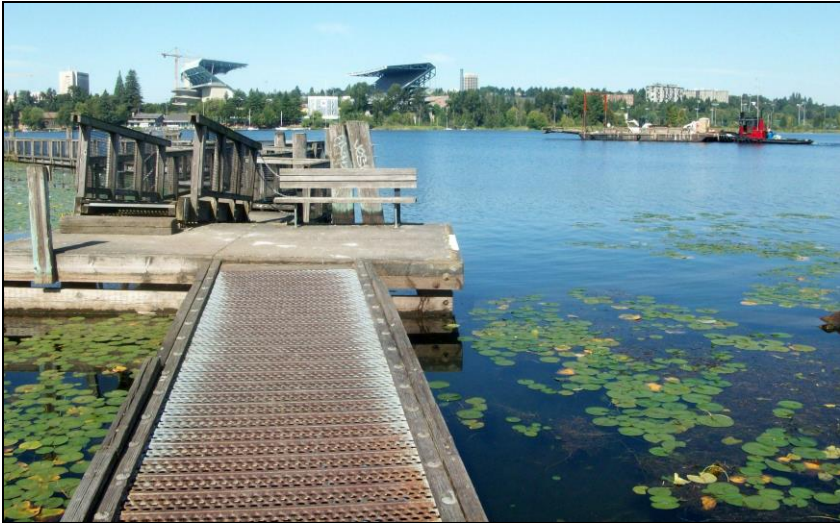


The McNair Scholars Journal
of the University of Washington



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From the
Vice President and Vice Provost for Diversity

One of the great delights of higher education is that it provides young scholars an opportunity to pursue research in a field that interests and engages them. The McNair Scholars Program offers support and opportunity for students to pursue scholarly research, and The *McNair Scholars Journal* plays an important part in that support by publishing their results. The Office of Minority Affairs and Diversity is pleased to publish the twelfth edition of *The McNair Scholars Journal* of the University of Washington.

The McNair Scholars Program offers opportunities to a diverse group of students—students who may not otherwise get the chance to work closely with a faculty mentor on in-depth research. The young scholars who participate in the McNair program are among the most motivated and dedicated undergraduates at the UW. Their hard work and accomplishments put them in a position to succeed in graduate school. The *McNair Scholars Journal* plays an important part in the career of these young scholars by publishing their research at an early stage.

Please join me in thanking the faculty, staff, and students who came together and made this journal possible.

Sheila Edwards Lange, Ph.D.
Vice President for Minority Affairs
Vice Provost for Diversity

From the
Director

I am very pleased to present the twelfth edition of the University of Washington's *McNair Scholars Journal* to our reading audience. The collective excellence of these seventeen projects is a testament to the hard work of our students and the unwavering support of faculty mentors who supervised these projects. As always, I want to extend my gratitude to the faculty, whose guidance and support has allowed our students to grow in meaningful ways, while giving our scholars the foundation to enter graduate school with confidence and solid research experience.

The McNair Program at the University of Washington strives to create meaningful academic experiences that will enable our students to succeed at the next level. The research component for McNair Scholars has two specific goals: First, engage students in the research enterprise at the undergraduate level so they develop the analytical and methodological skills, academic sophistication, and confidence that will make them successful students in graduate school. Second, provide students a unique opportunity to publish their undergraduate research, so the scholars gain an early understanding of the critical role that publishing will play in their academic careers. In this respect, the McNair Journal is a key component in the preparation of our scholars for careers in research and teaching.

Our journal involves the work of several people who work behind the scenes proofreading, editing, and preparing the final draft for publication. I would like to extend my appreciation to the UW McNair staff, Dr. Gene Kim, Associate Director, Rosa Ramirez, Program Coordinator, and our graduate student staff, Brooke Cassell and Raj Chetty, for their commitment to the McNair mission and for bringing this project to completion. They are an asset to the program and have been instrumental in preparing this high quality journal.

On behalf of the entire McNair Staff, I sincerely hope that you enjoy reading the twelfth edition of the *McNair Scholars Journal*.

Dr. Gabriel E. Gallardo
Director, McNair Program
Associate Vice President, Office of Minority Affairs

From the
Dean of the Graduate School

It is a privilege to introduce the twelfth volume of The McNair Scholars Journal. This publication contains papers comprising an impressive spectrum of disciplines and representing the depth and potential of scholarship which the UW offers. The work of the McNair Scholars in this volume is absorbing, eloquent and impassioned—and all of us affiliated with the program (the Scholars, their faculty advisors, the McNair Program staff, and the Graduate School) should be proud of their work.

As you are aware, the McNair Scholars Program honors the memory and achievement of the late Dr. Ronald E. McNair, the physicist and NASA astronaut. Its goal is to encourage young women and men to emulate his academic and professional accomplishments. One of the McNair Program's goals is to encourage students who have been disadvantaged in their pursuit of academic excellence to attain not only a baccalaureate degree, but to continue a career in graduate education, culminating—we hope—in a doctoral degree.

The leadership, faculty and staff of the UW keenly believe that graduate education is much more than a private benefit for individuals—it profoundly serves the public good by educating people who can promote the shared ideals of our nation. A strong democracy depends on advanced-degree holders who can address the complex demands of 21st century society. As a public institution, the UW has a responsibility to prepare future leaders—such as the McNair Scholars—who, after they earn their advanced degrees, will be called upon to solve problems and enhance quality of life, both locally and globally. Hence, the Graduate School is honored to partner with this program and with the UW Office of Minority Affairs & Diversity.

Please join me in recognizing and thanking all of our McNair Scholars and mentors for creating a robust, vibrant intellectual community at the UW. These young future professors, leaders and policy makers epitomize the talent and intellect which no doubt will have global import, and will provide crucial leadership in an increasingly complex and changing world.

Gerald J. Baldasty, Vice Provost and Dean of The Graduate School
Professor, Communication
Adjunct Professor, Women Studies, American Ethnic Studies

Journal Disclaimer

While the McNair Program Staff has made every effort to assure a high degree of accuracy, rigor and quality in the content of this journal, the interpretations and conclusions found within each essay are those of the authors alone and not the McNair Program. Any errors or omission are strictly the responsibility of each author.

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The Female Body: A Place of Sexual Violence and Site of Economic, Social, and Cultural Exchanges

Merzamia Sison Cagaitan

Abstract

*My research aims to counter the notion that women do not mind the silencing, sexualization, and objectification of their bodies by providing a platform whereby the often unseen and unheard female body can voice a resounding reply that, on the contrary, she does mind. My research examines works of contemporary historical fiction, including Toni Morrison's *A Mercy* and Chang-rae Lee's *A Gesture Life*, in order to explore the silencing of particular women in critical moments of capitalist transformation within and beyond the United States: the transatlantic slave trade, colonization, and imperialism, and the subsequent 20th century proliferation of neoliberalism, nation-building, and imperialism. It traces traumas the female body endures by defining the different female body parts that function as primary shock absorbers as women who are coping with the effects of dislocation, displacement, and diaspora are not only gendered and sexualized in these labor markets but are also raced, a key component of representation and sexual exploitation. Luce Irigaray, whose essay "This Sex Which Is Not One", is concerned with the search for and implementation of a uniquely feminine language, vehemently criticizes the phallocratic order responsible for these various states of uprootedness. My research investigates the existence of such a language and the significance it would bear in breaking the univocal shroud restricting the expressions and movements of the female body. This analysis utilizes a Marxist reading of the commodification of woman and her sex and employs Irigaray's conception of mimesis as it pertains to the recognition and viewing of the female. The injuries of being sexualized, gendered, and raced restrict potential feminine discourse from female bodies by dehumanizing the female and rendering her nothing but a voiceless soft slip of flesh.*

Introduction

At an unknown airport, a traveler waiting for his flight to arrive observes as a line of voluptuous female passengers parade past him in one seamless, erotically provocative flash of high heel stilettos clicking, red lips smacking, and exposed cleavage heaving on their way through airport security. This departure lounge, beyond which flight attendants are seen gyrating, is the setting for Jamaican dancehall superstar Sean

Paul's latest music video called "She Doesn't Mind." In the video, each woman who wants entry to her flight is portrayed yielding (with only signs of mock protest) as her body and person are subjected under the scrutinizing eye of a metal detector, a hand-wand screening, and a pat-down inspection conducted by overzealous security officers. Paul's obvious enjoyment from watching these attractive women being manhandled by security officers drives the message of his music video that she doesn't mind her body being touched and groped; she doesn't mind being voiceless; she doesn't mind being examined and searched; she doesn't mind being objectified.

Or does she? Beyond Paul's music video and myriad other popular cultural representations like it, the voices of several women in essays such as Luce Irigaray's "This Sex Which Is Not One" and novels like Toni Morrison's *A Mercy* and Chang-rae Lee's *A Gesture Life* clamor together to produce a resounding "Yes!" Yes, she minds. She minds the groping and touching that often leads to her sexual exploitation, and she minds the objectification that often precedes her dehumanization.

The paramount concern of this paper is the female body – particularly the female sex (the organ, the act, the identity), and the various displacements it undergoes, the traumas it endures, and the exchanges to which it is subjected within a male-dominated society. Invoking the credibility of history and the vitality of fiction, Morrison and Lee both paint a most unsexy picture of the travels of their female characters, which involve unshod, dirty feet instead of stiletto heels (because the women were abducted) and ripped, shoddy garments instead of form-fitting dresses (because the women fought back as they were beaten and raped). Beyond dealing with their diminishing sense of selfhood, these female characters are also seen grappling with the loss of their family, culture and homeland as their forced transnational and intranational migration compel them to face their uprooted and rootless state. Their bodies then become places where pain is absorbed: pain from the struggles of coping with the effects of dislocation, displacement and diaspora. For Florens, Morrison's protagonist, it is her feet that absorb much of the traumatic episodes that occur as she ventures out into a world dominated by land-owning white males. For *a minha mae*, Florens' mother, and Lee's Kkutaeh, it is their vaginas and wombs that absorb much of the pain from the brutal violation of their sex. While these various female parts absorb the pain of dislocation, sexual brutality and dehumanization, the female body is mercilessly razed, eventually making it necessary for a female voice to emerge in order to counter the

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univocal assertions that “She Doesn’t Mind” because, of course, she does. Most women do.

The lives of these female characters are woven together in this paper and their stories are given voice primarily through their interactions with an essay by Irigaray, a woman who definitely minds and, in fact, concerns herself greatly with the marginalization and othering of woman and the erasure of her sex in a phallocratic society where, historically, it has been the case that a man and his penis are always the last ones standing. Irigaray’s vehement rejection of a masculine economy that values man and his penis and excludes woman as the other is traced within this paper in three parts: her push for the establishment of a uniquely feminine language formulated outside the phallic economy, her use of the strategy of mimesis in order to convert misogynistic stereotypes from forms of female subordination to affirmation, and her interpretation of the commodification of woman and her sex using a Marxist analysis.

The Commodification of Woman and Her Sex

Irigaray addresses the commodification of women by saying that “in our social order, women are ‘products’ used and exchanged by men” (84). Women’s status as objects is illustrated in both *A Mercy* and *A Gesture Life* in the abductions, sales and shipments of female characters by their male counterparts for profit, power and pleasure. In *A Mercy*, Morrison writes of the voyage of *a minha mae* (Portuguese for “mother”), an African woman who is traded and transported as cargo from one continent to another after her kingdom is conquered (power); and of the exchange of *a minha mae*’s daughter Florens, an African-American girl whose person is used as partial payment for one man’s debt to another (profit). In *A Gesture Life*, there is also the transport of Lee’s Kkutaeh, one of five young Asian women who are abducted and shipped across nations to serve the Japanese Imperial Army as “comfort women” while world powers war against each other (pleasure). Treated as mere “‘products’ used and exchanged by men,” the female body is constantly changing hands, migrating to and fro depending on how men settle their various transactions and grievances with each other (Irigaray 84).

In these texts, the commodification of women is seen extending to the commodification of their sex as evident first in the apparently business-motivated gang-rape of Florens’ mother, *a minha mae*, and, second, in the seemingly routine manner by which military officials from the Imperial Japanese Army orchestrated the repetitive rape of Kkutaeh and a handful of other young women by hundreds of their soldiers.

Regarding the gang-rape that produced her eldest child, *a minha mae* says to the absent Florens: “I don’t know who is your father. It was too dark to see any of them. They came at night and took we three including Bess to a curing shed. Shadows of men sat on barrels, then stood. They said they were told to break we in” (191). The business-like quality of this gang-rape, which *a minha mae* refers to as “the mating,” is first made apparent by her use of the words “dark,” “night,” and “shadows” to refer to the details surrounding the event. These words all hide the face of the men who came to “mate” with her and two other women, and therefore leave her in the dark as to who the father of her child is. The men’s anonymity is significant because it tells the reader that what mattered most was not who the men were, but that the job of “breaking in” the women was accomplished. In addition, the fact that the men appeared to have notified her that they were “told” to “break” them in and were merely following orders further strengthens this business-like quality of the use of women’s sex because it alludes to a higher authority that commanded such a deed to take place. This instrumentalization of women’s sexuality and reproductive capacity is not only mandated by the corporation for profit and power but also by the state.

In *A Gesture Life*, the reader sees another instance of men just following orders when it comes to carrying out the systematic rape of young women, otherwise known as “comfort women” deployed for the purpose of helping “maintain the morale of officers and foot soldiers in the field” (163). In speaking about the impending arrival of the “female volunteers,” Lee’s protagonist, a paramedical officer named Kurohata, advises another soldier whom he suspects of suffering from an unhealthy level of sexual frustration that: “perhaps it would be good if you make your own visitation. This is most regular” (162). The fact that Kurohata is able to casually refer to the potential rape of one of the “female volunteers” as a mere “visitation” speaks to his initial naiveté concerning the true nature and full implications of this “longtime mobilization of such a corps” (163). His use of the business-like word “volunteers” and the clinical word “visitation” excuses the injustices done to the female bodies as the “most regular” of practices, and reduces the crimes to a picture of accommodating and consenting women “volunteering” the use of their sex for the “comfort” of weary soldiers whose morale is flagging. Later in life, when Kurohata reflects upon his medical treatment of Korean comfort women during the Second World War, he admits that it was “the most naïve and vacant of notions to think that anyone would willingly give herself to such a fate” (250).

As both of these novels illustrate, the commodification of woman and her sex all too easily descends into her dehumanization as

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she is treated like an animal. In *a minha mae*'s case, the curious task of having to "break her body in" is reminiscent of the way certain animals are conditioned and tamed to obey commands. It suggests a rather bleak future for this female slave under a master who seems to require the absolute and thorough domination of the bodies of his female servants. Similarly, the comfort women in Lee's novel also experience treatment as animals. Kurohata continues his reflection saying, "to the men in the queue, [the girls] were nothing, or less than nothing" (250). He recalls one soldier crudely referring to a comfort girl using a base anatomical slur which also denoted her Koreanness, her ethnic identity. Kurohata observes that "there was a casualness to his usage, as if he were speaking of any animal in a pen" (251). Although he is quick to assert that he never considered them to be animals, Kurohata further admits that the girls never "held any sort of position" in his regard. He elaborates upon this statement, saying, "perhaps my thinking was as a rich man's, who might hardly acknowledge the many servants working about his house or on the property, their efforts and struggles, and see them only as parts of the larger mechanisms of his living, the steady machine that grinds along each night and day" (251). The commodification of women is palpable in Kurohata's invocation of a [rich] man's non-existent regard of his servants (aka the girls) as humans. To him, they are mere "parts," and "machines" whose work in the background is so "steady" in grinding along "each night and day" as to call to mind the dependable but commonplace rise and fall of the sun. Kurohata's regard of the comfort women as something akin to how he might regard a machine calls into question whether his conception of the women is any better or worse than thinking of them as animals. Although he appears to be the only advocate for the girls (or at least the only one who doesn't think they are animals), the anger Kurohata felt upon hearing the soldier's use of an anatomical slur could just as well have stemmed from his taking offense at the invocation of the girl's being Korean, which he is also. From here, one could argue that Kurohata challenging the soldier's base comment was not done to protect the girl's sexual reputation, but to assure himself of the intactness of his own ethnic identity.

The image of women as parts, products, and material substance reminds the reader of Irigaray's Marxist reading of the commodification of woman and her sex. Read through Irigaray, the business-like atmosphere surrounding the gang-rape *a minha mae* endures, and the official mandate supporting the systematic sexual exploitation of the comfort women are clear examples of women occupying "a situation of specific exploitation with respect to exchange operations: sexual exchanges, but also economic, social, and cultural exchanges in general"

(85). The fact that a woman and her sex do not hold “any sort of position” in the masculine economy is a clear source of agitation for Irigaray who demands that women be seen – not as fragments but as wholes, and not as mere holes but as a sex. One of her strategies for overcoming this situation of specific exploitation is through her conception of mimesis, used specifically in her attempt to render women visible.

The Importance of Woman Being Seen and Acknowledged

This paper makes a case for the importance of woman being seen and acknowledged using Irigaray’s essay “This Sex Which Is Not One,” wherein she argues that Freud’s Oedipal Complex places women in a position of being “historically assigned” to mimicry. She points to the rejection and exclusion of a female imaginary that puts woman in a position of “experiencing herself only fragmentarily...as waste, or excess, what is left of a mirror invested by the (masculine) “subject” to reflect himself, to copy himself” (30). Revolted by this definition of the feminine as an imitation, as a lack and, therefore, a nonexistent entity, Irigaray advocates the utilization of mimesis as a philosophical strategy to “recover the place of her exploitation” and “to make ‘visible,’ by an effect of playful repetition, what was supposed to remain invisible” (76). Irigaray’s concept of mimesis involves the unfaithful copying of stereotypes that fetter and subjugate women, and of a deliberate assumption of the feminine role such that a form of subordination is converted into an affirmation. She is interested in thwarting the system by making “visible” what was supposed to remain “invisible” (76). The concept of visibility re-emerges with Irigaray’s project of shedding light on a part of woman’s body that is “supposed to remain invisible:” her sex. From here she uncovers the female body’s multiple erogenous zones, one of which is the “self-touching” lips that, unlike man, require no mediation for pleasure. Despite everything that woman has to offer, Irigaray criticizes the fact that, to the sexual imaginary, woman’s sexual organs still represents “the horror of nothing to see” (26). In her effort to elevate woman’s status from “object” to “subject,” Irigaray looks down and zooms in to expose one of the innermost external body parts of a woman. She calls attention to the capacity of female sexuality to disconcert the current male-dominated discourse. Her strategy of mimesis and its goal of making visible that which is supposed to remain invisible is clearly tied to Lee’s and Morrison’s narratives about invisible and marginalized people who have thus far been likewise rejected from scenes of representation, and are striving to fortify their identities if not to carve them out on American soil.

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Like the attempts of the women in Irigaray's text to be recognized as a subject, and be seen as a sex and not merely as a "lodging" or a "hole- envelope" for the penis, Florens, *a minha mae*, and Kkutaeh's characters likewise vie for recognition and visibility, to be seen as something more than fragments that washed in from foreign shores. The importance of visibility and recognition figures in these two novels where Irigaray's "horror of nothing to see" appear greater in that it is not just the female characters' sexual organs that are not recognized but the whole of their humanity. While locked up inside a surplus supply closet in *A Gesture Life*, Kkutaeh tells Kurohata about her life before her abduction, saying that she is "one of four unwanted daughters" (245) to a father who hardly ever addressed them because he found their femaleness "unaddressable." Continuing her reflection on the great emotional and physical distance between her and her father, she says, "I didn't sense hatred or bitterness from him. But what he had for me was mostly nothing at all, as if I were of the most distant blood" (245). Heartbreaking as it already is, the dismal treatment Kkutaeh receives from her father is shared by her three sisters who are all unwanted because of their sex, and unaddressable because they are women. This fact about Kkutaeh's life reveals the unfortunate reality that even if she had not been conscripted to this wartime "effort," her being a woman would still have subjected her to a status of nothingness and to a state of invisibility. Kkutaeh's invocation of the great distance her father placed between himself and his daughters parallels the experiences of another young woman who is reduced to a "nothing at all" by society.

