Design of an In-Situ Fuel, Oxygen, and Potable Water Supply System on Manned Mars Missions
(Technical Paper)

The Impact of Surveillance Technology on Women in Contemporary East Asia
(STS Paper)

A Thesis Prospectus Submitted to the

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

One contemporary technological issue that I am passionate about is the universality and pervasiveness of surveillance technology in East Asia. In South Korea, there are hidden cameras called *molka* that are ubiquitous in both public and private spaces, violating the privacy and security of women. According to Gong in a 2018 article, "police data show that the number of 'illegal filming' crimes sharply increased from 1,353 in 2011 to 6,470 in 2017." In China, there is an extensive facial recognition system in place throughout the country, which questions the right to privacy. In Japan, there has been an increase in the number of security cameras set up on commuter trains, which also threatens the right to privacy. I will explore this complex issue through the lens of actor-network theory (ANT), normalized deviance, sociological analysis, and ethical framework, in order to understand and evaluate the depth of impact on women in East Asia. A possible concluding section of this project would address how these issues could be ameliorated.

The technical portion of my thesis will be presented in the form of a proposal summary and has been a product of collaboration between me and my technical team members. The technical proposal is still a work in progress, but I will summarize the version that our technical advisor recently approved. We seek to design a cost-effective in-situ resource utilization (ISRU) system on Mars that can meet the resource demands of ten colonists for a yet undetermined length of time. These resources include hydrogen for fuel (with oxygen for oxidation), oxygen for life processes, and water that is potable and could be used for minimal farming. This project topic was chosen because one of NASA's most pressing goals is to send a manned mission to Mars in order to establish the first extraterrestrial colony.

Technical Report Prospectus

Design of an In-Situ Fuel, Oxygen, and Potable Water Supply System on Manned Mars Missions

How can we design a cost-effective system on Mars to produce hydrogen/oxygen fuel for transportation to and from the planet, and provide oxygen and water to the inhabitants of a manned outpost?

Our group's capstone advisor is Professor Anderson and the group members are Craig Doody, Michael Mace, Spencer Plutchak, Sabrina Stenberg, and Rahim Zaman, all of the Chemical Engineering Department. Our project goal is to optimize the utilization of Martian resources to provide water and oxygen to sustain a human colony, as well as produce enough hydrogen/oxygen fuel for their return trip to Earth. Design work for this project will be continued in the Spring semester with the same team.

The National Aeronautics and Space Administration (NASA), other federal space agencies, and private companies plan to send humans to Mars in the next several decades. The costs of material and equipment transportation from Earth will comprise most of the mission costs. According to a NASA report by Kleinhenz and Paz (2017), storage costs could be drastically cut with the use of In-Situ Resource Utilization (ISRU), which will utilize Martian resources for Mars base necessities. These essentials include fuel for a return trip, as well as oxygen and water for a life support system. The process must be economically viable to ensure adequate investment, the importance of which is discussed by Shishko et al. (2015).

ISRU optimizes the use of materials, recycling where possible, as described by NASA (2019). Powell et al. explains NASA has researched optimal ways to provide oxygen and water

for a Martian colony, as well as sufficient hydrogen to fuel a rocket for their return trip (2001). Hydrogen will be obtained using multiple methods and stored for later use, and the Mars Oxygen ISRU Experiment (MOXIE) is the current method proposed to produce oxygen, as reported by Meyen et al. (2016). The water will be mined from the ground, either in solid or liquid form, and purified. Our proposal is to design a continuous process, utilizing available resources, to improve production output and energy efficiency. The hydrogen production will be achieved by reforming methane, collected from the regolith, and from the water-gas shift reaction. These reactions produce carbon monoxide and carbon dioxide, respectively, that can be recycled to increase hydrogen production. MOXIE will generate the oxygen necessary for the colony. Some specifications still undefined include energy sources to keep the processes running for the colony and the equipment to extract the materials from the atmosphere and regolith.

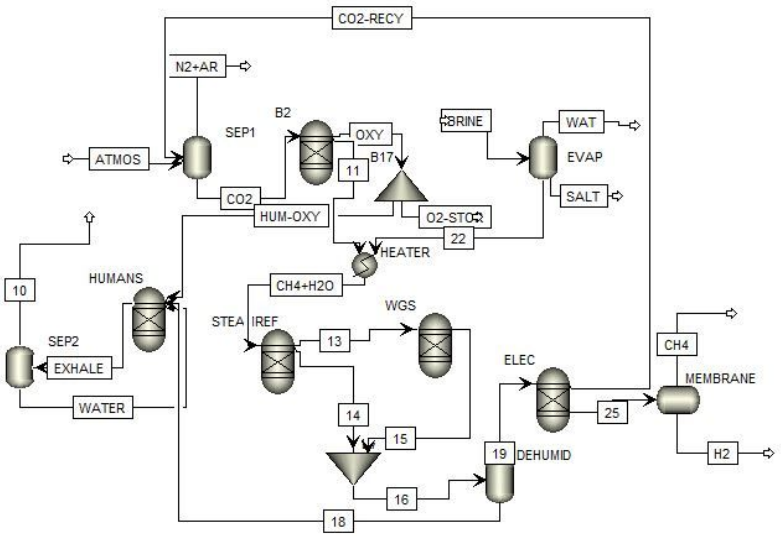

Figure 1. Process flow schematic including the integral operations of reactions, separations, and storage.

