internet companies after the dot com bust of 2001. Elon's passion for sustainable technology led to the founding of Tesla Motors, developing electric cars, and the initial concept for Solarcity as a vehicle to bring cost-effective solar energy to the residential market.   He founded SpaceX, in 2002, whose SpaceX's Falcon 1 rocket became the first privately funded liquid-fuelled vehicle to put a satellite into Earth orbit.

Elon is known as a disrupter, who's motivation comes from 'personally looking at things that don't work well and feeling a bit sad about how it would manifest in the future. And if that would result in an unhappy future, then it makes me unhappy. And I want to fix it'.

Elon is defined by his passion and need to improve the world, and an unstoppable attitude to get it done under any circumstances.

He doesn't hesitate at all in learning anything he needs to, or finding the right people that already know what he needs to make the world a better place.

He has, at times, blind ambition driven by that arrogance and uses sheer force of will to get things done, over ever accepting that a different option may be the better choice.

His sources of power pertained to personal power, referent and expert.

He treats his employees well and fosters a culture of trust and respect throughout his organizations.

He always met his goals and on time.

Ethical actions drive his every decision. He donates his money to charity, gives himself no salary, and gives all of himself to the betterment of the planet."

7.3 Paper Excerpt - Frank Crowe

"Frank Crowe is known as the Chief Engineer of the Hoover Dam. Beginning early in his career, Crowe became obsessed with process improvement and increased efficiency. He developed new methods to move earth and lay concrete faster than ever before. Every dam he oversaw was completed on time and under budget. Early success catapulted Crowe to the top of the field of engineers, and he was rewarded with promotions and more significant projects.

Hoover Dam was approved and opened for bidding in early 1931 after more than a decade of planning by the US government. Crowe succeeded in bidding and winning the project and completed Hoover Dam 2 years ahead of schedule and under budget.

Crowe always positioned himself to work directly on the best projects and what he wanted to do.

Crowe was competent in decision-making and problem solving, able to find a solution to the most difficult situation.

Crowe was obsessed with doing everything faster, and always delivered on time or ahead of schedule.

Crowe was extremely focused on the tasks at hand, often foregoing sleep.

In his constant desire to increase efficiency, Crowe sometimes sacrificed safety. He disregarded Nevada mining safety regulations, which banned gasoline engines in poorly ventilated areas. The buildup of carbon monoxide sickened workers and resulted in deaths.

Crowe had the courage to face high-risk situations head-on.

Crowe had good vision, and conveyed it well to others.

Crowe was an expert at implementing the vision through new processes.

Crowe worked very hard to gain knowledge and become an expert in his field.

Crowe's innovations and his reputation for delivering on time and under-budget earned him a great deal of respect. He was widely regarded as the best in the business.

Do leaders care? In the interest of time, Crowe pushed his crew hard, sometimes subjecting them to added danger. When overseeing thousands of individuals, it can be difficult to show care for each one. Crowe could have showed more care for his workers by pushing for improved work conditions."

7.4 Paper Excerpt - Ellen Swallow Richards

"Ellen Swallow Richards was the first female environmental engineer, and the first female to get accepted to MIT. She was born December 3, 1842 in Massachusetts and mostly home educated by her craftsman father. She became a test case to see if women could handle the rigors of a science degree. Although she was in a very male-dominated field, she was able to conduct respectable research and lectures on topics of air, water, and sewer analysis, biology, and chemistry. Her lessons influenced the development of the first municipal sanitation facilities. She also established the first water quality tables for the United States.

She was able to mentor her female students and conduct research that focused on living conditions of poor people living in cities.

She was visionary for establishing the relationship between human technology and the health of the globe.

She excelled at intuition and thinking at a systems level to establish patterns in the natural world.

Her charisma inspired others to make changes in their homes and companies.

Another strong point was initiative – she saw a need or a goal, and she achieved it."