In *A Mercy*, Florens undergoes a traumatizing episode in the Widow's closet (reminiscent of Kkutaeh's imprisonment inside the surplus supply closet), where she is stripped naked and examined by a group of white people who suspect her of being Satanic. Florens says, "Naked under their examination I watch for what is in their eyes. No hate is there or scare or disgust but they are looking at my body across distances without recognition" (133). Florens is watching them watch her, inspecting her body like it was not that of a human child. She is chilled by the fact that there are no emotions reflected in their eyes, and the reader can assume that, like Kkutaeh, she would rather have odious reactions be present than have them look at her with such seemingly unbridgeable distance. These moments of total dehumanization and othering rob young women like Florens and Kkutaeh of their voices as they are reduced to a level far below that of even animals. Here, the reader sees that the great distance society places between itself and these female characters produces a voicelessness that exacerbates their

invisible state, and exacts great damage upon the psyches and bodies of these women.

The Female Body as a Place of Sexual Violence

The image of damaged or wounded women is a strong one that permeates throughout these texts, especially in scenes where female characters' voices are heard detailing the rapes, beatings, betrayals, and dehumanization they experience at the hands of men. Conceptualizing the female body as a place of sexual violence allows this paper to trace the different female body parts that function as primary shock-absorbers for the various physical, emotional and psychological pains, wounds and damage that the women endure as part of the effects of dislocation, displacement, and diaspora. In Irigaray's text, these harmful acts against women boil down to the image of woman's genitals experiencing an invasion. She says, "This autoeroticism is disrupted by a violent break-in: the brutal separation of the two lips by a violating penis" (23). This zoomed in shot of this private site of sexual violence is, arguably, where the woes of woman originate.

In *A Gesture Life*, the reader witnesses the raw pain from being exploited sexually. There is the pain from the outer labia lips separating, from the hymen tearing, and from the female sexual organs being violated as women are abducted and shipped to be a part of the wartime effort as "comfort women" to whole armies of men. While giving one of the girls a physical examination after their first night of "service," Kurohata observes that, "The girl's privates were terribly swollen and bruised, and there were dried smears of crimson-tinged discharged on her thighs and underside" (183). Clearly, this female body had experienced "a violent break-in," and the "privates had endured much of the blow.

Describing the comfort house where each of the girls are given a separate compartment in which to "entertain" and "visit" with the men, Kurohata says, "In the middle of each space was a wide plank of wood, fashioned like a bench but meant for lying down on, with one's feet as anchors on either side. At the other end, where the shoulders would be, the plank was widest, and then it narrowed again for the head, so that its shape was like the lid of a coffin" (176), foreshadowing the grizzly deaths of the girls. From Kurohata's description, this "comfort house" is not so comforting at all. It is built with a precision one can imagine soldiers employing in designing the construction of a building inside where they are to gratify their various lusts. Because the men do not even see the women as humans but consider them as "soft slips of flesh, a brief warm pleasure to be taken before it [is] gone" (251), they house the girls in tiny spaces that are "more like a stall than a room" (226).

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When he later stumbles upon the comfort house, Kurohata says, “There was no one there...Just the oddly shaped plank of wood,...the wood stained dark at its bottom end. This is what the enlisted men had been queuing for these past few afternoons” (226). The comfort women’s genitals experience terrible and prolonged abuse as three of them (with the exception of Kkutaeh whose horrible end is reserved until the end), are divided between “nearly two hundred men in the encampment” (165) who take their turn raping the girls by a somewhat orderly queuing system. Despite his efforts to protect Kkutaeh (with whom he has fallen in love), Kurohata is helpless as tens of soldiers overwhelm him in their desire for her relatively fresh body. One soldier says, “Everybody’s bored with just the three others. They’re nearly useless now besides. Fucking skeletons. Can’t you fix them up or something? It’s almost better with your own hand. At least you don’t want to throw up when you’re doing it” (302-303). This scene demonstrates the utter objectification of the comfort women in the eyes and hands of the soldiers and points out that their bodies have been nourished at the barest minimum in order to keep them alive long enough for the men to exhaust their lusts. Their sex is used as “machines that grind along each night and day” for as much pleasure as men can derive from them (251). The soldier’s further complaint that sex with the women induces him to want to throw up allows the reader to see without actually seeing that the women’s genitals have been so overused and over-abused that they are disfigured to the point of not being recognizable. The “brief warm pleasure” from the “soft slips of flesh” that is their sex is gone, and because of this, the comfort women are rendered useless.

In considering the female body’s role throughout much of history as a place of sexual violence and a site of economic, social, and cultural exchange, it cannot escape the reader that the women mind these instances where they are sexualized, objectified and, ultimately, silenced in the most complete sense of the word: physical death. Even before Kkutaeh’s rape and murder by more than 50 men, her communication with Kurohata already hinted at the death of her humanity. She says, denying the presence of a growing child inside her body, “There’s nothing in me. There can’t be” (294). Although the immediate context of her words regards the denial of the presence of a fetus within her, the all-encompassing phrase “There’s nothing in me” hints towards what Kurohata would later realize is the absence of integral parts of what makes a person human. He says, “She had not hurt me for the same reason that she had given over her body some hours before, not for passion or love, or mercy, or humanity, but their complete absence and abasement, such that there were no wrongs remaining, no more crimes,

nothing to save herself from” (294). From this, the reader can assess the damage Kkutaeh’s person sustained from the various crimes she endured in the presence of an emotionally-distant father who did nothing to protect her from being “conscripted” into the “war effort,” and at hands of the brutal soldiers whose ravenous sexual appetites amounted to the death of her and a fetus that did, in fact, exist in her womb.

Although the gang-rapes of Kkutaeh and *a minha mae* both illustrate the capacity of the female vagina and womb to absorb numerous pains, the absorption of pain does not necessarily have to fall on the female body’s sexual organs. In *A Mercy*, Florens’ physical travels and wanderings through society and wilderness immediately necessitate that her feet do much of the work of absorbing pain from being enslaved, being othered, and being dehumanized.

Though institutionalized race-based slavery has not yet been born in Morrison’s seventeenth century America, other forms of enslavement have already been spawned in the newly-settled grounds of the New World. These different forms of enslavement are made manifest in *A Mercy* in the subjection of all women, regardless of religion, race and class, under the power of their male counterparts. This, again, is what Irigaray describes as phallocratism, where women’s sexuality, imagery and language are rejected and excluded in the “little-structured margins of a dominant ideology” (30, 33). In the context of this world of entrapment, *a minha mae* gives up her young daughter as an attempt to push her closer to the line of liberty, all the while praying the child will understand her reasoning based on the belief that, “to be given dominion over another is a hard thing; to wrest dominion over another is a wrong thing; to give dominion of yourself to another is a wicked thing” (196). This child is none other than Florens, who undergoes a dramatic transformation from an impressionable enslaved girl to that of a resilient, mentally-liberated woman, as illustrated through Morrison’s construction of a world that relies on a multi-vocal narrative, where Florens’ first-person narrative dominates, interrupted only by the third-person narrative of the other characters on every other chapter. Florens’ transformation comes about after she suffers through the dehumanizing episode in the Widow’s closet. Her transformation is sealed as she exercises one of the few ways in which a black slave might be heard: through literacy that has the potential to bridge the gap between the free and enslaved in a patriarchal society.

Florens’ transformation is a journey that begins from the very first page of *A Mercy* and continues to the very last; a journey which, as she describes in page 4, “begins with the shoes.” Shoes usually serve to protect the owner’s feet by absorbing the painful impact of one’s

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movements and travels. However, Morrison uses shoes as a motif to represent the vulnerability of women in a world of men. To Florens' mother, who is aware of the lustful nature of men, the child's early manifestation of the desire to "prettify" herself by wearing high heels is dangerous because the high heels serve more to highlight her sexuality, to flaunt it before hungry men, and less to the more practical use of shoes: that of absorbing impact. Fearing that Senhor D'Ortega, her sexually exploitive master, might also take advantage of her young daughter, Florens' mother makes the wrenching decision to part with her daughter and give her up to the hands of another man who she believes sees her daughter as "a human child, not pieces of eight" (Morrison, 195). Her action is a clear portrayal of her standing belief regarding domination that to be given dominion over another human being is a "hard thing." Within the context of the mother-daughter relationship central in the novel, the reader can understand this to mean that parents have a dominion over their children that gives them the right to exercise the ability to do such a "hard thing" as cast them off in order to save them. *A minha mae's* invocation of a human being's monetary value speaks to Irigaray's agreement with Marx that women have traditionally been regarded as commodity between men. She says, "In our social order, women are 'products' used and exchanged by men. Their status is that of merchandise, 'commodities'" (31). However "merciful" the act might appear to *a minha mae*, the exchange between Senhor D'Ortega and Jacob Vaark, the man who agrees to accept Florens as partial payment for D'Ortega's debt, is a clear illustration of Irigaray's scathing review of the current social order.

The motif of shoes further suggests that, even in matters of footwear, one can see women tiptoeing on the territory of men, not wishing to draw attention for fear that it might lead to [further] abuse. Florens recalls Lina, Jacob's Native American servant who becomes her surrogate mother in his household, telling her that her "feet are useless," as a consequence of her having worn high heels and, "will always be too tender for life and never have the strong soles...that life requires" (Morrison 4). Both mothers want to prepare her for the kind of life where, "There is no protection. To be female in this place is to be an open wound that cannot heal" (Morrison 191). The image of damaged or wounded women permeates throughout the novel, especially in scenes where female characters' voices are heard detailing the rapes, beatings, betrayals, and dehumanization they experienced at the hands of men. For Irigaray, these harmful acts against women boil down to the image of woman's genitals experiencing an invasion. She says, "This autoeroticism is disrupted by a violent break-in: the brutal separation of

the two lips by a violating penis” (23). It is interesting to note that this extremely zoomed in shot of this private site of sexual violence is, arguably, where the woes of woman originate. This distraction and deflection of woman’s unconscious biological act of “self-caressing” by the self-asserting penis is what permanently fragments her by the temporary separation of the two lips. While Florens’ feet may have been “too tender for life” in the beginning, the reader sees her transformation in that, at the end, she addresses her absent mother, saying, “Mae, you can have pleasure now because the soles of my feet are hard as cypress” (Morrison, 189). While the figurative strength of Florens’ feet will offer a bit of protection as she continues to tread on the world of men, the bitter tone of her address alerts readers to the fact that she still does not understand the cause of her abandonment and, much less, the concepts of dominion which her mother wishes for her to hear and know.

While Florens’ feet are meant to absorb the pain from various traumas she experiences, this part of her body, calloused as it is, cannot absorb every painful thing that she encounters. What the feet don’t absorb, her mind and consciousness do. After the dehumanizing experience she endures inside the Widow’s closet, Florens dreams “a dream that dreams back at me...I notice I am at the edge of a lake...I make me go nearer, lean over...Right away I take fright when I see my face is not there. Where my face should be is nothing...I am not even a shadow there. Where is it hiding?” (162). This moment is not only alarming for Florens but heart-wrenching for the reader because it speaks to how much the scrutinizing but unrecognizing gaze of the white people affected her – and, in fact, appear to have stripped away a huge portion of her self-regard and identity. When there is no face to be seen, there is no identity to be recognized. The fact that Florens doesn’t even see a shadow where her full reflection ought to be speaks to the total rejection of her person and of her race by seventeenth century America. Read through Irigaray, Florens’ discovery of her absent reflection becomes even more distressing in that she can no longer be “the beautiful object of contemplation” (26) without a face. Without a face, without a shadow, Florens’ person and not just her sexuality and femininity are reduced to a “nothing-to-see” that, according to Irigaray, “has to be excluded, rejected, from such a scene of representation” (26).

The Importance of the Female Voice Being Heard

The importance of being visible is matched by the importance of being heard, which also reverberates throughout *A Mercy* apparent through the platform of multi-vocal narration that Morrison sets up, where she affords each of her main characters a chapter wherein their

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unique perceptions can be heard. By switching from Florens' first-person narrative to the third-person narrative of other characters, this literary form allows the reader to enter into the minds of the novel's diverse cast of characters, and to listen as voices belonging to those who have been historically marginalized in colonial American times (women, non-whites, orphans) relish in a moment where they are acknowledged and heard. However, it is important to note that some intended audiences do not and cannot hear. For instance, the perpetual sense of abandonment that Florens feels in her separation from her mother is borne out of her inability to hear her mother's words. Morrison uses this multi-vocal narration to great effect when she summons the voice of Florens' mother at the end of the novel, providing relief to the reader in finally knowing the meaning behind the title of the book *A Mercy*, and inciting grief over the fact that it is the reader and not Florens who "hears" the mother's justification for her action.

This perceived abandonment has unforeseen consequences as Florens begins to seek out the love of other people to complete her – eventually becoming romantically enslaved to a free blacksmith to whom the majority of the novel's passionate and intimate words are addressed to. Throughout this address, the importance of being heard resurfaces as the reader realizes that Florens' recounting of events is being done through writing, and not just ordinary pen-paper writing, but using a nail to etch every letter of her tale out of the walls and floors of her deceased master's grand, new house. The sense of urgency that might compel this young woman to express the contents of her heart in such a way is preceded by a transformation, which, in Florens' case, is not only the hardening of the soles of her feet, but the fortification of her sense of identity as a woman, and acceptance of her role as a slave. In one fateful scene, the black man tells Florens to leave him alone after she nearly kills a child who she perceives as competing with her for his affections. He tells Florens that she has become a slave by choice by allowing her body to go wild and by losing herself in her desire for him to possess and own her. "Own yourself, woman, and leave us be" (166).

The blacksmith's command calls to mind Irigaray's belief that a woman who take pleasure in the enactment of man's fantasy, (where she is a more or less "obliging prop"), is one who knowingly or unknowingly subjects her body to "masochistic prostitution" (25). This is because, to begin with, the desire is not her own, and because ultimately the short pleasure she derives from the experience leaves her dependent upon man. The appetite in Florens which Lina recognized as being once her own ("a bleating desire beyond sense, without conscience" (70)), is reminiscent of Irigaray's observation that woman's desire is nothing and everything

at the same time. Not knowing the depths of her own desires, Florens insists against Lina's words that she is only "one leaf on his tree" by confidently proclaiming that she, in fact, constitutes the entirety of "his tree" (71). By reading Florens through Irigaray, one could say that she has internalized the role woman has been given within the context of the current sexual imaginary, hungering for the blacksmith, wishing even that he, according to Irigaray, "take" her as his "object" (25).

The Emergence of a Specifically Feminine Language

The various ways that feet and shoes operate in Morrison's novel affords the reader a glimpse into a mimetic strategy at work in Florens' transformation. Instead of growing up with useless feet due to her wearing high heels like Lina had prophesied, Florens develops calloused feet by shedding all forms of protective footwear and baring herself to the world in her natural state: woman, bare. Though the picture of Florens walking barefoot back to her master's house is bleak, there is hope in that she continues to survive – a much stronger woman, a much less dependent woman. Before all credit falls upon the high heels mentioned in the beginning of the book, there is another type of footwear that Florens dons: Sir's boots. Before sending her off to search for the blacksmith, Lina and Mistress invest in Florens' feet by giving her the deceased master's boots to wear. She says, "So when I set out to find you, she and Mistress give me Sir's boots that fit a man not a girl. They stuff them with hay and oily corn husks and tell me to hide the letter inside my stocking" (4). This passage deserves highlighting not only because it is another instance of the feet/shoes motif, but also because it calls to mind Irigaray's argument that "the issue is not one of elaborating a new theory of which woman would be the subject or the object but of jamming the theoretical machinery itself, of suspending its pretention to the production of a truth and of a meaning that are excessively univocal" (78). When read through Irigaray, the older women's attempt to outfit Florens with "boots that fit a man not a girl" represents women's vain efforts of acquiring their subjectivity.

Irigaray's goal is for women's language to take their place, not for women to wield man's language (wear man's boots) in order to attain liberation. To her, doing the latter would be pointless since history is bound to repeat itself and will likely "revert to sameness: to phallocratism" (33). Irigaray would say that, instead of stuffing a man's boots with "hay and oily corn husks" to fit a girl's feet, spend your time "jamming the theoretical machinery itself," and "suspending its pretention to the production of a truth and of a meaning that are excessively univocal" (78). Here the reader is forced to consider another

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aspect of the previous scene in Morrison's novel, the part where Florens is told "to hide the letter inside my stocking." The letter is her ticket to be out in the world. As a slave, Florens becomes ever more vulnerable outside her master's house and into the world. The letter contains the univocal truth and meaning that Irigaray speaks of. It contains the language of the mistress, who, though also a woman, derives her power and authority from her husband's name and place in society. As mentioned before, Irigaray is interested in the search for and implementation of a uniquely feminine language. The fact that Florens even has any use of the letter (her own voice not being enough to grant her passage along the roads of white men), is another instance of wearing man's boots, of an already-failed attempt at securing female subjectivity.

Once Florens has traversed this road, the black man's rejection of her love adds to the wounds inflicted by a prior traumatizing episode she undergoes in the Widow's closet. Bearing the wounds of her lover's rejection and of this dehumanizing experience compels Florens to turn to the only person whose approval she has not sought: herself. In doing so she recovers her voice and dares speak through the language of the free, of the literate, by writing. Towards the end of the novel, she writes to the black man, "You are correct. *A minha mae* too. I am become wilderness but I am also Florens. In full. Unforgiven. Unforgiving. No ruth, my love. Hear me? Slave. Free. I last" (189). Though she does not know it, these written words are a silent fulfillment of her mother's wish that she come to understand the fact that allowing anyone to have dominion over her is a "wicked thing." Her words, her language can also be said as a form of women's language the existence and propagation of which Irigaray advocates. Once Florens learns to live for herself and to appreciate the fruits of self-liberation, she discovers a completeness ("In full"), and a sharpness of identity that allows her to own her disparaged roles as woman and slave in society. In this way, she becomes free in the sense that she owns her past ("Florens") and who she has become ("wilderness"), and rests assured that her words will "last." Florens would not have been able to undergo such a transformation if it weren't for the feet that propelled her from her master's house out into the world in search of the blacksmith. Her journey and experiences in the brutal wild (encompassing not just the woods through which she traversed at night, but also the racist society that recoiled at the sight of her blackness) is what forced her growth.

Conclusion

This paper has attempted to engage with Irigaray's vehement rejection of a masculine economy that extols the phallus and excludes the female as the defective other. It has critically analyzed the commodification of woman and her sex through a Marxist reading; and the importance of the female being seen and acknowledged as supported by Irigaray's conception of mimesis. It has uncovered the fact that her body functions as a place of sexual violence, most vividly encapsulated by the experiences of Lee's Kkutaeh; and it has highlighted the emergence of a specifically feminine language, formulated and achieved by the transformation of Morrison's character Florens. Inasmuch as these various female body parts serve to absorb the pain of being unacknowledged and invisible, they also function mimetically in that the authors use these parts in order to unveil transformations, epiphanies and discoveries on the part of the characters. *A minha mae* discovers a way of sheltering her innermost self from being completely enslaved by never allowing anyone to have dominion over her person. Kkutaeh commits emotional suicide by emptying herself and siphoning off the passion, love, mercy and humanity that would have certainly kept her pegged to the coffin-shaped bench and forced her to feel every bit of the pain of the wrongs and crimes committed against her body and person.

In considering the female body's role throughout much of history as a place of sexual violence, and site of economic, social, and cultural exchange, it becomes necessary to acknowledge contemporary media like Sean Paul's music video, which is significant not only for its harmful portrayal of women (not minding being silenced, sexualized and objectified), but also relevant in its demonstration of a univocal world singularly possessed and jealously guarded by man alone, and that stretches, (at least for the purposes of this paper), from Morrison's seventeenth century America, and Lee's World War II-era Japan, to Paul's very own twenty-first century airport. While the masculine economy's univocality tragically silences many voices and keeps many stories from being heard, the reader can find relief in Florens' victory in the battle of reclaiming her dominion over her person from the various people who have made her feel small. In her journey through the wilderness, she develops calloused feet necessary for her to survive in a brutal world, something her mother has always wanted and intended when she severed their mother-daughter ties in giving her over to Jacob for servitude. To the very end, Irigaray's strategy of mimesis and its goal of making visible that which is supposed to remain invisible work seamlessly with Morrison's and Lee's narratives about the unheard and the invisible persons. These marginalized individuals have been likewise

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rejected from scenes of representation, and are struggling with all their might to fight against the racism and sexism that infects their existence irrespective of whether they remain at home or abroad.