Our system consists of multiple reactor and separation units, as seen in Figure 1. Reactor units will reference literature for kinetic constants, catalytic behaviors, and reactor size, using hand-calculated scaling and approximation techniques when necessary. The reactions involved follow equilibrium behavior, which has several useful models to help predict properties. Separations will be evaluated using AspenTech simulation technology. Size, duty, and cost will come from Aspen calculations, with hand calculations for initial guesses and confirmations. Aspen will also allow us to optimize energy use in the system, modelling components such as heat exchangers and turbines for energy conservation. Since we do not have means to directly test the system, the Aspen models and reactor calculations will be combined for an overall cost proposal. The costs of operation and transport of our equipment will be compared to the costs of directly transporting our products to Mars.

At the end of this project, we seek to define a process with unit operations that can produce hydrogen, oxygen, and potable water on Mars. Oxygen and water production will meet the life-support demands of 10 colonists for an indeterminate period of time, and the hydrogen and oxygen fuel will sufficiently support a return trip to Earth. Since equipment and materials will have to be transported from Earth, accurate cost estimates are integral to this project. This project will contribute to ISRU research for manned missions, and later colonies on Mars. Future research projects should include drilling designs for water extraction on the Martian surface and living spaces for the colonists.

STS Research Paper Prospectus

Research Question:

How does surveillance technology target young women in contemporary East Asia?

Problem and its Significance:

One of the current ubiquitous technological issues in South Korea is the practice of using *molka*, or hidden cameras, in places such as public restrooms, motels, and private homes. These pieces of technology have been violating South Korean women's privacy in their personal and even sexual moments. As a result, there have been feminist movements that protest the ubiquity and lack of government action against *molka* (Gong, 2018). On June 9, 2018, more than 30,000 women gathered in Seoul to challenge the prevalence of *molka.* It is considered the "largest women-led protest in South Korean history," granted that Seoul is a city of almost 10 million (Lenamon, 2018). Given that China and Japan have also undergone rapid economic development and technological advancement in the past fifty years, they have also experienced issues related to the universality and pervasiveness of surveillance technology.

Motivation:

Since the STS capstone thesis is a long-term project, I sought to find a technological issue that struck home and resonated with me. Since high school, I have done much research on pre-modern, early modern, and modern East Asian history both for school and for pleasure. As a young woman and a half-Korean who is deeply interested in her mother's country, I have felt disturbed about the violations of female privacy in South Korea due to the surgence of *molka*.

Outside of South Korea in East Asia, I had learned about the facial recognition software employed in China, a country known to foreigners for its "lack" of personal privacy. In Chinese, there is a word "yinsi" (隐私), which translates to seclusion with a connotation of secrecy. The association of private action with concealment and secrecy (i.e ill intentions) is one reason why Chinese frown upon the Western ideal of personal privacy (Tam, 2018).

Looking further east, my Japanese friend informed me of new CCTV cameras in Japanese trains that could possibly violate the rights to privacy and security of women. Many Japanese commute to work or school in large metropolitan cities, such as Tokyo, Yokohama and Osaka. Furthermore, due to the 2020 Tokyo Olympics, East Japan Railway Co. (JR East), the largest member of the seven Japan Railways Group, announced in March 2019 that they will install 22,000 new cameras in both local train cars and bullet train carriages. In the event of an emergency, this camera system can send images "directly and automatically" to police; this system is a reaction in light of violent incidents abroad bullet trains, such as a man's self-immolation in 2015 (Kyodo News, 2019).

The more I explored, there seemed to be plenty of ways and means for women in East Asia to be exploited through surveillance technology, especially small, easily concealed cameras.

Objective:

The aspects of my research question to be investigated are mainly focused on comparison and contrast, depth of impact, and possible routes for amelioration of surveillance technological issues throughout these three East Asia countries - China,[1] Japan, and South Korea. One potential

[1] The People's Republic of China, not Taiwan.

issue that I might need to address later is how much breadth my spring STS paper should have, but for now I will include all three countries in my scope.