7.5 Poster – Admiral Hyman Rickover

Figure 4: Poster - Admiral Hyman Rickover

7.6 Poster – Karl Terzaghi
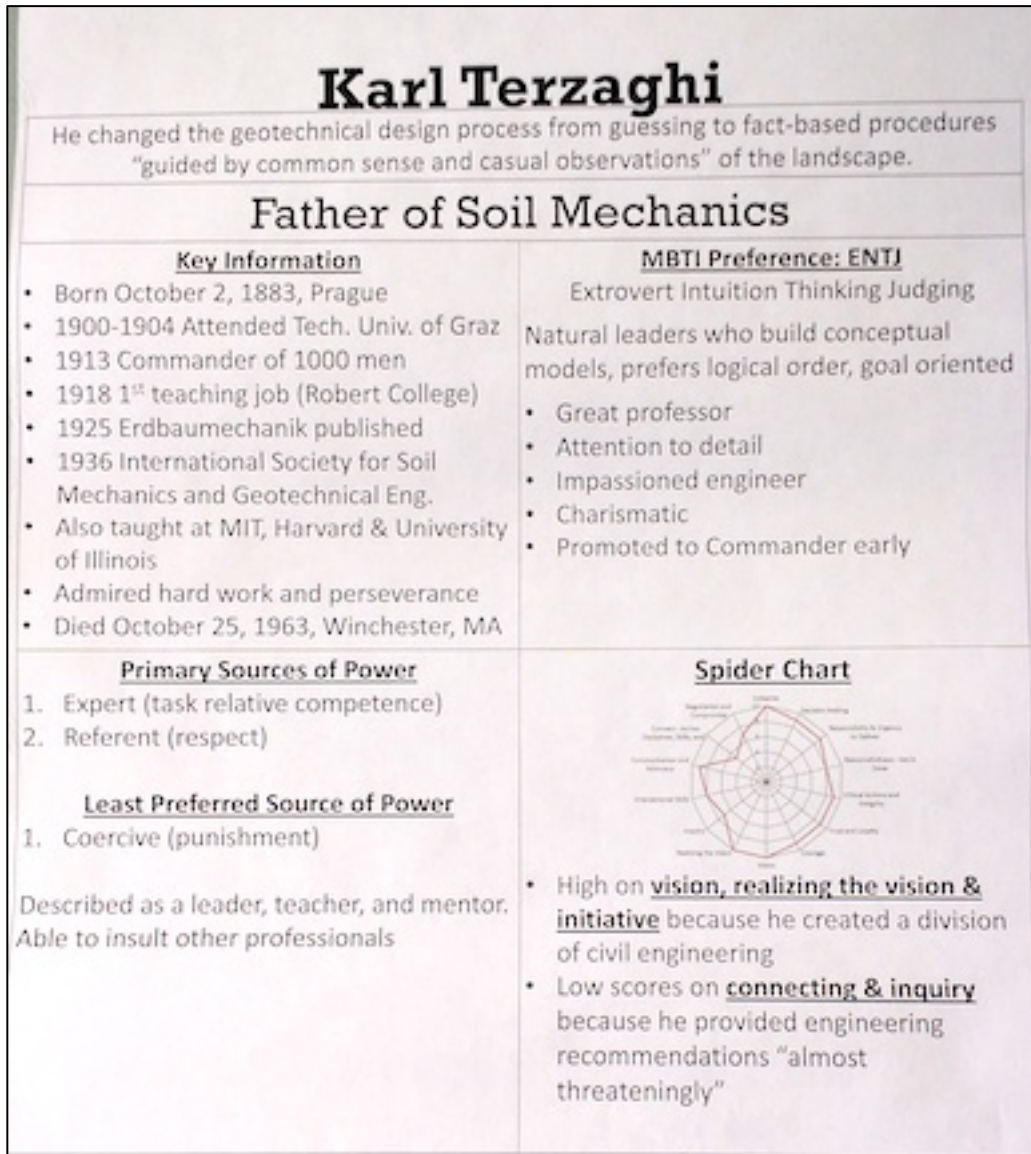
Figure 5: Poster-Karl Terzaghi

7.7   Poster – Jeff Bezos