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I am interested in recognizing power inequalities on a local/global scale, and examining the role of the individual as it figures in the topics of transnational identity politics, human/women's rights, immigration, and violence, and as it exists within the scope of structured systems of power, privilege, dominance, oppression, agency, and resistance. Following graduation, I will pursue a Ph.D. in English and a position as an English professor at a university, where I will teach and research my studies better understanding the position certain bodies occupy within this sociocultural and geopolitical network by critically assessing the intersections between gender, women, and sexuality studies, and modern and contemporary hemispheric American literary works. I will focus on texts that depict transnational travel and produce different kinds of migrant genres, including immigrant, exile and diaspora literature.

Look Who's Laughing: Black Buddies, Bodies, and Unlaughter in the Neo-Slave Narrative

Alexander Catchings

Abstract

*This paper analyzes how the neo-slave narrative literary form can utilize humor as a sociopolitical index. Using Charles Johnson's *Oxherding Tale* (1982), I highlight how the neo-slave narrative can work to capitalize on people's normative notions of how the world and history should be represented and confounds said notions. This confounding is the basis of incongruity humor theory, which I use to suggest that a separate kind of laughter can occur: unlaughter. Unlaughter is the point at which a person's conscience halts laughter in favor of ethical silence. This disruption of laughter, I suggest, can help people move past ideas of essentialism (reductive views on entire groups—in this case African Americans and whites) to acknowledge the subjective, or individual value of people within community groups.*

Interracial, comical camaraderie propels Charles Johnson's 1982 *Oxherding Tale*. Some time around 1840, a drunken Jonathan Polkinghorne, master of the South Carolina Cripple Gate Plantation, sips whiskey alongside his most loyal house slave, George. The chums sit on the house's porch when Jonathan confesses that his wife Anna would "brain me like a milkstool" for going to bed with her smelling of spirits (Johnson 2). George admits his wife would feel equal disapproval in the slave quarters, so Jonathan suggests the two switch bedrooms (and consequentially, wives) for the evening. He explains that if they follow his plan then neither wife can be mad at her respective husband for coming to bed drunk. The men shake hands, and minutes later George is engaging Anna, who sleeps with a sleeping eye mask, in intercourse. After "gripping the headboard" and gleefully groaning, "Oh gawd, Jonathan," Anna realizes who her partner really is, letting fly a horrified shriek (6). Almost synchronously, a shrill cry comes from the slave quarters—Jonathan screams in fright while being chased off by George's enraged wife, Mattie. As the two men, naked and frenzied, pass each other at the house's entrance, Jonathan asks George, "Whose fat idea was this?" With countrified candor, George reminds his owner, "Suh, it was *you* who told *me*..." (7).

This carnivalesque opening scene bears an easy humor as it ruptures traditional dynamics between slave and master. Jonathan's role as a momentary trickster figure, duping his own slave in order to be

sexually deviant with a woman in the slave quarters, moves this scene into the realm of absurdity. Mattie's dismissal of Jonathan evokes an unconventional if not pleasurable ending. However, beyond the levity of this neutering of master power is a series of alarming constructs that move the scene into the realm of the tragicomic. The commoditization of both wives' bodies in this transaction is itself unnerving, and George's obsequiousness and participation in sexual depredation (not to mention infidelity) invokes a gamut of docile and violent black stereotypes.

This scene invites laughter, but has on its underside a highly charged, politicized humor, which makes for ambivalent responses. In "Laughter: an Essay on the Meaning of the Comic," Henri Bergson suggests, "indifference is [laughter's] natural environment, for laughter has no greater foe than emotion" (Bergson 63). In this paper I contend that humorous contemporary representations of slavery challenge readers and viewers to mix their laughter with their emotions and their politics—to perhaps be overcome by laughter at the inversion of power dynamics, but also to suppress it in recognizing the heinous endurance of racialized "Othering." This general suppression of laughter has been theorized by Michael Billig as "unlaughter," a silence that wrests the political from the psychological by supplanting joy for "mute outrage" (Billig 194). In contemporary representations of slavery (hereafter referred to as neo-slave narratives) the outrage is clear: Salamishah Tillet suggests that a "democratic aesthetic" is eschewed in neo-slave narratives—that by reinvoking images of slavery, artists can illustrate the ways in which African Americans, despite bearing legal citizenship, have maintained a status of "civic estrangement" from America's civic myths and democratic imperatives as a whole (Tillet 6). In a similar vein, Glenda Carpio looks toward the very presence of humor in the fictions of slavery to "make clear both the distance and the layers of mediation through which we invoke slavery *and* the nearness of its legacy" (Carpio 213). Indeed, slavery's legacy is manifested in the exclusion of African Americans in politics. The humorists of interest here toy with stereotypes rooted in the justification of Triangle Trade slavery to show how these misrepresentations have altered black identity formation, consequentially contributing to the complex enactment of civic estrangement. As I will argue, Johnson uses *Oxherding Tale* to dissect the potentially essentialist identity politics of Black Nationalism, and Paul Bogart's film *Skin Game* (1971) seeks to examine the self-commodification and interracial social relations of the 19th century freedman. Both texts use humor to scrutinize the history of African Americans' civic estrangement, pointing toward the complexities of both racialized division and black belonging. Each text also probes the fraught

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possibilities of coming together through interracial relationships often elided from traditional slave narratives. At times, humorous neo-slave narratives push biases, traditional representations of slavery, and hyperbole past the point of the comical. They tread the line of politically transformative and opprobriously offensive. They move us from empathy to discovery to horror. And in so doing, they open a unique space to re-envision the history that has led to race relations today.

Refiguring Subjectivities through a Form

The neo-slave narrative form, which can be traced to Margaret Walker's 1966 *Jubilee*, is a contemporary rendering of past slave life and culture, often based on post-memory and faction, a portmanteau of fact and fiction. *Jubilee* and other prominent neo-slave narratives such as Octavia Butler's *Kindred* (1979) and Toni Morrison's *Beloved* (1987) work masterfully to recover the memory of antebellum slavery in the decades after the final members of the American slave generation passed away. The vitality of these novels comes in their ability to enfold myriad literary elements to destabilize and rewrite history (Rushdy 7). Realism, speculative fiction, and ghost stories are the respective imaginative implements of Walker, Butler, and Morrison. Destabilizing history is no small task. The neo-slave practitioners I examine here construct American counter-histories through a different rhetoric: humor.

Oxherding Tale and *Skin Game* utilize humor in the neo-slave genre as a vehicle for contemporary political intervention and sociohistorical insurrection. The humorists' art intervene in discussions of race. They take on socially contentious ideas, counterposing Black Nationalist prescriptions for authentic, separatist black identity with the fraught possibility of interracial intimacy in the form of friendship and romance. Such an investigation is structured through the epoch of slavery and its legacy. Simultaneously, the art revolts against notions of one-dimensional emancipation represented in American history. The artists point to the duplicity of racial experience, and attempt to move readers and viewers away from reducing all black narratives to what Arlene Keizer calls an "Up From Slavery" trajectory by problematizing the "overvaluation of direct, armed slave resistance" (Keizer 9). Both *Oxherding Tale* and *Skin Game* exaggerate and upend racial stereotypes. They mask their fictions in foolery while keeping the fantasies "close enough to recognizable situations" to accentuate the "ludicrous quality of everyday racial practices" (Ferguson 213). In the neo-slave narrative, the complex comfort of humor's most familiar forms—catharsis, incongruity, and laughter—allow for subtle and powerful sociohistorical insurrection (Billig 104).

Neo-slave narratives, humorous or otherwise, are effective due to their functional contrast with traditional slave narratives. Traditional slave narratives (also called slave testimonials) were rhetorical appeals to the broad United States to abolish slavery. Veracity, or at least popularly perceived veracity, was paramount to the success and effect of the traditional slave narrative. Enduring and canonical slave narratives including Harriet Jacobs's *Incidents in the Life of a Slave Girl* (1861) and Frederick Douglass's *Narrative of the Life of Frederick Douglass* (1845) bear distinct markers of authentication by prominent abolitionists. *Incidents* is prefaced by abolitionist Lydia Marie Child, who reassures readers that "those who know [Jacobs] will not be disposed to doubt her veracity, though some incidents in her story are more romantic than fiction" (Jacobs iv). For Douglass's narrative, social reformer William Lloyd Garrison anticipates and assuages Christian readers' concerns regarding Douglass's firm acknowledgment of Southern religious hypocrisy when he notes, "there is a great difference between Christianity and religion at the south" (Douglass 52). Garrison insists, "the testimony of Mr. Douglass, on this point, is sustained by a cloud of witnesses, whose veracity is unimpeachable" (iii).

The traditional slave narrative fixates on verity while the neo-slave narrative is overtly dependent upon the writer's imagination. Kant's theory on laughter and incongruity moves that "in everything that is to excite a lively laugh there must be something absurd [...] Laughter is an affection arising from the sudden transformation of a strained expectation into nothing" (Kant I, I, 54). Neo-slave humorists pivot their comedy around the genre's form by loosely following the plot points of the traditional slave narrative but departing from that narrative's central tropes. Frances Smith Foster outlines the skeletal traditional narrative: it often includes a slave describing a descent from a state of innocence into a recognition of inferiority, a progressive dehumanization at the hands of a master, a subsequent growth of self-reliance and education, the acknowledgment of the hypocrisy of slavery, some sort of subversive resolve, and a conclusion with flight or redemption (Foster 85). Authors of the neo-slave narrative deviate from the tenets outlined by Foster to produce radically different renderings of slave interority, and thus imagine less restrictive forms of agency within the black past.

Oxherding Tale's protagonist, Andrew Hawkins has a particularly unique agency, for he is George and Anna's light-skinned child, a living reminder of the outrageous wife swap. Andrew navigates the Antebellum South to earn money and purchase his girlfriend and slave family's freedom from the Cripple Gate plantation. His pursuit of freedom and happiness, which features a motley crew of irreverent

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characters, is aptly described by Philip Page as “a symposium of the self and the Other” (Page 125). Andrew’s own peculiar narrative is comprised of encounters with characters like Flo Hatfield, the hedonistic sovereign of the Leviathan plantation, who exudes a din of “noisy eroticism” (Johnson 44). A vacationing Karl Marx makes a cameo, admitting, “everything I’ve vritten has been for a voman—is one way to view Socialism, no” (20)? Andrew’s interactions with these characters creates an imbroglio of philosophy, subjectivity, and race. Andrew seeks Others so he can finally locate his own sense of self. He navigates the art of being a freeman by examining other characters, and the one who bears the final answer is the most comically peculiar of the entire cast: the slave hunter and Soulcatcher, Horace Bannon.

Bannon is a crucial character because he fills a voice often elided in the traditional slave narrative. In *Incidents*, Jacobs spends an unfathomable seven years hiding in her grandmother’s garret, a space that is three or four feet high and about nine feet long (Yellin 9). She cannot leave knowing “the patrols and slave-hunters conferring together” would be “rejoiced” to catch her (Jacobs 71). Jacobs cannot incorporate the slave catcher’s voice in her story, both because of the narrative’s first-person perspective and because of the necessary distance between slave and slave catcher. But in *Oxherding Tale*, Andrew’s ability to pass as white allows him to speak with Bannon. Johnson imbues Bannon with a voice that represents a contemporarily allegorical perspective on runaway slaves. Bannon’s flawless record of catching runaways comes from his understanding that “yo mind has to soak up his mind. His heart. [...] you become a Negro by lettin’ yoself see what he sees, feel what he feels, want what he wants” (Johnson 68).

As Andrew and his sagacious African Allmuseri companion, Reb, travel North, Bannon remains in quiet pursuit. When Andrew settles in a northern town to pass as a white schoolteacher, Reb chancily continues toward Chicago. At the apex of the novel, Bannon comes to Andrew bearing a single dismembered finger with Reb’s tribal ring on it. Rather than announce his most recent murder, as Andrew anticipates with stinging tears, Bannon instead announces his own retirement. He reveals,

—yo friend, as Ah was sayin’, didn’t have no place inside him fo’ me to settle. He wasn’t positioned nowhere. [...] Befo’, afterwards, and in between didn’t mean nothin’ to him. He had no home. No permanent home. He didn’t care ‘bout merit or evil. What Ah’m sayin’ [...] is that Ah couldn’t entirely become the niggguh because you got to have

somethin' dead or static already inside you—an image of yoself—fo' a real slave catcher to latch onto. [...] Ah always said Ah'd quit if Ah come across a Negro Ah couldn't catch. (174)

Bannon's explication of his failure is layered in context. In terms of the novel's plot, his explanation can prompt cathartic laughter because it relieves the tension that Andrew's greatest confidant has been murdered, and signifies an end to Bannon's killing streak. In terms of the novel's satire, the entire ironic construct is quite humorous—Bannon thrives on killing runaway slaves, and even takes on the traits of black dialect in spite of his “mongrel appearance” and his eyes, “one teal blue, one green” (68). Andrew narrates the irony as a “feeling that Bannon was in masquerade, a slave who, for reasons too fantastic to guess, hunted slaves” (68). The circumstance of Bannon's failing, though, creates space for attention to his allegory. Bannon operates as a humorous construct, initially. He code switches and speaks with assured confidence about his knowledge of the slave mind. Johnson humorously confounds the idea of an insightful slave catcher with that of the race fetishist. In shrouding Bannon's subjectivity with this incongruous humor, Johnson underwrites the fact that he is a villain—the constant source of anxiety for Andrew and Reb. When Bannon appears with Reb's ring (which Reb pawned during his flight—Bannon is not in actual possession of his finger) all attention is taken away from his power. Bannon's dialect and mien are no longer laughable—his homicidal occupation is no longer attached to nameless figures, it is the object of attention in a moment of utter unlaughter. Seizing the moment of Bannon's retirement, Johnson uses the silence of unlaughter to showcase how the Soulcatcher, in his own existence, exemplifies appropriated culture. His success as a slave hunter hinges on his ability to be an offstage minstrel figure. In lieu of temporary burnt-cork or greasepaint to cover his face, his body permanently morphs with each victim consumed. His appropriation is ultimately emblemized by an outlandish supernatural “flesh tapestry of a thousand individualities no longer static” on his chest and back, an animated tattoo mosaic of lost black lives (175).

Bannon teeters on black caricature and black negation. If he is caricature, he is a hypervisceral race fetishist, killing slaves in order to become more enmeshed in the literal souls of black folk. If he demonstrates black negation, it is because runaways who become free in spite of his efforts do not have a “dead or static” image on which he can capitalize: they don't allow themselves to become interpolated into essentialist notions of black identity. Bannon's career provocatively

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suggests that a runaway slave cannot be a freeman if the runaway is too resentful of the past, too fearful of the moment, or idealistically overzealous about the future. These tenets are transmutable from *Oxherding Tale* to Black Nationalist discussions of race in America during the 1970s, the same decade when Johnson penned most of the novel. Johnson operated as a peripheral figure to the Black Arts Movement, and he uses Bannon as a voice to respond to the movement's more central figures, like Maulana Karenga, who, in his essay "Black Cultural Nationalism," suggested, "Black art must expose the enemy, praise the people, and support the revolution" (Asante 23). By using the neo-slave form, Johnson unites Black Nationalism with the essence of its antagonism, slavery, in order to illuminate his concern with the movement. In a sense, Bannon's explanation suggests that to mark all black art with the resentment, fear, or capacious promise of black futures forever marks the race with the slave memory over which black nationalists intended to triumph. Bannon demonstrates that blackness, however empowering its intended representation may be, becomes so predictable that "runaways," or African Americans set between slavery and the pursuit of full, active citizenship, can actually be appropriated. Bannon, though, performs blackness through his dialect, his mien, and his day-to-day agenda. At moments, it can be difficult to trace whether he fetishizes blackness or loathes it. By emulating his victims, Bannon caricatures the essentialist problematics of an identity centered on monolithic notions of blackness, which is Johnson's largest problem with Black Nationalism. Interestingly, Bannon does not discuss the tracking of any female slave, showing the limitations of his soul catching. His embodiment of the runaway does not suggest the incorporation of female runaways, which underwrites the black woman's identity formation. This is not a surprising omission given some criticism regarding Black Nationalism as masculinist in rhetoric (Alexander-Floyd 175). In spite of this loose end, Johnson deftly draws our attention to a rich critique of Black Nationalism in the story's climax, and in a moment of contemplative unlaughter.

The humorous neo-slave aesthetic's political utility is not constrained to writing alone. Paul Bogart's *Skin Game* constitutes a filmic sociohistorical insurrection. The film's setting in the 1857 American West immediately sets it apart from the generally Southern-oriented slave narrative. *Skin Game* works uniquely as a revisionist Western: a Western that questions or changes typical conventions of Western cinema. An enduring example of the revisionist Western is John Wayne's *The Searchers* (1956). It is only fitting that a Western highlighting Northern and Western slavery in the 1850s came to

mainstream production in the 1960s and '70s. *Skin Game*, released in 1971, was produced in a tender moment after Stanley Kramer's socially pointed *Guess Who's Coming to Dinner* (1967) and before the production of Blaxploitation Westerns such as Jack Arnold's *Boss Nigger* (1975). Bearing a compromise between Kramer's sentimental film and the winnowed levity of Mel Brooks' *Blazing Saddles* (1974), *Skin Game* renders slavery through an oft-elided perspective—the freedman's perspective of black commodification (Watkins 329).

Skin Game uses the idiom of “honor among thieves” to bind its core characters and transcend racial idioms. The film chronicles Quincy, a white swindler played by James Garner, who sells his black friend Jason, played by Lou Gossett, to white plantation owners in 1857. Quincy then breaks his friend free and the duo skip towns with the money, sharing the loot and laughs between towns with names that refer to America's peculiar institution: Dirty Shame, Sour Grapes, and Second Best (*Skin Game*).

Skin Game is an interracial “buddy film,” which Brett Carroll prescribes as having an “African-American character [who] is typically the sidekick to the white hero and isolated from the African-American community. He thus offers his skills and bravery for the preservation of mainstream (white) cultural values” (Carroll 12). Michael Rogin spotlights the political ramifications in Carroll's definition, suggesting buddy films position the interracial double as “the split self, the white in blackface” (Rogin 419). Under Rogin's construct, the black buddy is exploited to reaffirm the white friend's power. *Skin Game* resists employing Jason as the interracial double to Quincy, despite Quincy's best efforts. Interestingly, Jason resists becoming an interracial double by himself reacting to the unlaughter in the pair's constant interracial signifyin(g).

Jason and Quincy's relationship is fraught with interracial tension from the beginning of the film. *Skin Game*'s first scene follows a successful heist in a small town, and finds Quincy and Jason resting under a tree before moving on to their next heist. While laughing so hard he snorts and coughs, Jason manages to say, “That was a whole lot of ‘Marser, marser, marser’ to go through for four hundred dollars” (*Skin Game*). Quincy claims Jason looks like he's only worth four hundred, but Jason asks why he went for double then in two other cities, refuting, “I'm the same fella every time, so it must be the way you're making the pitch.” Realizing his weaker hand in this friendly fire session, Quincy points Jason toward the unshakeable difference between them by proposing, “Very next place we go to we'll switch places and you'll sell me.” The scene's lightheartedness becomes heavy, and the two men

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prepare for the rest of their journey, blank faced. While the two have a clearly convivial camaraderie, they cannot adopt a genuinely empathetic view of one another for most of the film. Jason does manage to get the upper hand on Quincy in another exchange when Quincy refuses to stop as they head into an untapped town. Jason hops off of the mule he rides and snidely says, "I tell you what, you go on in to town, and if I'm not there in a little while you just start the sale without me" (*Skin Game*). Jason's pointed proposal points toward the men's fiscal reliance on one another as dictated by their performative slave and master dialectic. The two men ride on in silence. But even in between performances, Quincy struggles to identify the ways in which his privilege surpasses that of his black friend. Jason struggles to identify with unfree blacks, and the men's irresolute issues with identification lead to an interracial signifyin(g).

Both men's roles as lifelong con-men position them well to signify, as they are occupational liars. Even in navigating their reasonably authentic relationship, demarcated by racial difference, they signify on each other because "words cannot be trusted, [...] even the most literal utterance allows room for interpretation" (Gates 16). The partners in crime depend upon one another, as do two people enacting the tradition of signifyin(g). Their engagement with this black form of vocalization unbinds Rogin's "white in blackface" trope, instead positioning Quincy in a distinctly black narrative tradition. The friends' discursive repartee points to the inextricable shades of difference in their black and white freedom. The humorous elements of signifyin(g) are pushed from clever exchanges to unfunny claims to privilege. Quincy attempts to marginalize Jason with his barbs, but then accesses a sense of self-seeing through their interaction. Jason does not ventriloquize Quincy's sense of self, but instead leverages their coded humor to reaffirm his own autonomy. In this sense, the black tradition allows Jason to use Quincy as a foil, but not a split self, to understand the complexities of his role as a black freedman. Jason does his most identitarian work during the unfunny intrusions of Quincy's privilege in their signifyin(g).