I want to discover how the history and culture of each country has contributed to and propagated violations of individual rights through surveillance technology. East Asia has had a long, intertwined history that cannot be ignored when accounting for contemporary cultural values. For instance, consider how the Korean peninsula was once a Confucian "younger brother" state of Ming and Qing China, then later annexed as a colony to the Empire of Japan ("History of Korea," 2019). These histories have impacted these countries' contemporary legal frameworks, which must differ on how they treat surveillance technologies.

There are two main facets of the depth of impact aspect that I would like to address. First, I seek to ascertain the reason why such cameras are so omnipresent in these countries. Second, in order to measure the severity of any of these problems, I will research how these technologies have impacted East Asian women emotionally and mentally, especially in the long-term.

While I intend to focus my research primarily on the various impacts that surveillance technology have on East Asian women, I also want to delve into possible routes to ameliorate these issues. Such ways and means could include government response and the reactions and progressive actions (if any) taken by the public.

Approach/Method:

The types of issues that fit into this research question that I can investigate include hidden cameras (*molka*, 몰카) in South Korea, facial recognition software in China, and train cameras in Japan. Since all three countries experienced rapid development in the 20th century and onwards

to today, how the rapid technological advancement and economic development of each country has contributed to these issues and their injustices should be taken into account.

There are multiple avenues to investigate this topic in the social sciences, such as politics, sociology and history. The analysis methods I propose to use are actor-network theory, normalized deviance, sociological analysis, and ethical framework. If I discover that any of these analytical methods does not work next semester, I can adjust and realign my STS capstone paper onto different methods.

Actor-Network Theory (ANT) is an appropriate method because technological issues that are large in scale are the product of many physical and intangible reasons or actors, who operate within networks to propagate said problems. In Bijker et al., some principles that attracted me to ANT were generalized symmetry that accords a framework to analyze the disparate elements of a network, as well as the 'sociomateriality' of associative processes that gives roles to both nonhuman and human actors (2012). The actors and networks that I can identify currently are: governments, camera sellers (legal and illegal), citizens, criminals, history, and culture. In March 2019, there was a major sex crimes celebrity scandal involving singer Jung Joon Young and his implementation of *molka* for the filming of women without their consent and sharing the footage with others. His case gave light to not only some of the illicit activities that clubs and the South Korean entertainment world have performed, but also "the widespread profiligation of and outrage over spy cameras and illicitly filmed content of women and how legal forces in South Korea approach gender violence" (Herman, 2019).

Normalized deviance of South Korean society merits consideration. Normalized deviance can be defined as a management problem where people in power ignore the accumulating

evidence of problems while forming a "confirmation bias" that allows negative evidence to be classified as errors (Gorman et al., 2010). The preponderance of illegal filming crimes in South Korea suggests a society of normalized deviance that does not try hard enough to protect women at risk. According to the Gong article, the amount of "illegal filming crimes" increased almost five times from 2011 to 2017 (2018). It is likely that the number of these crimes is much greater than 6,470 cases per year nowadays due to the likelihood of the lack of detection of many *molka*, as well as the general upwards trends of these crimes this decade. Given the positively increasing trend, there must be some accepted yet unethical norm of society that encourages South Korean citizens to commit "illegal filming crimes." As in the case of the Challenger incident, established patterns in societies can propagate breaches of ethics and human rights (Vaughan, 1997). This may not be the same kind of normalized deviance that transgresses engineering ethics, but it still merits research and analysis.

One key cultural facet that should be analyzed sociologically is how the concept of privacy is different in East Asian countries (Tam, 2018). That difference exacerbates the potential damaging effects of surveillance technologies on women in East Asia compared to the United States. I intend to research how each country's history has shaped its definition of privacy. For my sociological analysis, I can refer to the work in Michael (2017), before integrating everything into a cultural impact analysis.

When a society perpetuates a practice through normalized deviance, its immorality should be analyzed through an ethical framework. According to Santa Clara University's Markkula Center for Applied Ethics, a framework for ethical decision making has five different approaches: utilitarian, rights, fairness or justice, common good, and virtue (Velasquez et al.,

2009). After investigating the evolution and the current state of the concept of privacy rights in East Asia, ethical concerns, such as how cameras can violate privacy rights, can be treated. One of the nuances of the ethics of personal privacy is how consent is shaped and formed. Then, the rights of governments and private citizens to access the filming data can be considered along with how the data is used. When investigating the privileges of governments in accessing filming data, the extent and type of control must be addressed, whether consensual or non-consensual. This includes whether or not there are top-down controls, which use persuasive strategies like incentives and punishments. Another nuance is the characterization of long-term psychological and emotional damage created by being a victim of illegal filming crimes.