Figure 6: Poster - Jeff Bezos
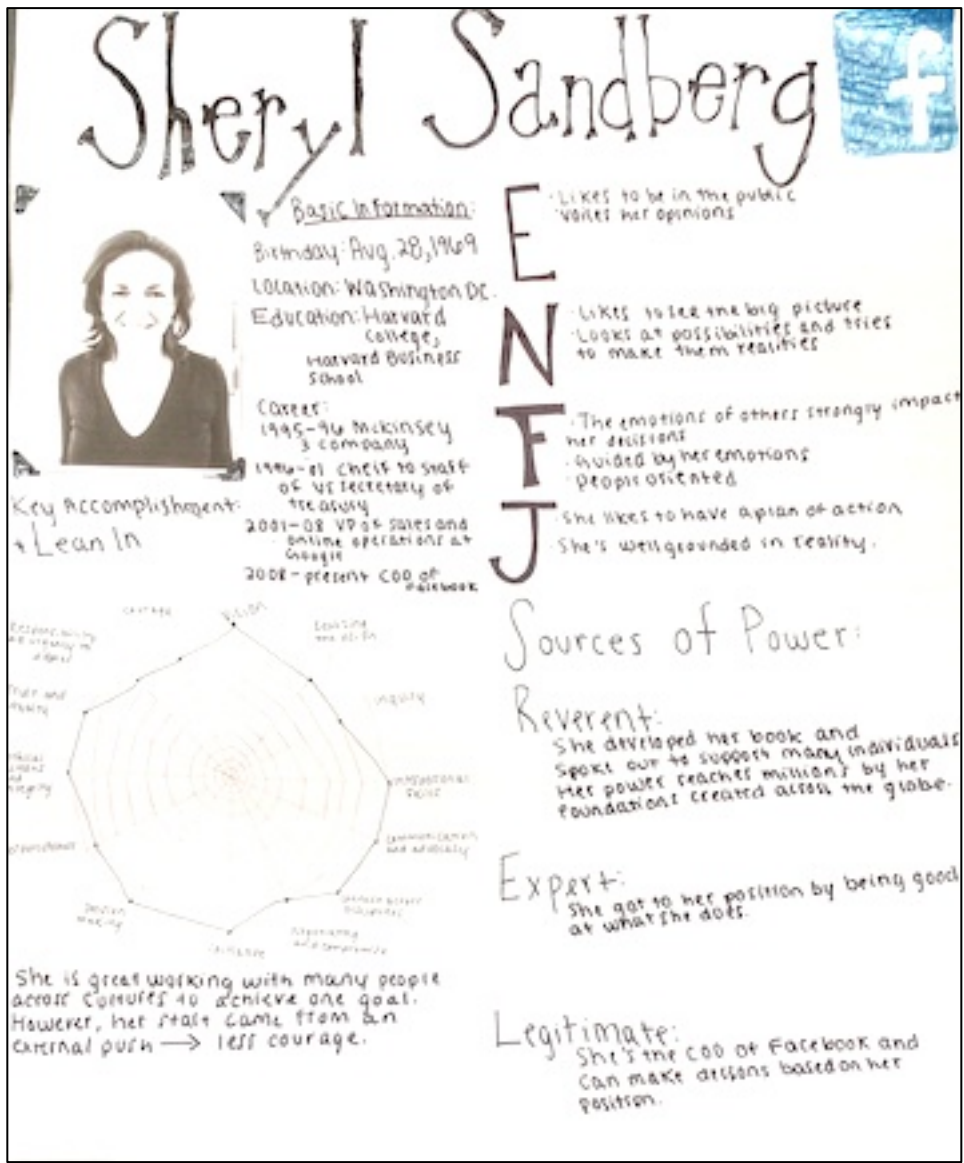
7.8   Poster – Sheryl Sandberg

Figure 7: Sheryl Sandberg

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