In spite of Jason's intellectual prowess, he has a jaded perspective on race for the first part of the film. His firsthand exposure to true slavery keeps him uneasy, as evinced in a scene in which Jason and Quincy watch a group of slaves in coffles led down a dirt road. Jason tells Quincy he would like to stop their ruse soon. Quincy agrees, promising the game will cease after one more sale in the next town. When they move on to their next target, they stay at the only available hotel, which forbids slaves from sleeping indoors. Instead, Jason must

stay in a livery stable. While in the stable, Quincy happens upon a young, attractive slave woman, Naomi, played by Brenda Sykes. In a peculiar scene, Jason finds himself immediately struck by Naomi's beauty. She reveals that she is to be sold in the next day's slave auction, and Quincy explains that being up for sale is not so bad, and begins to brag about his expertise in "the field of being bought and sold" (*Skin Game*). Interestingly, Jason chooses to maintain his posture as a slave, and his tactic of underplaying the slave market illustrates how little he sees the institution playing a role in his own subjectivity.

When Naomi reveals why she is up for sale, she demonstrates another alternative for black and white interaction. She explains that, "Young massa and me growed up together. Used to climb trees together. Used to play games together. We even used to get ourselves scrubbed in the same tub together." Naomi's master is recently married, and his new wife has demanded Naomi be sold. In a proceeding scene Quincy buys Naomi with Jason's money, and Naomi's remorseful master hands him her papers while stuttering, "She—she likes molasses and sweet potatoes" (*Skin Game*). The implied interaction between Naomi, her master, and Jason provides a notably progressive triangulation of affection. Jason and Naomi become lovers the first night they meet, and she states that she was never romantically involved with her benevolent master. The question of the authentic interracial relationship undergirds Naomi's relationship with her master as well—her unique position of naiveté conjures similarities to George's relation to Jonathan Polkinghorne's sexually devious motives in *Oxherding Tale's* Cripple Gate Incident. Bogart's film leaves open the narrative of contented slaves, and provides an ambiguous counterpoint to traditional narratives of black female slaves and their white masters. In contrast to the buddy dynamic between Jason and Quincy, Naomi's interracial relationship demonstrates its intricacies without signifyin(g) pretenses or comical relief. She explicitly emblemizes a particularly underwritten subjectivity from traditional slave narratives: the content slave with an outrightly benevolent master. While this may well be a viable subjectivity, Naomi's role engenders a static political role. As *Skin Game's* only vocal black female, she carries a domestic docility that restrains some of the film's progressive work. For all of the film's political work advanced by laughter and counterpointed unlaughter, the stiff gender roles of women are treated with a forthright seriousness.

Laughing 'til We Can't: Unlaughter's Echo

Johnson and Bogart's texts prompt laughter while pointing out the stark inequities and prejudices that link the slave moment with the

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1960s and '70s. One of the broader incongruities underpinning the entirety of *Oxherding Tale* is the disruption of the slave narrative as a narrative of spectacular black suffering. I use the word "spectacular" in the vein of Saidiya Hartman in *Scenes of Subjection: Terror, Slavery, and Self-Making in Nineteenth Century America*. Hartman emphasizes the literal spectacle of black suffering as represented in the "routinized violence of slavery," both through gruesome, macabre scenes in classical slave narratives and also the "mundane and quotidian" signs of repression woven into white leisure, such as the theatricality of the slave coffle and auction block (Hartman 17). White reader's potential pleasure in witnessing black enjoyment and black suffering in the nineteenth century is based around projections on to Othered bodies. In terms of violence, voyeurs (especially those trying to empathize with the slaves) could identify with the enslaved, but did so "at the risk of fixing and naturalizing the condition of pained embodiment" (20). Hartman suggests that this "naturalizing" reverses the intent of empathy, and "increases the difficulty of beholding black suffering" (20). The voyeur's attempt to impossibly imagine the slave's pain confirms a "spectral character of suffering" that pleasurably reifies the voyeur's position as not enslaved (Hartman 20). Johnson plays on scenes of subjection and the grotesque to invoke unlaughter by exaggerating racialized forms of female suffering, to uncertain effect.

Two scenes of suffering female bodies bookend *Oxherding Tale*. The first highlights Anna Polkinghorne's literal disintegration as she reflects on her sexual encounter with George. The second scene of suffering highlights Minty, the slave Andrew works to free throughout the novel, dying due to an illness acquired from her poor living conditions at various plantations. The scenes have the potential to serve as ironic foils—Anna's death poking fun at the hyper-virtuous mistress of the traditional slave narrative, and Minty's death showcasing the more routinized abasement of the female slave's body. However, the political effect of these vignettes' humor is dampened by Johnson's use of the female body as a target for hyperbolic bludgeoning. His satire transgresses the useful murkiness of unlaughter into a general commoditization of the female body. Johnson's hyperbole centers on the vulnerability of the female's capacity to reproduce racial progeny and property, and simply flattens female corporeality into unfiltered abjection.

The joking begins when Anna falls ill after her tacit admittance to enjoying sex with George. Although Jonathan gives up on loving Anna after her resentment ceases to lift, he still takes care of her during her sickness. As the narrator reports, "duty replaced his desire" for Anna

(Johnson 14). Anna's virtue has been violated, and she can no longer maintain the plantation mistress trope of looking askance at the sexual improprieties of her environment. Completely downcast because of her shame over miscegenation, her sickness progresses over five years, and Anna's eyes become "burnt-out" as she "cough[s] blood into her brass thunderpot, crepidations like the dry induviae of brittle leaves in the folds of her nightgown" (Johnson 14). This graphic rendering of Anna's bodily dissolution plays with the humor of incongruity. She is so ashamed of her evening with George that she becomes physically sick with shame, a reaction that counters the more expected response that George would be reprimanded or possibly even executed for his hypersexuality. Anna's abjection and overreaction equates miscegenation with a terminal disease. Gesturing toward Anna's enmity, the narrator describes a "fragile mass of living jelly," no more of a wife to Jonathan than "a stump of firewood" (14). The notion of "living jelly" plays on her corpulence and suggests the idea of putrefication. Choice images like "fragile jelly" and "firewood" in the context of this scene show Johnson's riskiness with diction. These concrete images deeply mock the proverbial matron of the plantation. In drawing a contrast with Minty, though, Johnson exacerbates this language even further, oversaturating the incongruity of the women's experiences. Johnson anticipates Hartman's suggestion of white, nineteenth century readers' fascination with "the exposure of the violated body" and pairs this normative expectation of the slave narrative reader with the concerns of miscegenation which pervaded the nation at the novel's inception, but he does not stop (Hartman 15).

After being purchased by the racially passing Andrew on a trading block, Minty suffers from the effects of untreated pellagra. In a show of true excess, Johnson describes how Minty's pellagra reduces the kindhearted woman to a literal disintegration. "Sugar in water," the narrator describes, "Form into formlessness. Her left leg had separated from her knee, floated away like that of a paper doll left in the rain [...] She had bitten off her middle finger" (Johnson 166). "Sugar in water" carries similar incongruity to death that "fragile jelly" does. Johnson deploys an onslaught of graphic images to describe her suffering, detailing her eyelids that "quivered, showing white surfaces gone gray. Milky pupils large as dimes" and "cracked lips sucked back against her gums" until she finally dies (Johnson 167). A "gush of black vomit" indicates the moment "[t]he Devil came and sat on Minty, his weight pressing open the valve to her bladder and bowels" (Johnson 167). This disturbing scene revolves around Andrew watching the woman he would have married—in fact, the very reason he is passing literally dissolves

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into a mess from slavery. As he learned at the coffle, Minty's time moving from household to household undervalued and undernourished has reduced her to a dying state.

Minty's dilapidation is based in a more serious and probable context of slave suffering, but the actual act of Minty dying is strangely rendered. The language and imagery are at once graphic and tonally incongruous. Aside from Minty's entire process of dying as being like sugar in water, the childlike image of a paper doll losing its knee seems to bear more lightness than the literal loss of a knee ought to. Ultimately, in spite of their reductive use of female bodies, Minty's death and Anna's sicknesses can be read as ironic foils—Anna suffers as an abject figure of embarrassment while Minty suffers at the hands of her slave owners. While the two women both face inequities in the novel, Johnson probes their dichotomous positions as relationally funny. However, the gross exaggeration of Anna's sickness pales in comparison of severity and logical rationale to Minty's death, and certainly prompts a consideration of their contrasting situations.

While Johnson ironizes the corporeal in the figures of Bannon, Anna and Minty, black vocalization becomes the object of unlaughter in *Skin Game*. Jason slips in and out of a stereotypical slave dialect and a refined New Jersey diction, depending on if he's posing as a slave or not. This code switching serves as a common trope for laughter throughout the first half of the film. While in Kansas, Jason and Quincy find that Jason "passing" as a slave must stay in a barn overnight. After a night in the barn, Quincy, joined by Ginger, a redheaded, blue-eyed thief with whom he's smitten, enters the barn while Jason's back is turned. Quincy offers Jason breakfast, and Jason sardonically begins "Ah ha! Don't tell me that aside from providing a breathtaking panorama of a horse's ass that this fine ol' establishment also provides offering him br—" He breaks off when he turns around and notices Ginger, then howls, "—LAWDEEE Marse Quincy! Dey ain't nooobody treats his po' black folks betta den he does. Yessuh. Brought dese biscuits all de way down heah so a body don't starve. Mm mm mm. Now that sho' is a powerful big heart, and dat's de truth" (*Skin Game*). Quincy waves off Jason's act, and explains that Ginger knows about their scheme. Ginger, though, implores Jason not to stop the thick code switching, for he is "very good at it." While Jason's exaggerated slave dialect serves as a humorous schtick begat by minstrel memory in the film, he later becomes separated from Quincy and is legitimately sold to the malicious Harry Calloway's (Andrew Duggan) plantation with no escape in sight.

Jason's agency in code switching moves from humorous to devastating in his first interaction with his new slave master. Stressing

his volubility and congeniality, Jason tries to rationalize his way out of slavery by explaining that his sale to Calloway is a “grievous injustice” and that how he arrived in such a “wretched condition is a story as vile and sordid as any you might imagine.” As Jason continues his loquacious plea, Calloway responds with incredulity and seeming awe, saying, “That’s the goddamndest thing I ever heard.” Jason offers to reimburse Calloway for his purchase plus interest in exchange for his freedom. Ignoring the offer, Calloway reiterates, “The goddamndest thing I ever heard—” but this time he continues, “I never heard a nigger talk like that.” As Jason begins to explain his origins from New Jersey, Calloway caustically interrupts, proclaiming, “If I ever hear it again I’m going to blow your black ass off. Understand me, boy?” Jason’s code switch kicks in with prompt abjection, “Yassuh boss, shooooo do.” Despite Jason’s acquiescence, Calloway has him flogged fifty times.

During this moment of terror, Jason’s accent loses its comic effect. Until Jason’s exchange with Calloway, his ability to code switch ironically serves as one of his most useful abilities. In prior interactions between the performative Jason and white characters, tension is derived from the possibility that one of his dupes will see through Jason’s performance. The tension amasses until resolution occurs and Jason comes away safely with his buyers’ money. Until Calloway, laughter as cathartic release is inevitable, as the protagonist stays safe and continues to pull the wool over the eyes of plantation owners and other racists. But once Jason exposes his authentic voice and the ruse is exposed to Calloway, the biting reality of their racial dynamic is brought to the fore. Calloway is an unapologetic bigot who can, ironically, only see Jason’s proper dialect as a performance. The reality of prejudice supersedes Jason’s agency as a passing slave, and his powerless, faux-dialect becomes pitiable. This is the moment of unlaughter. For the first time, a white person on screen refuses to acknowledge Jason the freedman’s personhood, signified by his true accent, and his immobilization forces Jason to succumb to a slave status to which he was not born.

In recognizing the delimiting effect of Jason’s skin color on his role as the lionized protagonist, laughter at his performance subsides. The Calloway scene demonstrates how the empathetic repression of laughter operates well within the realm of the neo-slave aesthetic. Due to Jason’s position from the opening scenes as both protagonist and a black freedman, the narrative arc of the film is oriented around his experience. As a result, Jason’s interaction with his network defines his agency, and also garners a sense of social relations for a freedman in 1857. Jason is comfortable with Quincy, comfortable with Ginger once she joins their fold of mischief, and talks often of New Jersey—a state where he is free

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to pursue his whims. Jason's interactions with the white slaveowners preceding Calloway come through as purely performative and thus, an inauthentic mode. In a sense, his authenticity and personhood is defined by his gregarious yet constantly analytical frame of mind. It is Jason who constantly reminds Quincy of their unequitable roles in society, from the film's start to the film's end, and an moment of unlaughter that even occurs for Jason shifts his own way of seeing his performance. Now in a safe locale, Quincy asserts he and Jason are, "like enough to be brothers." Quincy's final words of the film come when he rebuts, "Except for one little thing, one small little difference. And because of that, I can be bought and sold like a horse, and you can do the buying and the selling" (*Skin Game*). For the first and only time in the film, Jason claims his disadvantage and illuminates his Otherness.

Jason's sense of identity and the textured revelations Andrew gains about black social mobility underscore manifold possibilities for black subjectivities during the slave moment. Many of the possibilities and limitations for mobility are centered on stereotypes in requisite characters like the obsequious Uncle Tom or the carnal Mandingo, who bear trace appearances in these revisionist scenes. But the literal embodiment of such tropes through corporeal manipulation and black vocalization show how these stereotypical subjectivities can be both subverted and reinforced. These neo-slave humorists reveal the insurgent potential in re-envisioning the role of the black body and the amplification of the black voice in history. Unlaughter demonstrates that when stereotypes are upended, stretched, and reapplied to other races, they can be de-essentialized. Ultimately, neo-slave humor locates and magnifies the antiquated roots of sentiments that sustain racial civic estrangement today. Through this identification, the neo-slave narrative does insurrectionist work, reimagining and at times re-enfranchising black bodies and black voices.

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Gender Rights and Unionization in the Maquiladora Sector

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Abstract

Does foreign direct investment lead to female empowerment or female exploitation? I address this question by analyzing how the maquiladora program, manufacturing operations based in Northern Mexico that employ large numbers of women, operate in free trade zones. I argue that the culture of patriarchy produces new forms of female exploitation in the workplace. I conducted an extensive review of available literature and news media, as well as logit models testing personal freedom, reproductive freedom, and sexual violence in the home. My findings indicate that while occupation has no direct effect on empowerment, increase in income does improve personal freedom but can also lead to male backlash. Despite increased wages and economic independence, along with increased life satisfaction among women who are young, single and childless, those with families often find themselves facing a double burden of having to work and fulfill their traditional domestic responsibilities. Such women are often made to feel guilty for not spending enough time with their children and some endure sexual intimidation both at work and at home. In addition, maquiladora work is dis-empowering for both childless women and mothers because of patriarchal relations in the workplace that lead to isolation and a lack of self-identity (i.e. conscious awareness of the self as having a unique identity). For example, women face forms of harassment, including questions regarding their sexual practices, pregnancy screening prior to employment, sexual objectification embodied in the occurrence of workplace beauty contests, sexual propositioning and unsafe working conditions. As a result, women are less likely to unionize and tend to accept work conditions men are less likely to accept.

Introduction

In the mid-1960s, the Mexican government launched the Border Industrialization Program, also known as the Maquiladora Program, to combat rising unemployment along the northern border (Kamel, 1988; Grimm, 1999). Maquiladoras are manufacturing operations in free trade zones where raw materials are imported duty free and tariff free, and then the manufactured products are re-exported, sometimes back to the same country from which the raw materials originated. In Spanish, the term maquiladora refers to millers charging a *maquila*, or "miller's portion" for processing other people's grain. Through these foreign-

owned factories, developed countries are able to take advantage of cheap labor and mass produce consumer goods for their domestic markets, thus creating high profits for international capitalists (Cypher, 2010).

Maquiladoras expanded at a steady pace during their first thirty years, a process only deepened by the passing of the North American Free Trade Agreement (NAFTA) in 1994 (Westfall, 2009). Traditionally these factories have been concentrated along the northern border region, although in recent years they have also begun to predominate in other parts of Mexico (Kamel, 1988). Since 1996, they have been the second largest industry in Mexico behind petroleum (Peters, 1990). Prominent companies include Ford, GM, IBM, GE, Whirlpool, Motorola, Honeywell, Mattel and Bose. 80 percent of this billion dollar industry is owned by the United States (Pantaleo, 2006).

There are currently over 1.3 million Mexicans employed in approximately 3,000 maquiladoras. The majority are women, usually between the ages of 18 and 24, although some are older, and some are as young as 12 (Mexican Labor News and Analysts, 1999). The essence of this industry is to free international capital from having to pay wages that would likely be paid in advanced industrial nations, even as the complex combination of machinery, technology and organization bring extremely high levels of labor productivity and allow high-value-added activities to take place in the offshore profit centers chosen by transnational corporations (Cypher, 2010). Maquilas' financial structures are designed so that they are deemed cost centers rather than profit centers, meaning their account books are set up such that the Mexican subsidiaries show virtually no profits (Kamel, 1988). By allowing this practice, the Mexican government enables the maquilas to subvert its own law requiring 10% of all corporate profits to be distributed among workers. In this industry, laws surrounding issues such as employee benefits, severance pay and unionization also remain largely unenforced (Petros, 2006).

Over the years, maquiladoras have proven quite controversial. While some claim that they bring better paying jobs for low-educated, low-income women than those to which they would otherwise have access, others decry them as centers of crude exploitation.

Theoretical Framework

In order to approach this study I used the neoclassical tradition of economics as a reference. Neoclassical theorists would contend that liberalizing trade and opening the door to increased foreign direct investment (FDI) would be the most effective way to empower marginalized groups. From this standpoint, the thinking is that first they

will become economically empowered, and then, as a result, what should follow will be political and social empowerment. According to this perspective, concerted action by a government is deemed unnecessary for ensuring social justice, even for those groups with long histories of abuse and discrimination, because markets and economics will accomplish this without interference.

The alternative hypothesis, however, which I support, is that liberalization will instead lead to the further exploitation of vulnerable social groups. A "race to the bottom" may occur where governments allow deplorable conditions to perpetuate due to their desire to attract FDI and avoid turning away corporations by demanding better conditions which could potentially increase costs. Indeed, Mexico has one of the most progressive labor codes of any country, yet in the case of maquiladoras the government has willingly obliged to refrain from enforcing it.

That reluctance to enforce decent labor standards has resulted in extremely difficult conditions, particularly for women, inside maquiladoras. In Mexico, as in all countries, globalization in part entails the acclimation of capitalism, with its requisite division of labor, into a society's preexisting social hierarchies. Capitalism and gender exploitation are closely intertwined, and there are a number of gendered power complexes characterized by male domination and female subordination (Wilson, 2003). This includes patriarchy grounded in patrimony, a male gerontocracy (i.e. the oligarchical rule by a few who are significantly older than the general population) and extended family structures. There is also neopatriarchy, based on a male breadwinner and a nuclear family, and Phallocentrism, a machista reaction partly representing male backlash to women's increasing economic independence. Each of these gendered power complexes interconnects with capitalism in multiple ways.

Maquiladoras and Female Labor

Maquiladora work in Mexico continues to reflect the societal norms of patriarchy and male control over women that exist in Mexican culture, which is evident in the gendered division of labor. Men occupy the majority of supervisory and leadership positions, and women generally work in jobs that receive lower wages, less respect and that are set in poorer working conditions. There are also reports of what is termed "lay down or laid off" whereby a male in a supervisory position threatens loss of a female employee's job if she refuses his sexual advances.

Kalm (2001) finds that the relationship between maquiladoras and the female labor force is mainly one of exploitation, but not exclusively.

There are some positive reports, which although sparse are still worth noting. Some women say they gain a sense of satisfaction from their work. Those tend to be women who are young, single and childless. Some believe this work is contributing to changing gender roles, enabling women to obtain jobs and become more economically independent. They assert that maquiladoras present better economic opportunities than elsewhere and wages comparable to men amongst different sectors (Villareal and Yu, 2007). The maquila system has greatly increased the number of women bearing family and breadwinning responsibility. Also, increased economic independence may allow females the ability to leave bad relationships.