The resources I plan on utilizing include, but are not limited to, the following five categories. First, I will read and analyze news articles in English and Korean. Since news agencies and broadcast companies are often subject to bias, whether due to sponsorship or other reasons, I need to find a lens to identity bias. Bias could also be more passive, such as cultural values and interpretation that influence how a writer forms the tone and connotations in his or her writing. Second, I will access academic journal publications and research papers that investigate the impact of surveillance technology on women. Third, I will gain insight of how young East Asian women feel about these issues. I have several friends and family members in China, Japan, and South Korea, so I have been considering sending them a survey about different aspects of the intrusiveness of surveillance technology. I could also look for existing information on the opinions of both South Korean men and women about the *molka* issue. Fourth, I will locate and analyze published messages or social media posts. Especially in South Korea, criminals who misuse *molka* for their own greed have been exposed through the public

investigation of their Kakao Talk or SNS posts (Herman, 2019). Lastly, I will scrutinize and evaluate the portrayal of *molka* or surveillance technologies in the media. Korean dramas that have featured episodes exploring (and criticizing) these issues include Hotel del Luna (2019, 호텔 델루나), A Korean Odyssey (2018, 화유기), and Suspicious Partner (2017, 수상한 파트너).

Bibliography

Bijker, W. E., Douglas, D. G., Hughes, T. P., & Pinch, T. (2012). The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. Retrieved from http://ebookcentral.proquest.com/lib/uva/detail.action?docID=3339458

Dunbar, B., & Mahoney, E. (2019). *In-Situ Resource Utilization*. NASA. https://www.nasa.gov/isru

Gong, S. E. (2018, October 19). South Korean Women Fight Back Against Spy Cams In Public Bathrooms. Retrieved October 31, 2019, from NPR.org website: https://www.npr.org/2018/10/19/648720360/south-korean-women-fight-back-against-spy-cams-in-public-bathrooms

Gorman, M. E., & Werhane, P. H. (2010). 12 Using Trading Zones to Prevent Normalized Deviance in Organizations. 245–264. https://doi.org/10.7551/mitpress/9780262014724.003.0012

Herman, T. (2019, March 12). Jung Joon Young Confesses to Filming Women Without Their Consent Amid Sexual Crime Ring Investigation | Billboard. Retrieved October 31, 2019, from https://www.billboard.com/articles/columns/k-town/8502216/jung-joon-young-confesses-filming-women-without-consent-south-korean-sexual-crime-ring

History of Korea. (2019). In Wikipedia. Retrieved from https://en.wikipedia.org/w/index.php?title=History_of_Korea&oldid=923327789

Kleinhenz, J., & Paz, A. (2016). *An ISRU Propellant Production System to Fully Fuel a Mars Ascent Vehicle*. https://ntrs.nasa.gov/search.jsp?R=20170005179

Kyodo News. (2019, March 6). JR East introduces system to send security camera images directly to police in emergencies. The Japan Times Online. Retrieved from https://www.japantimes.co.jp/news/2019/03/06/national/jr-east-introduces-system-send-security-camera-images-directly-police-emergencies/

Lenamon, H. (2018, July 12). Mobilizing Against Molka: Exploring South Korea's Largest-Ever Women-Led Protest – Ms. Magazine. Retrieved October 31, 2019, from Ms. Magazine website: https://msmagazine.com/2018/07/12/mobilizing-against-molka-exploring-south-koreas-largest-ever-women-led-protest/

Meyen, F. E., Hecht, M. H., & Hoffman, J. A. (2016). Thermodynamic model of Mars Oxygen ISRU Experiment (MOXIE). *Acta Astronautica, 129*, 82-87.

Michael, M. (2017). Actor-Network Theory: Trials, Trails and Translations. https://doi.org/10.4135/9781473983045

Powell, J., Maise, G., & Paniagua, J. (2001). Self-sustaining mars colonies utilizing the north polar cap and the martian atmosphere. *Acta Astronautica, 48*(5-12), 737-765.

Shishko, R., Fradet, R., Saydam, S., Dempster, A., & Coulton, J. (2015). *An Integrated Economics Model for ISRU in Support of a Mars Colony--Initial Status Report*. Paper presented at the 10th Symposium on Space Resource Utilization, Grapevine, Texas. https://arc.aiaa.org/doi/pdf/10.2514/6.2015-4564

Tam, L. (2018, April 2). Why privacy is an alien concept in Chinese culture. Retrieved October 31, 2019, from South China Morning Post website:

https://www.scmp.com/news/hong-kong/article/2139946/why-privacy-alien-concept-chinese-culture

Vaughan, D. (1997). *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA* (1 edition). Chicago: University Of Chicago Press.

Velasquez, M., Moberg, D., Meyer, M., Shanks, T., McLean, M., DeCosse, D., … Hanson, K. (2009, May). A Framework for Ethical Decision Making. Retrieved November 22, 2019, from Markkula Center for Applied Ethics website: https://www.scu.edu/ethics/ethics-resources/ethical-decision-making/a-framework-for-ethical-decision-making/