The claim that maquiladoras present better economic opportunities for women has, however, been problematized, and in some cases outright disproven, by other expansive research taking into account longer time horizons and the heterogeneity of employment sectors (Braunstein, 2006; Dominguez, 2010). Also, women with families often find themselves facing the double burden of having to work and fulfill their traditional domestic responsibilities, which do not diminish with the acquisition of employment. Mothers are often made to feel guilty for not spending enough time with their children. Also, women are placed in unsafe and unhealthy working conditions, and then made to feel at fault if they have an accident. They are given tougher work assignments that men are less disposed to accept. Many women interviewed had chronic pain or illness caused by the work conditions, and it is common for females under the age of 30 to suffer from arthritis or rheumatism. Close study revealed that maquiladora women are three times more likely to have low birth-weight babies and three to five times more likely to have babies that suffer from anencephaly (Kagan, 2005). Studies have also linked a high rate of mental retardation in children of maquiladora women to exposure of mothers to PCB.

Patriarchal relations in the workplace can lead to isolation and lack of self-identity. Females are questioned about their sexual practices and forced to take pregnancy tests prior to employment (Kagan, 2005). If a woman should become pregnant shortly after being hired, a manager may reassign her to more physically difficult work or make her work overtime in an effort to force her to resign. This is likely to avoid Mexico's labor law that provides six weeks of paid maternity leave prior to a woman's delivery date, and another paid six weeks following delivery. The UN recognizes the human rights to privacy, non-discrimination, and to decide freely and responsibly on the number and spacing of one's children, of which these aforementioned occurrences are a clear violation.

Other harassment includes sexual objectification in the embodiment of workplace beauty contests for the entertainment of workers and direct sexual propositioning. There are also many reports of rape. In addition, Mexico is currently in a state of chaos with the drug civil war, among other problems. One of the most dangerous times for people is when they go to and from work, and there is research suggesting that maquiladora work leads to women being murdered (Wright, 1999; Arriola, 2005).

Late human rights' activist Gary MacEoin, who spent his life advocating on behalf of workers throughout the developing world, once said of maquilas: "Few survive the unhealthy working conditions, poor ventilation, verbal abuse, strip searches, and sexual harassment for more than six or seven years." The discrimination in this industry continues due to a confluence of interests and needs: the economic interest of maquiladora operators to keep their operating costs as low as possible, government interest in attracting FDI, and women's desperation for jobs.

Currently there is a fight to unionize maquiladoras and correct the terrible conditions within them, which has met with some resistance by the government. Despite the corporatist state's willingness to use gun-toting thugs to intimidate female workers, an insurgent movement cutting across multiple constituencies and interests has sought to educate and develop class consciousness among workers and bring about social transformation (Hennessy, 2002).

Measuring Women's Empowerment

A quantitative analysis measuring women's empowerment was conducted using 2003 survey data from the Mexican government¹. We selected three foci: 1) personal freedom, 2) control over contraception and 3) forced sex acts. We ran three separate models, one for each of these three criteria. These measures were selected based on a combination of assessing both the 12 UN-designated critical areas of women's empowerment as outlined in The Beijing Platform for Action (Moghadan and Senfton, 2005), as well as the purposes of this project specifically.

Personal freedom was measured by whether or not a woman taking the survey needed to ask her husband or partner's permission to undertake certain activities. There were five such activities questioned as follows:

¹ Instituto Nacional de Estadística y Geografía

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- 1a) If you want to work for pay...
- 1b) If you want to go shopping...
- 1c) If you want to visit your relatives...
- 1d) If you want to visit friends...
- 1e) If you want to go to parties...

The five possible responses to each question were:

- 1) I must ask permission
- 2) I must notify
- 3) I do not have to do anything
- 4) I do not, will not go alone, we go together, other
- 5) No response

Control over contraception was measured based on answers to the following survey questions:

- 2a) Who decides on contraception use?
- 2b) Who decides on methods used?
- 2c) Who decides on who uses methods?

The four possible responses were:

- 1) Not applicable
- 2) I decide
- 3) My husband or partner decides
- 4) Other people

And with the third measure, sexual violence in the home was captured in the question:

- 3a) Has your husband or partner forced you to do sex acts in the last 12 months?

The two possible responses were:

- 1) Yes
- 2) No

Numerous controls were also implemented including age, marital status, education, household amenities (radios, blenders, etc.), drainage, electricity, total residents in the household, income level and whether or not the respondent's husband or partner works. We divided our

independent variable, occupation, into five categories:

- 1) Unemployed
- 2) Professionals
- 3) Artisans
- 4) Semi-skilled
- 5) Maquilas

For our purposes the main concern is the difference in empowerment between women who stay at home (our base category Unemployed) versus those who work, and hence, differences in empowerment amongst the different types of work.

As recent scholarship has pointed out, cultural forms connect the private with the public sphere. In many developing countries where there is growth of manufacturing operations employing large numbers of females, the socialization processes which take place in the home and teach women to be docile and subservient to male household members (fathers, brothers, husbands, etc.) carry directly over to the male supervisory figures in the workplace. The inference in our analysis is that a woman more empowered at home would also feel more empowered to stand up for her rights in the workplace. Therefore, by measuring the at-home experiences of women in various occupations, we put to the test the idea that maquiladora work empowers women.

There were 23, 875 observations total. Our null hypothesis is that occupation has no effect on female empowerment. Occupation was treated as a non-ordered factor.

For the first measure, personal freedom, an ordered logit model (Table 1) was used treating personal freedom as an ordered variable, i.e. the more activities for which the woman did not need to ask permission the higher her score.

Table 1. *Personal Freedom.*

Variable	Value	Std. Error	t value
WOMAN'S PAY	-0.148780	0.258565	-0.57541
PROFESSIONAL	0.048931	0.257246	0.19021
ARTISAN	0.090599	0.275792	0.32850
SEMI-SKILLED	0.038286	0.258300	0.14822
MAQUILAS	-0.133440	0.263564	-0.50629
INDIGENOUS LINGUAG	0.000376	0.028154	0.01334
INDIGENOUS LGE SPSE	-0.012460	0.029784	-0.41840

MONEY RECEIVED/ PRTNR'S WRK	0.068096	0.023505	2.89708
HUSBAND'S WORK PAID OR UNPAID	-0.241630	0.058051	-4.16244
PAY RECEIVED FOR HUSBAND'S WORK	0.012131	0.014376	0.84386
TOTAL RES	0.028303	0.009217	3.07084
AGE	0.065604	0.012781	5.13287
MARITAL STATUS	-0.038140	0.038671	-0.98615
SCHOOLING LVL	0.041201	0.007931	5.19478
TYPE	-0.304800	0.043338	-7.03308
DWELLING TYPE	-0.103180	0.057997	-1.77904
WATER	0.132536	0.062642	2.11578
SERVICES	-0.003220	0.033812	-0.09522
GOODS	0.070638	0.010635	6.64208
DRAINAGE	-0.064680	0.053224	-1.21526
EXCLUSIVE KITCHEN	-0.011140	0.017312	-0.64370
BEDROOMS	-0.025450	0.019101	-1.33263
HOUSEHOLDS/GROUPS	0.132268	0.108537	1.21865

In essence, with an ordered logit we are making an assumption that there is a latent continuous variable, in this case for personal freedom, which we cannot measure, and so thus we measure in cruder categories and cut-off points through the proportional odds model (figure 1), transforming our interpretation of those results. This is the ordered log-odds estimate for a one unit increase in personal freedom score on the expected professional level given the other variables are held constant in the model. Using the third row, professionals, as an example, if a subject were to increase her personal freedom score by one point, her ordered log-odds of being in a higher personal freedom category would increase by 0.04 while the other variables in the model are held constant. The signs of the coefficients tell us the directional relationship.

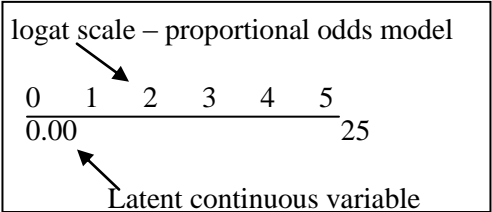


Figure 1. Ordered logit model assumption.

As seen in the first model, moving from unemployed up to professional or semi-skilled marginally improved freedom, and moving to artisan had the biggest improvement. Moving to maquila work was the only one to have a negative impact, but none of these aforementioned changes were statistically significant. What is statistically significant is that the higher a woman's income, the more likely she'll experience increased freedom. If her husband works the probability that she will experience less freedom increases by 25%. $P=0$ indicates that we did indeed explain the variance. $R^2=0.03$ indicates that the variables selected explain about 3% of the variance. There is not enough evidence to reject the null hypothesis that occupation has no effect.

For the second measure, control over contraception, a binary logit model (table 2) was used. The z-value tells us, from 0-1, whether or not the null hypothesis is true. Here, with occupation, the coefficients are moving in the direction we might expect but are not statistically significant. What was statistically significant was that if a woman worked, she was more likely to have control over contraception. If her husband works, however, it decreases the likelihood that she has exclusive control, but the more he earns increases the higher the chance that she has control.

Table 2. *Control over Contraception*

Variable	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	1.957	0.602	3.253	0.001	**
WOMAN'S PAY	0.108	0.286	0.377	0.706	
PROFESSIONAL	0.194	0.285	0.679	0.497	
ARTISAN	0.213	0.303	0.704	0.482	
SEMI-SKILLED	0.095	0.286	0.333	0.739	
MAQUILAS	0.052	0.289	0.180	0.857	
INDIGENOUS LANGUAGE	0.030	0.029	1.050	0.294	
INDIGENOUS LANGUAGE SPOUSE	0.024	0.031	0.774	0.439	
MONEY RECEIVED FOR PARTNER'S WORK	0.019	0.025	0.741	0.459	
HUSBAND'S WORK PAID OR UNPAID	-0.366	0.064	-5.705	1.17E-08	***
PAY RECEIVED FOR HUSBAND'S WORK	0.049	0.015	3.316	0.001	***
TOTAL RES	0.0189	0.010	1.958	0.050	.

AGE	-0.764	0.015	-50.578	< 2e-16	***
MARITAL STATUS	0.053	0.040	1.339	0.181	
SCHOOLING LVL	0.067	0.009	7.876	3.37E-15	***
TYPE	-0.056	0.042	-1.335	0.182	
DWELLING TYPE	-0.074	0.064	-1.160	0.246	
WATER	0.204	0.059	3.441	0.001	***
SERVICES	-0.068	0.036	-1.923	0.055	.
GOODS	0.083	0.011	7.631	2.34E-14	***
DRAINAGE	-0.023	0.052	-0.451	0.652	
EXCLUSIVE KITCHEN	-0.008	0.017	-0.481	0.631	
BEDROOMS	-0.019	0.020	-0.954	0.340	
HOUSEHOLDS/GROUPS	-0.173	0.118	-1.466	0.143	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

For the third measure forced sex acts, an ordered logit model was once more conducted (Table 3).

Table 3. *Forced Sex Acts.*

Variable	Value	Std. Error	t value
WOMAN"S PAY	0.47467	0.73097	0.64937
PROFESSIONAL	-0.17406	0.72874	0.23885
ARTISAN	0.33465	0.78375	0.42699
SEMI-SKILLED	-0.13901	0.73068	-0.19025
MAQUILAS	-0.20432	0.74139	-0.27559
INDIGENOUS LANGUAGE	0.03493	0.07597	0.45976
INDIGENOUS LANGUAGE SPOUSE	-0.11375	0.07498	-1.51697
MONEY RECEIVED FOR PARTNER'S WORK	0.11011	0.06771	1.62621
HUSBAND'S WORK PAID OR UNPAID	0.47813	0.15911	3.00513
PAY RECEIVED FOR HUSBAND'S WORK	-0.02349	0.04122	-0.56993
TOTAL RES	-0.08339	0.02492	-3.34586
AGE	0.14059	0.03594	3.91177
MARITAL STATUS	0.21959	0.10304	2.13105

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SCHOOLING LVL	0.10150	0.02365	4.29235
TYPE	0.15182	0.11291	1.34460
DWELLING TYPE	-0.06663	0.16900	-0.39423
WATER	-0.17463	0.16028	-1.08952
SERVICES	0.08869	0.09589	0.92489
GOODS	0.06102	0.02896	2.10728
DRAINAGE	-0.01226	0.13687	-0.08958
EXCLUSIVE KITCHEN	0.04604	0.04804	0.95818
BEDROOMS	0.06313	0.05347	1.18067
HOUSEHOLDS/GROUPS	0.14309	0.30007	0.47684

Maquila work has a marginally negative effect but is not statistically significant. What is statistically significant is that the more money a woman makes, the more likely she is to have been forced into sex acts. Also, perhaps surprisingly, if she is older, married, or more educated she is more likely to have been forced into sex acts. Quantitative data seems to support the earlier qualitative information about the existence of male backlash to women's increasing independence, indicating it to be more than merely a localized phenomenon.

Across all three of our models, there is insufficient evidence to reject the null hypothesis that occupation has no effect on women's empowerment. The woman's occupation does not matter for empowerment. If there is an occupational effect it operates through income. One maquiladora worker only provides 19.8% of what a family of four needs to live on (Westfall, 2009). Therefore, it is little surprise that the maquila occupation shows so little impact in the way of empowerment. What matters the most is a woman's education, and whether or not her husband works.

Conclusion

There is little statistical evidence that maquila work does or does not empower women. There is, however, strong evidence of male backlash. As a woman's income, age, education and household goods increases, her personal freedom also increases, but so does the likelihood of her having been forced into sex acts. Also, the persisting centrality of a male as breadwinner is evidenced, as inferred by the fact that a woman's personal freedom increases along with her income, yet having a husband employed increases by 25% the probability that she experiences less freedom. For women's empowerment, cultural factors such as the

attitudes and education of men, and their beliefs about what is acceptable treatment towards women may be what matter the most. Therefore a similar statistical testing of women's empowerment correlated with the educational level and surveyed personal opinions about gender roles espoused by the corresponding male population may serve as a logical focal point for further research.

Neoclassical theorists are fond of emphasizing the power and non-discriminatory nature of markets. While the idea that economic empowerment is the key to fulfill the social and political empowerment of marginalized social groups may seem compelling for some, it simply does not hold up to the observable data. For women in Mexico, having long endured severe oppression within a culture of male domination and machismo, economic opportunity is surely a necessary prerequisite for empowerment. To claim, however, that it is all that is required to accomplish that end, without other attitudinal changes or the government enforcing their basic rights is a whole different matter entirely.

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Developing a Municipal Digital Inclusion Plan for the City of Seattle

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Abstract

Digital inclusion is the ability of individuals and groups to access and use information and communication technologies. Despite the City of Seattle being home to a thriving technology sector, many disadvantaged and underserved residents are excluded from participating in its digital economy. This negatively impacts their ability to find jobs, succeed in education, and access vital services and information. High-tech cities like San Francisco, Philadelphia, and Chicago already have digital inclusion plans adopted by their municipal government, whereas the City of Seattle has yet to create its own. This research extends the University of Washington Technology & Social Change Group's framework for building digitally inclusive communities to create a digital inclusion plan for the City of Seattle. This project involves reviewing literature on existing municipal plans, interviewing relevant city officials, and inquiring how a municipal plan intersects with state and federal strategies. The developed plan will be presented to the Mayor and City Council for hopeful adoption and to offer improved direction for citywide businesses and institutions to fully participate in the City of Seattle's 21st century digital economy.

Background

Digital inclusion is the ability of individuals and groups to access and use information and communication technologies. Digital inclusion encompasses not only access to the Internet but also the availability of hardware and software, relevant content and services, and training for the digital literacy skills required for effective use of information and communication technologies. Inclusion seeks equity for all residents, as well as small businesses and community-based organizations.

The skills necessary to work, prosper and participate in current society are tied to the ability to use information and communication technology (ICT) tools. Individuals without Internet access or the knowledge to use computers and the Internet are disadvantaged when trying to complete online applications for jobs or postsecondary education opportunities without online access. Digital inclusion is a critical component to the growth of the City. The community's vibrancy, personal quality of life, economic viability, and business competitiveness depend on it.

Seattle's Current Digital Inclusion Strategy

Information Technology Access and Adoption

The 2009 Information Technology Access and Adoption report presents the findings of the City of Seattle's latest residential information technology survey. The City's survey and focus groups confirm that Seattle continues to be a leading city in the deployment and adoption of information technologies, but that it also continues to have a troubling lack of digital equity for all residents. Since their 2000 and 2004 surveys, Seattle has made great strides in the adoption of computers, higher speed Internet and cell phones. There is also much greater use of the applications and services that enable people to stay in touch, learn, work or obtain essential services. There is growing use of mobile Internet devices and of social networking tools. Seattle has an increasingly technology-skilled and broadband-using populace, which also has a need and a desire for faster and affordable broadband services.

Information Technology (IT) Indicators Project

The City of Seattle Department of Information Technology developed a set of technology indicators through the Department of Information Technology (DOIT) with significant participation from a wide range of interested residents, including technology, education and community leaders. Information Technology is a growing sector of the City's economy, although it faces a hurdle in growing a local diverse workforce to meet the need. IT has also become an important tool for community and non-profit organizations despite the fact that the applications and infrastructure for these organizations are still emerging. The DOIT was surprised at the degree to which Seattle residents are already connected and using IT for local business, civic and personal activity. This shows that there is a large population available electronically, which has already impacted City government outreach strategies and should impact marketing strategies for all sectors. However, this project confirms that citizens need to stay very aware and continue to move to address the significant disparities in levels of opportunity for different populations.

Digital Inclusion Programs and Services

These are a few snapshot examples of the range of digital inclusion programs available to help vulnerable residents with technology skills and adoption (refer to appendix). These community programs provide combinations of training in technology skills and use of online services, computers for the home, low-cost Internet services, technical support and support for other learning, such as job skills or

academic help. Technology training programs are offered in a range of settings, including public community centers, senior centers, libraries, immigrant/refugee organizations, a variety of multi-service social service agencies, and special media training centers.

Broadband Deployment

In 2010, the Citizens Telecommunications and Technology Advisory Board (CTTAB) urged the Mayor and the Council to bring a Fiber-to-the-Premise network to Seattle. Access to a broadband internet connection at all premises in the city is the critical technology that enables Seattle's citizens, businesses and institutions to compete and thrive in the global marketplace. CTTAB envisions access to the internet for all Seattle citizens, businesses, and institutions that is fast, fair, and everywhere. Achieving that vision required the City to create a Fiber-to-the-Premise (FTTP) network. A city-run FTTP network provides superior speed, offer users more options, and provide equal opportunity to internet access across all Seattle neighborhoods.

Digital Inclusion Plans Elsewhere

Digital Inclusion beyond Seattle

According to the Pew Internet & American Life Project, approximately four out of five American adults are online in 2012. In less than 10 years, the Internet has fundamentally transformed how people work, shop, educate children, communicate, and even date. However, a quarter of the population remains offline. Among some populations—low-income families, minorities, people with disabilities and seniors—many more than a quarter are offline. Even for those getting online, a new divide is opening, as broadband speed becomes more important for new media, and those with only low-speed access are again left behind.

This is a critical problem. The growth sectors of the economy—IT, finance and insurance, health care and education—are highly dependent on electronic communications. Digital literacy is becoming as important as reading, writing and math. Increasingly, those without computer skills or access to high-speed Internet service need not apply. The digital divide is not just a problem for the excluded: everyone has a stake in closing the digital divide. Common sense suggests that inclusive economies and societies do better. Improving the information resources and networks of lower-income communities helps those communities, but it also opens up new markets for business, expands the supply of labor, provides new sources of entrepreneurial energy, and reduces the costs of poverty.

The National Broadband Plan

The National Broadband Plan, released by the Federal Communications Commission in March 2010, noted “absent action, the individual and societal costs of digital exclusion would continue to grow.” The Plan’s recommendations outlined ways the federal government can influence the broadband ecosystem, as well as included a call to the Institute of Museum and Library Services (IMLS) to provide leadership to libraries and community-based organizations as they improve digital adoption and use. The Proposed Framework for Digitally Inclusive Communities is IMLS’s initial response to that request.

The Institute of Museum and Library Services, in cooperation with the University of Washington’s Technology and Social Change Group and its partner International City/County Management Association (ICMA), is working to convene representatives from libraries, community-based and non-governmental organizations, business, and local government — ensuring broad participation in the process of identifying the principles, elements, and characteristics of organizations and communities that foster digital inclusion. The resulting framework will be a first step toward the development of benchmarks and guidelines to help libraries and community-based organizations assess their needs for public-access workstations, portable devices, and bandwidth. This work is sponsored by IMLS as part of its effort to address the recommendations of the National Broadband Plan.

Comparing Existing Government Digital Inclusion Plans and Strategies

Table 1. Matrix of existing digital inclusion plans.

AREA	DOCUMENT TITLE	REPORT HEADINGS	STRATEGIC AREAS (TASCHA FRAMEWORK PRINCIPLE)
Chicago, Illinois, United States	The City that Networks: Transforming Society and Economy Through Digital Excellence (2007) http://echicago.illinois.edu/2011backgddocs/CityThatNetworks2007.pdf	Acknowledgements, Foreword, Table of Contents, Executive Summary, Background Context, Considerations, Recommendations, Conclusion, Glossary	Availability, Affordability, Civic Engagement, Public Access, Education, Social Connections
Philadelphia, Pennsylvania, United States	Digital Inclusion Program: Final Report of the	Executive Summary, Table of Contents,	Availability, Affordability, Digital Literacy,

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	Rapid Assessment (2008) http://www.ntia.doc.gov/legacy/broadbandgrants/comments/6E3B.pdf	Introduction, Lessons Learned, Evaluation Findings, Summary Assessment, Stakeholder Interviews, Interview Protocols, Recommendations, Focus Group Guide	Public Access, Relevance
Los Angeles, California, United States	Digital Inclusion Strategy for the City of Los Angeles (2008) http://clkrep.lacity.org/onlinedocs/2007/07-3367_rpt_ita_10-14-08.pdf	Legislation Information, Message to the City Council, Discussion, City of Los Angeles Digital Inclusion Programs, Summary, Recommendations	Availability, Affordability, Public Access, Consumer Safety, Civic Engagement, Health Care, Public Safety and Emergency Services
Minneapolis, Minnesota, United States	Wireless Minneapolis Digital Inclusion Task Force: Final Report (2006) http://www.digitalaccess.org/documents/MDITF%20complete.pdf	Executive Summary, Table of Contents, Introduction, Digital Inclusion Initiative, Task Force Findings, Appendices, Participant Biographies, Stakeholder Responsibilities, Vision Statement, Map of Area Community Technology Centers, Recommendations	Availability, Affordability, Digital Literacy, Public Design for Inclusion, Relevance
San Francisco, California, United States	Digital Inclusion in San Francisco (2007) http://sfgov3.org/ftp/uploadedfiles/digital_inclusion/reports_publications/UCBDigitalInclusionReport060282007_Final.pdf	Table of Contents, Introduction, Scope, Current State of Digital Inclusion Efforts, Gaps Analysis, Programming Tradeoffs, Recommendations, Benchmarks,	Civic Engagement, Consumer Safety, Education, Economic and Workforce Development

		Suggestions, Appendices	
Wales, United Kingdom	Delivering Digital Inclusion: A Strategic Framework for Wales (2010) http://www.communities.gov.uk/documents/communities/pdf/1001077.pdf	Introduction, Shared Vision, Framework, Barriers, Current Initiatives, Evaluation	Education, Economic and Workforce Development, Public Safety and Emergency Services, Social Connections

Federal, State, and Local Efforts

Historically, the federal government has supported Internet adoption through efforts that are part of broader programs. The American Recovery and Reinvestment Act of 2009 (Recovery Act), in addition to funding broadband deployment, marked the first large-scale federal broadband adoption effort. A minimum of \$450 million within the National Telecommunications and Information Administration’s (NTIA) Broadband Technology Opportunities Program (BTOP) was set aside for sustainable broadband adoption programs and public computing centers.

While the federal government has provided important financing for Internet adoption efforts, Tribal, state and local governments are often in the best position to identify barriers and circumstances unique to their communities. State leaders can play an important role by building on existing social programs and partnering with community organizations that non-adopters already rely on as trusted sources of information. They can tailor adoption efforts to address language barriers, lack of credit, low basic literacy levels and other issues faced by non-adopters.

The City of Seattle has a number of ongoing digital inclusion initiatives including: The Bill Wright Technology Matching Fund which funds community-driven technology projects; promoting public access terminals in public places; Puget SoundOff, a youth-driven online portal to promote civic engagement and digital skills; and, Seniors Training Seniors in Technology, a peer education program helping seniors learn basic computer and Internet skills. States and municipalities across the country are working on specific efforts to increase adoption and utilization of broadband. Through local action, coupled with federal support, America can connect people with technology to improve their lives.

Methodology

Specific city departments were determined as stakeholders in developing a municipal plan based on their existing linkage with Community Technology. Their input was recorded through formal interviews, where city officials were asked to develop a shared community understanding of digital inclusion. City officials were asked the following questions through an open-ended interview format, although not all questions that were asked were applicable to each department interviewed.

1. What does the term digital literacy mean for the community?
2. What digital technologies are currently available, and to whom?
3. Where are the gaps? Who is left out and at risk of being left behind?
4. What are the most important community goals of digital inclusion?
5. What are measures of success (benchmarks) of digital inclusion?

Department of Information Technology

Vicky Yuki, Outreach & Education Coordinator

Derrick Hall, Community Technology Support Specialist

Delia Burke, Program Advisor & Technology Matching Fund Manager

Sabra Schneider, Director of Electronic Communications

The City of Seattle is committed to promoting a technology healthy community with digital inclusion for all. This includes ensuring that residents have the technology training and access needed to ensure civic and cultural participation, employment and lifelong learning. Programs and services that promote digital inclusion level the playing field of opportunity by serving low-income or low-literacy residents, residents of rural communities, seniors, people with disabilities, at-risk youth, immigrants/refugees and people of color as well as small disadvantaged businesses and non-profit organizations.

The Technology Matching Fund supports community's efforts to close the digital divide and encourage a technology-healthy city. This program is administered by the Community Technology Program of the

City's Department of Information Technology and is funded with cable franchise fees. The program provides grants by matching the community's contribution of volunteer labor, materials, professional services, or cash. Many community-based organizations utilize the Technology Matching Fund as a significant source of funding for their digital inclusion programs to increase technology literacy, provide residents with computer access, and increase resident use of technology for civic engagement and democratic participation.

Education of computer literacy is a priority for Community Technology. Although attendance is high for elementary training, courses that take basic computer literacy skills to the intermediate level face steep drops in attendance. The city is struggling with ways to keep attendees coming back and attending intermediate and advanced training courses. Engaging at-risk youth is also a priority for Community Technology. Digital learning programs like Youth In Focus encourage at-risk youth to develop personal voice, positive identity, social skills and artistic skills. Seattle Public Schools also offers specialized tracks for technology occupational skills. Community Technology staff would like to see the digital inclusion plan tie into the Mayor's overarching city goals and priorities for 2013.

Human Services Department

Patti-Lyn Bell, Program Coordinator of Seniors Training Seniors in Computer Technology

Rowena Rye, Supervisor of Mayor's Office of Senior Citizens

Kelly Guy, Director of Community & Self-Sufficiency

The Human Services Department funds and operates programs and services that meet the basic needs of the most vulnerable people in the community—families and individuals with low incomes, children, domestic violence and sexual assault victims, homeless people, seniors, and persons with disabilities. The department invests in programs that help people gain independence and success.

Particular emphasis and strategies for the city's emerging refugee and immigrant population have included digital literacy. Family centers in Seattle all provide computer classes at varying skill levels. Demand for computer literacy is high as there is always a waitlist on computer classes. Mobility and staffing are the biggest challenges for the department to deliver digital inclusion, as they are having trouble with finding qualified staff to outreach to the greater community and run digital literacy programs. It is a constant challenge to find translators

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who speak the appropriate language to train basic computer skills to refugee and immigrant populations.

Within the Human Services Department, The Mayor's Office for Senior Citizens supports healthy aging, independent living, and social and civic engagement, all to make a difference in the lives of older adults and adults with disabilities. Although a majority of senior citizens already own their own computers, those that do not can visit their local library. However, libraries are restricted in the amount of time and assistance they can give elderly patrons. The biggest obstacle for senior citizens who do not own their own computer lies in finding transportation to a public library or community center. Many senior citizens are homebound and prone to social isolation because leaving their home is a challenge. The Mayor's Office for Senior Citizens hopes to see the digital inclusion plan address the need for computer literacy services for homebound senior citizens.

Department of Neighborhoods

Bernie Matsuno, Director

The Department of Neighborhoods works to bring government closer to the residents of Seattle by engaging them in civic participation; helping them become empowered to make positive contributions to their communities; and by involving more of Seattle's underrepresented residents, including communities of color and immigrants in civic discourse, processes, and opportunities.

Director Bernie Matsuno interprets digital literacy as the way people communicate through technology. Adults who do not use broadband at home generally are older, poorer, less educated, more likely to be a racial or ethnic minority, and more likely to have a disability than those with a broadband Internet connection at home. She wants to see more citizens aware of digital inclusion programs and services because not every home can afford a computer.

To inform the general public about their work, the Department of Neighborhoods regularly updates their webpages to share funding applications online, proliferates news through various social media networks, and sends important messages to differing city departments and interested citizens via their department listservs and other electronic media. Although the Department of Neighborhoods would like to see a computer in every resident's home, it also emphasizes the importance of providing access points to information technology resources. From a practical standpoint, Director Matsuno is not convinced that communicating and interacting with the public electronically creates the

ideal relationship and trust for citizens to engage in their government. She insists that there needs to be a healthy balance between digital and interpersonal approaches for civic engagement.

Office of Economic Development

Brian Surratt, Business Development Director

The Office of Economic Development (OED) works to maximize Seattle's potential as a thriving hub for businesses, jobs, robust neighborhoods and economic opportunity for everyone in the city. The OED works chiefly through partnerships with community-based organizations, community lending institutions, community colleges, individual businesses, and industry associations and business organizations. By providing support to local organizations serving Seattle's diverse communities, the Office of Economic Development leverages its resources and accesses the talents of many people to maintain and enhance the city's economic health.

Within the past year, the OED released its Seattle Jobs Plan, which outlined the Mayor's vision for next generation economic development in Seattle. Although not explicitly stated in the objectives of the plan, digital inclusion plays an implicit role in workforce development and training. Through Surratt, the City has made a strategic decision to care about post-secondary attainment. Many people are working in dead-end jobs and they cannot afford to take digital classes to expand their skill sets. The City needs to rethink how education is delivered to these folks so that they can continue working while getting trained for the next job. As a result, the City is working to partner with community colleges to deliver courses online.

The OED works closely with the Department of Information Technology to develop a municipal fiber network. The OED emphasizes that maintaining the right infrastructure to meet the needs of major businesses in the community should be the most important goal of digital inclusion. While the OED does not provide funding support for digital inclusion programs, the OED focuses on the strategic planning for the City's digital assets: dark fiber, telephone poles, etc. Surratt and the OED want to achieve a level of parity, equality, and uniformity across the city for consistent broadband services.

Seattle Office for Civil Rights

Julie Nelson, Director

The Seattle Office for Civil Rights (SOCR) has helped make Seattle a city where all people enjoy equal rights, equal opportunity, and

freedom from discrimination for decades. Recently SOCR has led the development of the City of Seattle's Race and Social Justice Initiative (RSJI) that focuses on ending racial inequity in the community. A new three-year plan is the result of an extensive assessment last year involving City employees and people from the community. The Department of Information Technology uses RSJI's Racial Equity Toolkit to ensure that the impact on communities of color is considered in new technology projects.

"Digital inclusion is the positive way of saying that there is a digital divide," says Director Julie Nelson. She has seen in her work how people of color and low-income communities have a more difficult time accessing technology than those that are privileged. She references youth, saying that children are disadvantaged if they are not as successful in school as kids who do have the resources. On the other side of the age continuum, the elderly feel disconnected from computers and other electronic devices because they have not grown up using computers as a tool. Relevancy is a challenge for digital inclusion—people need to understand how and why technology is important in their everyday life.

SOCR is not involved in the funding or programming of digital inclusion efforts. However, SOCR has worked with elected officials like Councilmember Bruce Harrell, who advocates for technology access in vulnerable populations. Harrell introduced the Great Student Initiative in 2011, a new partnership program with information, communication and technology companies, and financial institutions that provides low-cost, high-speed Internet access, hardware and software for low-income students in the Seattle Public Schools. SOCR is pleased to see inclusive outreach and public engagement through such initiatives that equip people with technology tools.

Results

Based on interviews conducted with city officials, the current level of collaboration between city departments on digital inclusion is limited. There is much overlap between goals, as well as communities served. Yet, while some strong partnerships exist, for example between Seattle Parks and Recreation and RecTech, most departmental linkages have little institutionalized communication. We recommend bringing together stakeholders to provide collaborative oversight of the digital inclusion strategy. To build on current efforts, this could be the expansion of a current collaborative body, revival of a defunct one, or the development of a new one. This might also facilitate the monitoring and measurement of progress in each city department, and allow for better documentation of city-wide progress as a whole.

Future Work

For further assessment, given the importance of the skills and training aspect of the digital inclusion challenge, the city can quantitatively assess the level of computer and Internet knowledge of Seattle residents. The City can also augment the aforementioned studies with qualitative research targeted at specific constituencies with special needs. This research can be conducted in the form of focus groups or interviews with individual Seattle residents. When focus groups are conducted, researchers should hold sessions in the communities they are seeking to assess in order to have the best chance of attracting a diverse and representative sample of participants.

Conclusion

Digital inclusion does not simply mean “connecting everyone to the Internet.” Digital inclusion is about affordable access to information technology, economic development of disadvantaged communities, creation of relevant web-based content, and inspiration of local communities to lifelong learning. If affordable online connectivity is not made available, low socio-economic groups will be without access to some of society’s most important tools. Social exclusion will be the unacceptable consequence. Advances in technology will undoubtedly continue to evolve over time, and those changes will continue to serve as a catalyst for readying the American workforce, enhancing economic opportunity, and driving innovation leadership.

Overall, Seattle is well-positioned to promote digital inclusion through the implementation of carefully crafted policies. Given the rapidly changing nature of digital technology, realizing “digital inclusion” is going to take an ongoing commitment from citizens of Seattle to ensure that communities that are currently disconnected are able to keep up as technologies continue to advance.

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Numerical Simulation of the Flow over a Circular Cylinder Using an Immersed Boundary Method

Amah, Edison

Abstract

In the field of fluid mechanics, the study of fluid passing through a stationary object is of importance because it lays the foundation for the reliability of Computational Fluid Mechanics (CFM) in approximating analytical solutions and experimental results. In this study, the incompressible viscous flow over a circular cylinder is studied numerically. The Navier-Stokes equations are solved numerically in 2D with the pressure-correction method and second-order finite difference scheme on a uniform Cartesian mesh. The circular cylinder is treated numerically by using the immersed boundary method originally developed by Peskin (1972, 2002), which is the main idea of the study. The simulations were performed at three different Reynolds numbers, Re_D , 55, 66 and 100, based on the diameter of the immersed cylinder. The numerical results such as the mean drag coefficient are compared at the three different Reynolds numbers with their experimental results. Tolerance is set at 0.001. The time step is set at 0.006, thereby leading to a CFL number of 0.2. For each of the Reynolds numbers, the solution converged around 1000 iterations. The pressure coefficient profiles around the cylinder meet expectations by exhibiting characteristics of a typical viscous flow over a cylinder. The mean drag coefficients also compare quite well to experimental values.

Mathematical Description of Problem

The first step in numerical computation of flow is solving the Navier-Stokes (N-S) equations. The N-S equations were normalized. The dimensionless viscous incompressible N-S equations are the continuity equation and momentum equations shown in Equation [1] and Equation [2] respectively:

$$\text{Eq. [1]} \quad \nabla \cdot \mathbf{u} = 0$$

$$\text{Eq. [2]} \quad \mathbf{u}_t + (\mathbf{u} \cdot \nabla) \mathbf{u} = -\nabla p + \frac{1}{Re_D} \nabla^2 \mathbf{u} + \mathbf{f}$$

Equation [1] is the constraint that keeps the Lagrangian control volume unchanged, and \mathbf{f} is the net force induced due to the presence of the cylinder. The unsteady two-dimensional Navier–Stokes and

continuity equations were solved throughout the whole computational domain, including the interior of the fixed circular cylinder. These equations are discretized in space in an Eulerian framework using a second-order finite-difference scheme on a uniform staggered mesh. Time integration was performed using the second-order Adams-Bashforth scheme. Boundary conditions are regularly imposed at each time step. The fluid acceleration, RU , due to the inertia and viscous forces is defined in equation [3]:

$$\text{Eq. [3]} \quad \mathbf{RU} = -(\mathbf{u} \cdot \nabla) \mathbf{u} + \frac{1}{Re_D} \nabla^2 \mathbf{u}$$

Equation [3] is reorganized in a compact form as:

$$\text{Eq. [4]} \quad \mathbf{u}_t = -\nabla p + \mathbf{RU} + \mathbf{f}$$

Time integration of equation [4], without the pressure gradient and force \mathbf{f} , is performed using the Adams-Bashforth scheme:

$$\text{Eq. [5]} \quad \frac{\mathbf{u}^* - \mathbf{u}^{n+1}}{\Delta t} = \frac{3}{2} \mathbf{RU}^n - \frac{1}{2} \mathbf{RU}^{n-1}$$

And \mathbf{u}^* is an approximate value of \mathbf{u}^{n+1} before applying the force term and the pressure term. The instantaneous forcing components \mathbf{f} are computed through the following steps:

$$\text{Eq. [6]} \quad U^*(\mathbf{X}_l) = \sum_{\mathbf{x} \in \Omega} u^*(\mathbf{x}) \delta_h(\mathbf{x} - \mathbf{X}_l) h^2$$

$$\text{Eq. [7]} \quad F(\mathbf{X}_l) = \frac{U^d(\mathbf{X}_l) - U^*(\mathbf{X}_l)}{\Delta t}$$

$$\text{Eq. [8]} \quad \mathbf{f}(\mathbf{x}) = \sum_{l=1}^{N_l} F(\mathbf{X}_l) \delta_h(\mathbf{x} - \mathbf{X}_l) \Delta V_l$$

The lower-case letters denote quantities computed at the Eulerian mesh point \mathbf{x} , and the upper-case letters denote quantities computed at the Lagrangian force points \mathbf{X}_l with $1 \leq l \leq N_l$. N_l is the number of Lagrangian force points distributed uniformly over the surface of on the circular cylinder. The uniform distribution of the Lagrangian points on the surface of the circular cylinder was achieved by using Uhlmann (2005) approach. h is the width of the uniform Eulerian mesh, and δ_h represent the regularized three-point delta function proposed by Roma et

Numerical Simulation of the Flow over a Circular Cylinder Using an Immersed Boundary Method

al. (1999), and the ΔV_L is the two-dimensional volume associated with each Lagrangian force point L . The description of the Eulerian and the Lagrangian points is shown in figure 1.

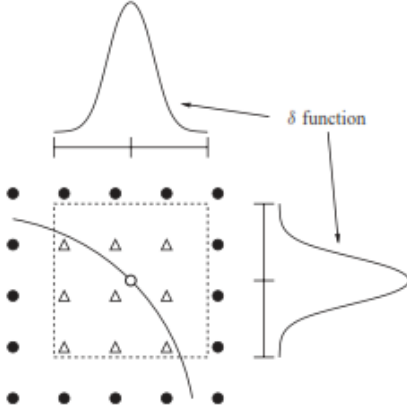


Figure 1. Eulerian grid points (triangles) influenced by the force at the Lagrangian grid point (white circle) of the cylindrical surface (black line).

In this study, the motion of the immersed circular cylinder is fixed such that the desired velocity, U^d , at the interface between carrier fluid and cylinder is zero. Thus, the force imparted by the particle is applied by updating \mathbf{u}^* :

$$\text{Eq. [9]} \quad \hat{\mathbf{u}} = \mathbf{u}^* + \Delta t \mathbf{f}$$

The fluid velocity is corrected with the pressure gradient:

$$\text{Eq. [10]} \quad \mathbf{u}^{n+1} = \hat{\mathbf{u}} - \Delta t \nabla p^{n+\frac{1}{2}}$$

The pressure is computed by solving the Poisson equation:

$$\text{Eq. [11]} \quad \nabla^2 p^{n+1} = \frac{1}{\Delta t} \nabla \cdot \hat{\mathbf{u}}$$

Discretization of Equations

In order to numerically solve the N-S equations, equations [5], [10], and [11] are solved numerically in 2D with the pressure-correction method and second-order finite difference scheme on a uniform Cartesian staggered mesh of 1000 x 750 grid points. The force imparted by the circular cylinder is treated numerically by using the immersed boundary method originally developed by Peskin (1972, 2002).

Staggered mesh grid were used to correct the high frequency oscillation of pressure in the collateral mesh, and also to make p and u in the discretized Poisson's equation to be fully coupled as shown in equation [12], unlike in equation [13].

$$\text{Eq. [12]} \quad \frac{p_{i+1}^{n+1} - 2p_i^{n+1} + p_{i-1}^{n+1}}{\Delta x^2} = \frac{1}{\Delta t} \left(\frac{\hat{u}_{i+\frac{1}{2}} - \hat{u}_{i-\frac{1}{2}}}{\Delta x} \right)$$

$$\text{Eq. [13]} \quad \frac{p_{i+2}^{n+1} - 2p_i^{n+1} + p_{i-2}^{n+1}}{4\Delta x^2} = \frac{1}{\Delta t} \left(\frac{\hat{u}_{i+1} - \hat{u}_{i-1}}{2\Delta x} \right)$$

This coupling of p and u helps in the conservation of kinetic energy in the inviscid limit. The final pressure from the Poisson Solver at each time step was computed using the Successive over Relaxation (SOR) iterative method described in Hirsch (2007, pp. 603-604) shown in equation [14]; $0 < w < 2$.

$$\text{Eq. [14]} \quad p_{ij}^{k+1} = w\bar{p}_{ij}^{k+1} + (1 - w)p_{ij}^k$$

The computational domain of the flow is shown in figure 2.

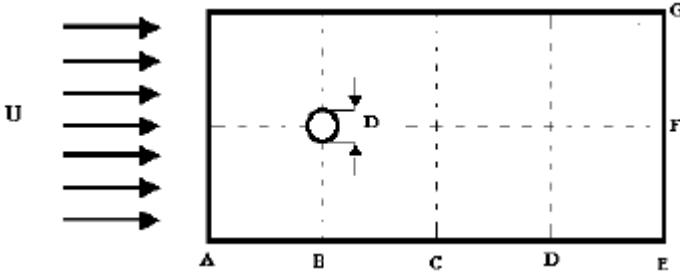


Figure 2. Computational domain of the flow (2D). $BE = 3AB$ and $EF = FG$

Figure 3 shows the flow solver diagram used to control the solution algorithm. Boundary conditions were regularly applied at each step.

Numerical Simulation of the Flow over a Circular Cylinder Using an Immersed Boundary Method

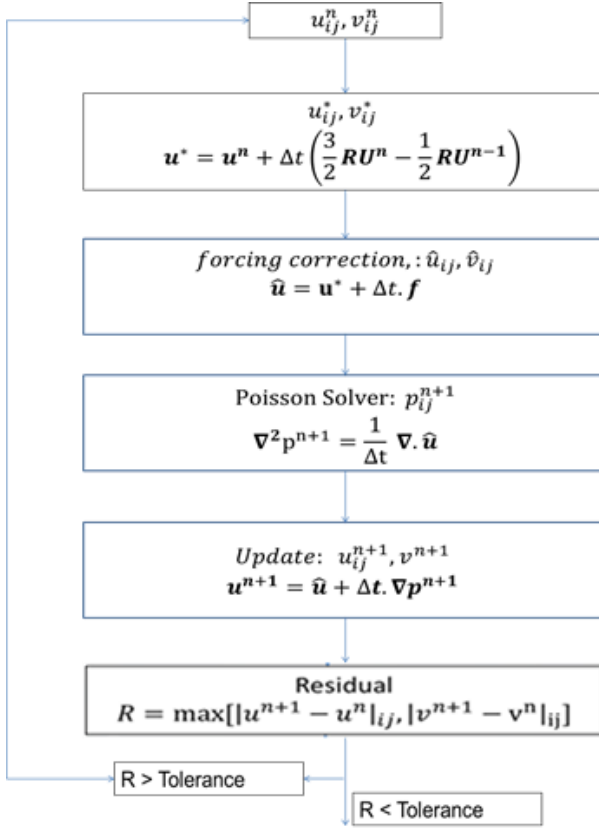


Figure 3. Flowchart for flow solver algorithm.

Results and Discussions

A cylinder of radius $r_c = 0.5$ is placed at the center of the domain $\mathbf{x} = [0, 30] \times [0, 22.5]$. At the three boundary segments $x = 30$, $y = 0$ and $y = 22.5$, a homogeneous Neumann condition was imposed on velocity. The boundary at $x = 0$ is treated by a uniform free-stream velocity $\mathbf{u} = (1, 0)$. For the Poisson equation for pressure, $p = 0$ was imposed at $x = 0$, while a homogeneous Neumann condition is used at the remaining three boundaries.

The mesh for the domain has a uniform grid of 1000×750 nodes. Thus, the ratio of particle diameter to mesh size is $\frac{D}{h} = 33.3$. The time step is $\Delta t = 0.006$, leading to a CFL number of approximately 0.2.

Figures (4)-(6) below show plots of computed flow quantities at each of the three Reynolds number, Re_D .

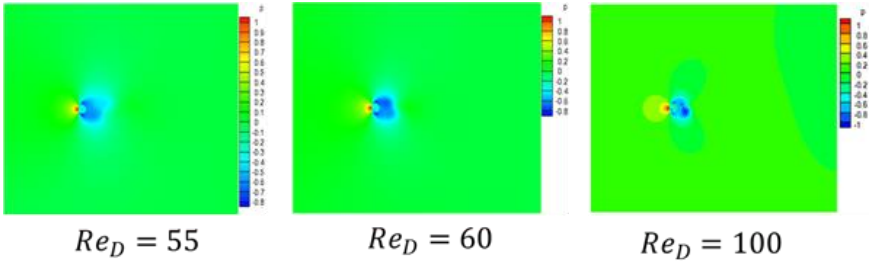


Figure 4. Pressure coefficient contour plots for each of the three Reynolds number.

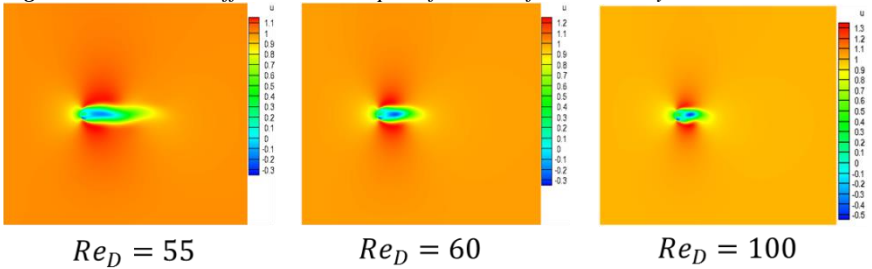


Figure 5. Streamwise velocity contour plots for each of the three Reynolds number.

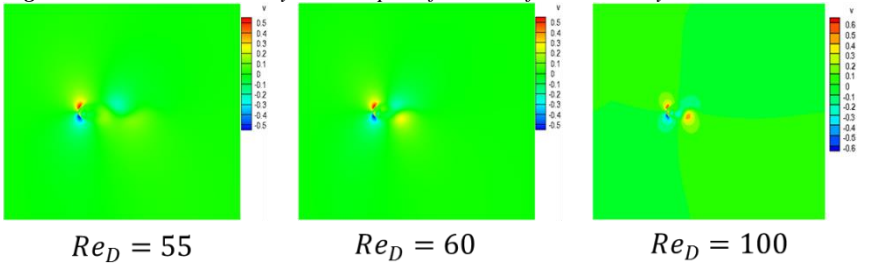


Figure 6. Normal velocity contour plots for each of the three Reynolds number.

The pressure coefficient contour plots in figure 3 meet expectations. Pressure coefficients are higher near the leading edge of the cylinder due to stagnation point. Further from the leading edge, pressure coefficients decrease due to fluid acceleration, which also leads to boundary layer separation at. Also, it can be seen that pressure gradient or pressure variation around the cylinder decreases from a lower to a higher Reynolds number. The plots are not quite as expected based on experimental data.

The velocity contour plots in figure 5 and figure 6 agree with the pressure coefficient contour plot in figure 4, which follows from conservation of energy, although small amount of energy is dissipated due to viscous effects. The flow is stagnant close to the leading edge, but it accelerates as it moves past the leading edge to satisfy conservation of

Numerical Simulation of the Flow over a Circular Cylinder Using an Immersed Boundary Method

mass. Figure 7 shows a schematic of what is happening as the fluid gets around the cylinder.

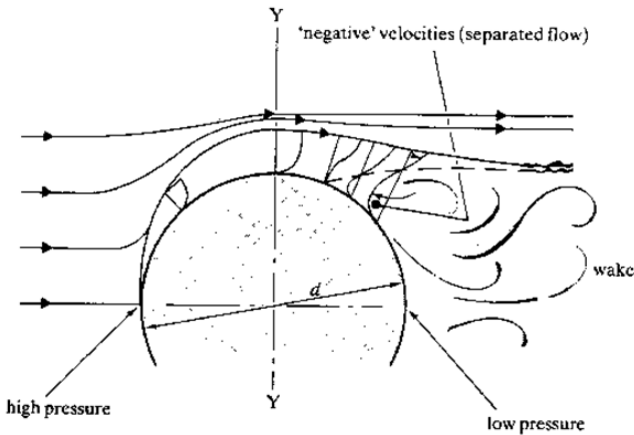


Figure 7. Emergence of flow separation and wake as the fluid gets around the cylinder.

Further examining the velocity contour plots of figures 5 and 6, the formation of the flow separation near the downstream side occurs as the fluid accelerates from the center, the leading edge, to get round the cylinder; it must accelerate as it has further distance to go than the surrounding fluid, thereby reaching a maximum speed at Y. The adverse pressure gradient between point Y and the downstream side of the cylinder will cause the boundary layer separation if the flow is fast enough, ($Re > 2$), which leads to the formation of the wake. In addition, as a result of pressure gradient between the near downstream sides of the cylinder and further down the stream, there are circulations of fluids, besides vortex shedding or Karman Vortex Street, which create those negative velocities depicted in the contours.

Figure 8 shows the pressure coefficient profiles around the cylinder.

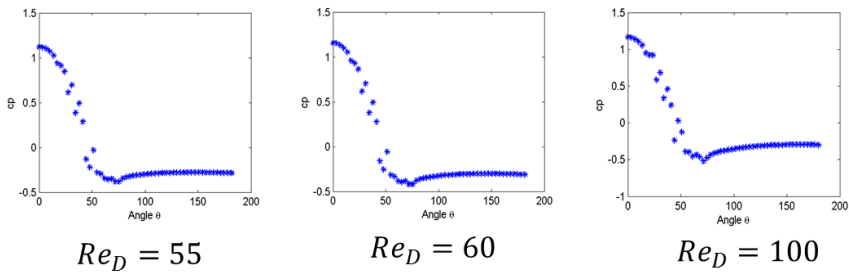


Figure 8. Surface pressure coefficient C_p as a function of angle θ ($\theta = 0^\circ$ corresponds to the stagnation points, $\theta = 180^\circ$ to the base point) at each of the three Reynolds numbers.

The surface pressure coefficient profiles in figure 8 meet expectations by exhibiting characteristics of a typical viscous flow over a circular cylinder. Due to poor mesh refinement near the surface of the cylinder, and the inaccuracies associated in sorting out the prescribed Lagrangian points on the surface, the pressure coefficient profiles do not quite match experimental plot as in Uhlmann (2005).

From Table 1, the percent error increases as the Reynolds number increases. This can be attributed to coarseness of the mesh close to the cylinder, which leads to poor resolving of flow as it transitions from steady to turbulent.

Table 2. Comparison of the numerically computed drag coefficient values to experimental values.

Reynolds Number, Re_D	Drag coefficient, C_D		% Error
	Present study	Experimental (Achenbach ,1968)	
55	1.275	1.18	8.05
60	1.272	1.16	9.65
100	1.205	1.08	10.7

Conclusion

The immersed boundary method has been applied to solve for the numerical simulation of incompressible viscous flow over a 2D cylinder at three different Reynolds numbers. Pressure and velocity contour plots agree with each other. The surface pressure coefficient profiles meet expectations by exhibiting characteristics of a typical

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viscous flow over a circular cylinder. The mean drag coefficient also compares quite well to the experimental value.

However, it must be emphasized that the results presented here are very preliminary. The grid used near the cylindrical surface, particularly before flow separation, is quite coarse judged by the need to generate better surface pressure coefficient data. Further systematic investigation is needed to resolve the grid resolution near the cylinder and fully validate the numerical methodology used in these simulations.

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My research interest is in integrated reservoir characterization due to my background in computational fluid dynamics. I will be starting a Masters program in petroleum engineering in the fall at the University of Southern California. My academic goal is to earn a doctorate degree and become a professor in petroleum engineering with an interest in Integrated Reservoir Characterization.

Use and Allocation of Colors in Display Design

Alma Emadi

Abstract

Displays in general are designed objects meant for communication and notification. The display design has become even more important as the necessity of such information communication increases, such as displays used in control rooms and in manufacturing systems. The ineffectiveness of such displays can lead the operator to make costly errors. While there has been much advancement in the physical configuration of displays, the use of color in designing such objects has not been rigorously studied. Moreover, no general solution exists for the selection of colors and color allocation on displays. This research emphasizes finding a methodology for the use and allocation of colors in display design and strives to be an innovative contribution to the field of display design and, more generally, human factors engineering. Our research question was divided into two parts: determining if incorporating colors into displays is effective in reducing recognition time and increasing accuracy of signals, and investigating how colors should be allocated, as well as successful methods of color-coding. Our research hypothesis was that use of colors would yield higher accuracy rates and lower detection time; however, we weighted accuracy more strongly than speed. We believed that using colors as an additional tag of data would improve both priorities. The form of this study was similar to a simulation game. We designed a display using the Multi-Agent simulation program, NetLogo. The display had multiple elements and was programmed to automatically simulate random reactions when activated. Human subjects were used to detect the signals in a timely manner. The simulation game recorded the time and accuracy of the responses. Data analysis revealed that colors made a significant difference in both accuracy and speed of signal detection.

Background

Purpose and Necessity of the Research

This research explored the use and allocation of colors in complex displays from the Human Factors Engineering principals' standpoint. Human Factors is defined as a field where designs are instructed to be "user-centered" instead of "product-centered" (Wickens, Gordon, & Liu, 1997). According to Wickens et al, who were the lead pioneers in the Human Factors Engineering field, there are 3 factors that constitute the goal of human factors engineering: enhancing

performance, increasing user satisfaction, and increasing safety in an engineering design. They define displays as objects “designed to support the perception of relevant system variables and facilitate the further processing of that information” (Wickens, Gordon, & Liu, 1997). The field of display design is no stranger to the Human Factors contributions. Displays are designed objects meant for communication and notification. If they don’t serve their purpose well, they are ineffective and inappropriate. This becomes even more important as the necessity of such information communication increases, such as displays used in control rooms as well as displays used in manufacturing environments to communicate the status of different processes around the manufacturing plant.

The ineffectiveness of such displays can lead the operator to be in one of the following situations: the operator will make a type-one error, where he/she falsely detects a signal that is not present (a false alarm); the operator will make a type-two error, where he/she fails to detect the signal when the signal is actually present (missed alarm); or the operator is under heavy stress and even though he/she has not make a mistake, the probability of an error happening increases steadily (Wickens, Gordon, & Liu, 1997). Therefore, there has been much research done in the field of display designs to minimize the cognitive load on the user. However, while there have been much advancement in the physical configuration of displays, the use of color in designing such objects has not been rigorously studied, and there have been contradicting results around the benefits of using colors in contrast to not using colors in display design. Moreover, no general solution exists for the selection of colors and color allocation on displays. “Allocating colors to the elements of a display may be as fraught a problem as selecting the colors in the first place. Once more, no clear solution exists, except possibly designer intuition or attempting” (Deshe & Van Laar, 2007). Hence, this research emphasized finding a methodology for the use and allocation of colors in display design.

Color Psychology as a Design Tool

Color psychology states that colors can evoke different emotions in the user. Furthermore, colors have different powers (ability to excite the senses). For example the color red elicits a stronger emotion than orange does. Designers can use these characteristics to convey the task of the display. Table 1 below shows the typical psychological associations of the colors used in our display designs (Fraser & Banks, 2004).

Table 3. *Common colors and their psychological associations.*

Color	Display Design Relate Associations
Red	Danger, power, evokes strong feeling
Green	Success, health, harmony, balance, equilibrium
Blue	Calmness, space, truth
Brown	Solidity, stability, it's overwhelmed by red but compliments green or blue
Yellow	Anxiety, fear
Orange	Attention drawing, excitement, combines the powers of yellow and red

Color Theory as a Design Tool

The first question to be answered is how we define colors. Leborg (2008) states that, "Colors are different wavelengths of light. Concrete objects and the material of which they are made reflect only part of the light spectrum and therefore appear as if they have color." Colors seen on digital displays are a virtual representation of this phenomenon and are referred to by RGB numbers. Table 2 represents the RGBs of the colors used in the design of the display for this experiment.

Table 4. *RGB settings of the colors used in the experiment.*

Color	RGB Setting		
	Red	Green	Blue
Red	0	0	0
Yellow	255	255	0
Green	0	255	0
Brown	163	120	85
Orange	255	128	0
Blue	0	0	255
Cyan	0	255	255

Colors possess many qualities. They can be bright and strong or dull and grayish, and the responsible factors of these characteristics are the color's hue, saturation, and brightness (Leborg, 2008). These qualities are all independent of each other, and to describe a color fully, the three measurements are required. These measures can be described as:

- *Hue*: the property of color associated with its wavelength in the light spectrum

- *Saturation:* determined by a combination of light intensity and the degree to which it is distributed across the spectrum of different wavelengths
- *Brightness:* A pigment of a given hue can be lightened or darkened by adding white or black to it. (Fraser & Banks, 2004)

One way to organize and relate colors is to use color wheels. Color wheels are common tools among designers and they are often used to define pairs or trios of colors that have a certain relationship with each other. Figure 1 represents a common 12-color wheel (Fraser & Banks, 2004).

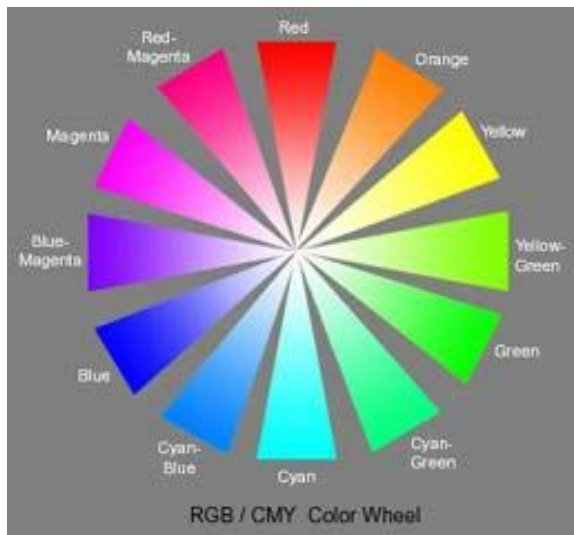


Figure 9. A common 12-colored color wheel.

There are many subsets of this color wheel that have certain qualities, one of which is the complementary quality. Two colors are complementary if they are directly across each other on the color wheel (Wong, 1987). On the other hand, split complements (or double complements) include both colors on either side of a color's complement (Figure 2). Complementary colors have been shown to work very effectively when used together (EasyRGB, 2012).

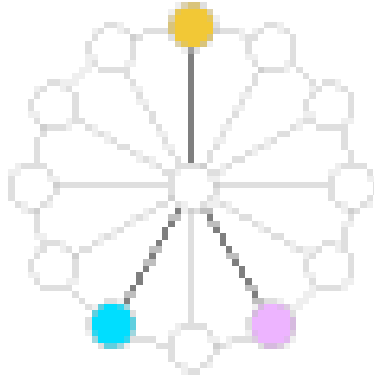


Figure 10. *Diagram of the split complimentary property.*

Research Questions

The research question can be divided into two parts. The first part asks if incorporating colors into displays is effective in reducing recognition time and accuracy of signals. The second part of the research question investigates how colors should be allocated, and what method of color-coding would provide better results. For example would use of complementary colors be better than analogous colors? Or, What is the optimal number of colors to use in a display. The research hypothesis was that the use of colors would yield higher accuracy rates and lower detection time. However, accuracy had a higher priority than speed. In that matter, we believe that using colors, as an additional tag of data will improve both priorities. Hence, the null and alternative hypothesis are provided as:

Null and Alternative Hypotheses

H_0 : Colors will not make a difference in signal detection time and detection accuracy.

H_1 : Colors will make a difference in signal detection time and detection accuracy.

Methodology

The form of the study was similar to a simulation game. We designed a display using a multi-agent simulation program called NetLogo. This display was similar to an analogous multi-element display in a simplified real life scenario such as a nuclear power plant control room display. The display had multiple elements such as gauges, meters and alarms. It was designed to randomly send signals to the operator (study subject). For example, at one instant, one of the gauges and one

of the alarms could send a danger zone signal simultaneously. The human subject's objective was to detect the signals in a timely manner and as accurately as possible. The simulation game lasted three minutes and recorded the time and accuracy of the responses and compiled them into an Excel file for future analysis. The human subject was given instructions about the methodology of the simulation before experimentation, and after the experiment they were asked to respond to a short survey regarding the use of colors in displays in general and this experiment specifically.

Subject Selection

All the study's subjects were between the ages of 18 to 50 and were students in science, technology engineering, and mathematics (STEM) or medical fields. This enabled all subjects to be somewhat familiar with technical data representation and to be in the average age range of a typical operator. Subjects with color deficiencies were excluded from the experiment. The subject population was mostly evenly distributed among female (54.9%) and male (45.1%) subjects. Almost 80% of the subject population found the simulation game moderately challenging. This shows that the tasks the user had to accomplish were not excessively hard, and the results obtained were not skewed by cognitive overload on the subject.

Experimental Design

Display Design

In order to design the displays used in the experiment, Color Theory, Color Psychology, and industry data were used. A total of four color-coding methods were devised and tested. Each of the four color pallets were compromised of three color levels:

- *Level 1:* The element is in the safe zone.
- *Level 2:* The element is in the warning zone. This indicates that the element requires attention and has a higher probability of going into the danger zone (Level 3).
- *Level 3:* The element is in the danger zone. This zone is the signal that the user has to detect.

Display Configuration

The display had six elements, and each element was linked to a key on a number pad. The subject had to push the corresponding element key every time the element went into the danger zone (Level 3). The

picture below shows the experimental display with a grayscale color pallet.



Figure 3. Experimental display in Color Pallet 4: Greyscale.

Color Pallet 1: Industry Used Colors (GYO)

This color pallet used the ordinary green-yellow-red (GYO) colors as its level safe, level warning, and level danger colors in order. This pallet was used as a control group towards the newer color pallets that were not already used in the industry.

Color Pallet 2: Color Allocation Based on Color Psychology (GYO-BYO)

This color pallet used two sets of tri-group colors. The first set had the GYO colors green-yellow-red, and the second set had brown-yellow-orange (BYO) for its Level 1-3 colors respectively. The objective of this pallet was to first assess whether or not the higher psychologically powered colors (GYO) would perform better or worse relative to the lower power trio (BYO). Furthermore, this color pallet showed the performance of using multiple sub-color pallets in one display.

Color Pallet 3: Double (Split) Complimentary Colors Trio (CT1)

This pallet was designed using a 12-colored color wheel. All the possible double complementary sets were iterated, and those sets containing the traffic light colors (green, yellow, red) were removed.

This was to eliminate any prior knowledge or interpretations of the user toward the colors used and to obtain unbiased results of the effect of double complementary colors in display design.

Color Pallet 4: Grayscale

This color pallet was used as a control group for all the other groups and had three shades of gray for its Level 1-3 colors. This pallet resembled a monochrome display (Figure 3).

Background Color Selection

Through literature review, it was evident that not only the color pallets used in the elements but also the background color of the display is important and can play a crucial rule in the effectiveness of the display. Wong (1987) states that, “A surrounded color exhibits a change in hue, because it is optically blended with the afterimage of the surrounding color, which is of a different hue.” This means that an orange element surrounded by green, whose afterimage (or compliment) is red affects the orange and makes the orange element look much redder. Therefore, the elements’ color can be perceived differently (change of hue with respect to the user’s eye) when their background color is much lighter or darker. If the background color is much lighter, the element color would appear darker and vice versa. Furthermore, Leborg (2008) found that, “Elements that differ most in value from the background will always draw the eye first, almost regardless of differences in hue.” Hence, in order to observe the effects of the color background we assigned four different background colors of black, white, gray and blue. These colors are commonly used as backgrounds in industrial displays. Table 3 shows the RGB count of each color.

Table 5. RGB settings of the background colors.

Color	RGB Setting		
	Red	Green	Blue
Black	0	0	0
White	255	255	255
Gray	128	138	124
Blue	0	0	255

The background colors and the color pallets were assigned to the subjects based on a 4x4 randomized factorial experimental design.

Results and Analysis

Summary Statistics

From the summary statistics, we can see that at first glance, CT1 and GYR color pallets had the best response rate. Furthermore, the GYR-BYO color pallet performed the worst in the missed signal category. Figures 4 and 5 demonstrate these findings.

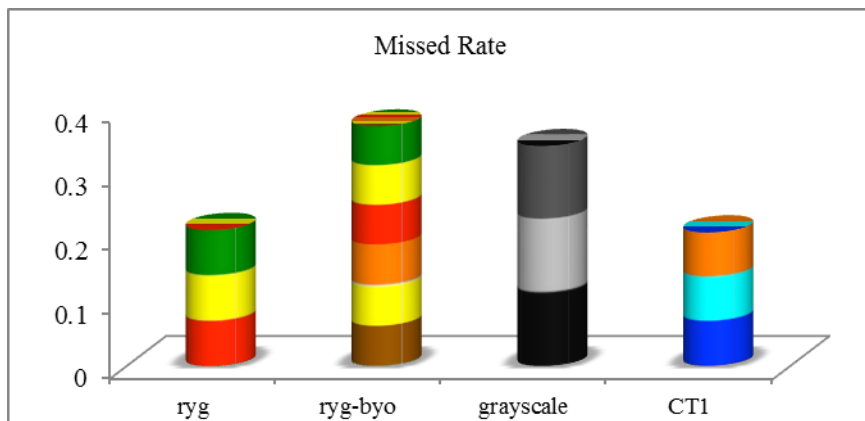


Figure 4. Missed rates for each color pallet.

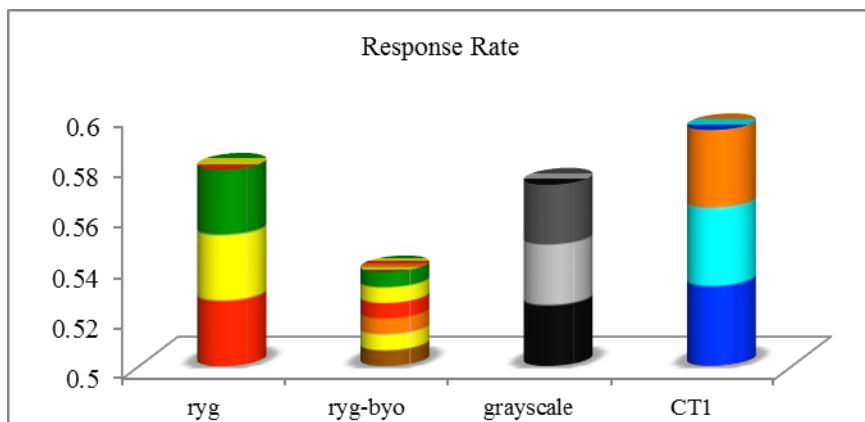


Figure 5. Response rates for each color pallet.

When looking at background color, we can see that response rates were much higher with the white background and were much lower for the blue background, as demonstrated by Figures 6 and 7.

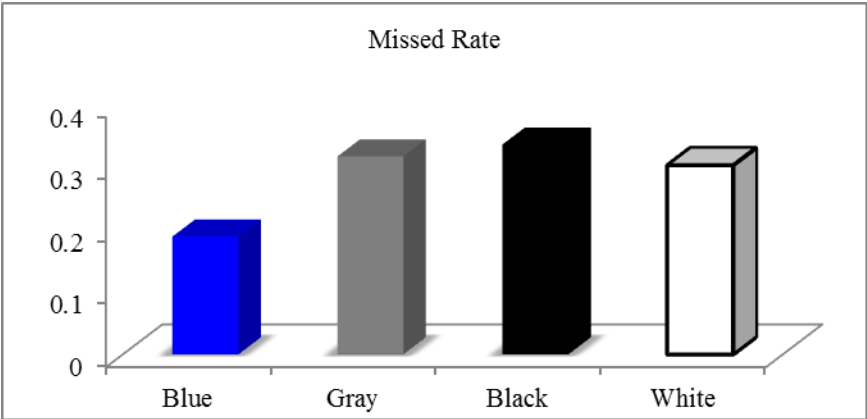


Figure 6. Missed rates for each background color.

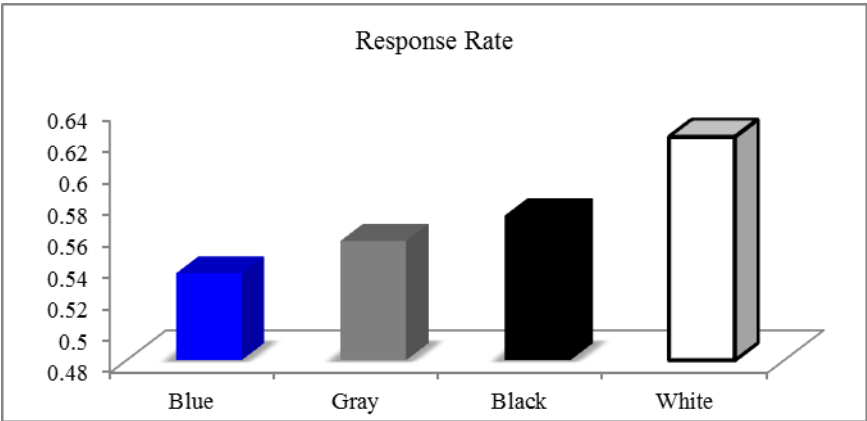


Figure 7. Response rates for each background color.

However, due to the randomized nature of the experiment and the unevenness of the sample sizes for each category, further analysis is required and the above results cannot be solely relied upon for future implementation.

Experimental Design Analysis

The data provided by the experiment produced two types of output: qualitative and quantitative. The response accuracy data points were qualitative since they were Boolean indicators of hit (+1), or miss/false positive indicators (-1). Hit happened when the user detected the signal correctly. Miss happened when the user did not detect the initiated signal (Type II error), and false positive happened when the user detected a signal when there was no signal (Type I error).

The quantitative data points were the response rates. A qualitative set of responses cannot be combined with quantitative responses without implementing a penalty system. Meaning, instead of a hit or miss recorded separately, it would be included in the response time data set with a score of 40 or 50 seconds. The problem with this approach is that the penalty would be chosen arbitrarily, and would potentially inaccurately skew the data. However there is room to make inferences about display choices depending on which type of error (false positive or a miss). Hence, the data was split, a nominal regression model was obtained first, and then a quantitative analysis was done to make inferences between the two outputs.

Binary Nominal Regression Model

The binary nominal regression model predicts a hit or a miss/false positive depending on the background color and the color pallet used in the display.

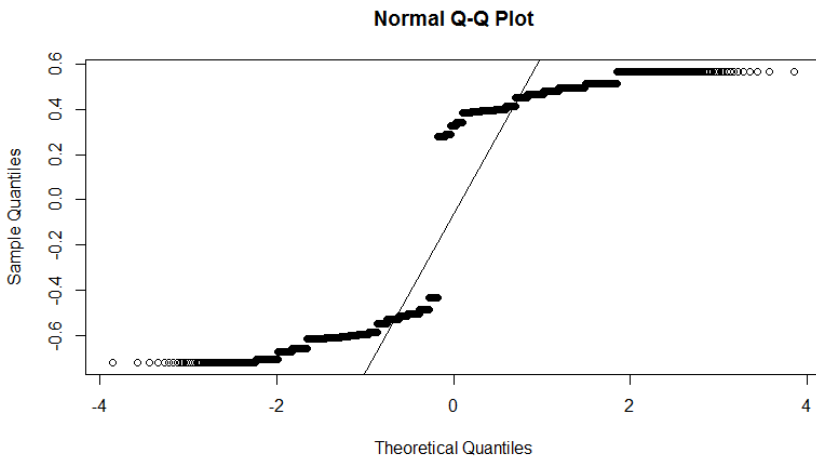


Figure 8. Normality plot of the residuals.

The data in the residual plot (used to check for normality) is skewed because the source data is binary. As such ANOVA analysis would not be feasible. However, interaction plots, which are another powerful statistical tool that display the dependence of the response variables on different factors, can be used. Figures 9 and 10 are interaction plots displaying the effect on the signal detection accuracy by varying the color pallet and the background color.

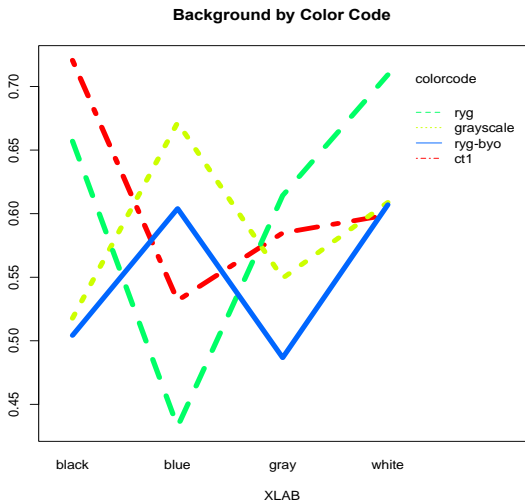


Figure 9. Interaction plot displaying the effect on response accuracy by varying color pallet by background color.

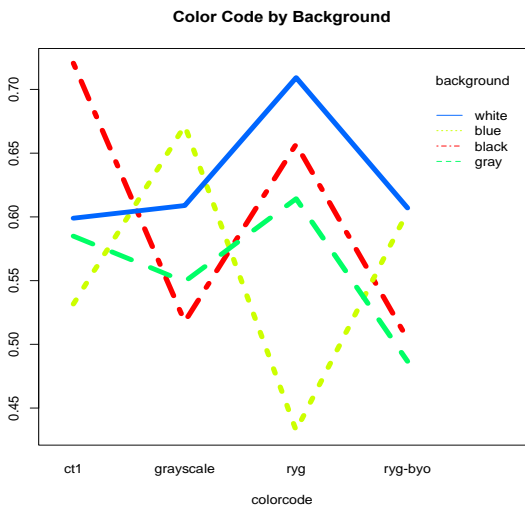


Figure 10. Interaction plot displaying the effect on response accuracy by varying background color by color pallet.

The interaction plot suggests that the “CT1” color scheme used with a black background produces the highest number of hits (least number of misses or false positives). However a GYO color scheme used with a white background will also produce favorable output.

Quantitative Analysis

Because of the multi-typed nature of the data, the data were partitioned and quantitative analysis was done on the set of data excluding false positives and misses (the binary types). An ANOVA analysis to determine which factors contribute the most to the variability in the data was computed using the R Statistical Software Package. The results are shown below. Figure 11 shows that the data is normal to a high approximation. Table 4 shows the ANOVA tables obtained from analyzing the quantitative data (signal detection time).

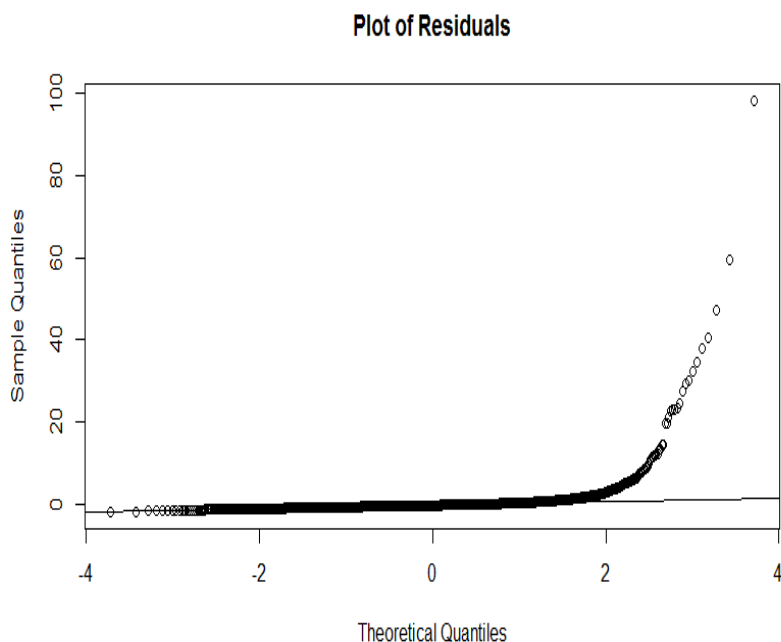


Figure 11. Plot of residuals for normality check.

Table 6. ANOVA analysis of the effect of each factor and their interaction on the response time.

	Df	Sum Sq	Mean Sq	F Value	Pr(>F)	Significance
Colorcode2	3	96	31.97	4.645	0.00302	**
Background2	3	169	56.30	8.179	1.98e-05	***
Colorcode2:	9	102	11.31	1.644	0.09716	.
Background2						
Residuals	4841	33320	6.88			
Significant. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1						

The output above illustrates that both the background color and display color have a significant effect on the response time. However it also shows that the interaction between background color and color pallets on response time is not statistically significant. This indicates that there is a need for further analysis into the reason of the lack of interaction between the color pallets and the background colors.

From the interaction plots (Figures 12 and 13) we infer that the best alternatives in terms of response time are achieved using a black background. The color pallets with the highest performance are then ranked as GYR, CT1, GYR-BYO, and Gray scale.

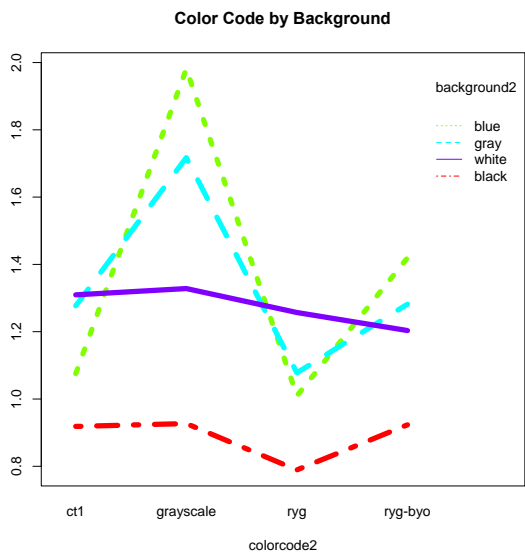


Figure 12. Interaction plot displaying the effect on response time while varying the background colors by color pallet.

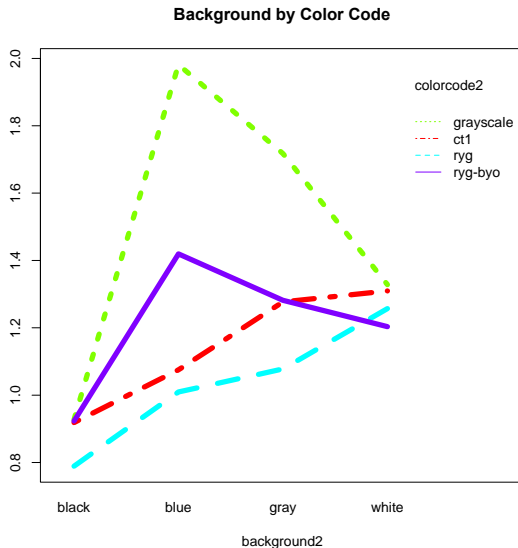


Figure 13. Interaction plot displaying the effect on response time while varying the color pallet by background.

Conclusion

Bringing all the results together, it appears that using a GYR color scheme on a black background produces the most favorable results by minimizing the number of misses and false positives while simultaneously reducing the response time. The performance however, is closely followed by the CT1 color scheme. However, it is possible that because the GYR pallet has been used traditionally on important displays (such as traffic lights) the cognitive familiarity of the pallet and the user could have contributed to its high performance. It should also be noted that the experiment was conducted in the dark and as such the varied background colors may have been confounded with the environment. Overall, we can conclude that using colors as an additional tag of data did help with the effectiveness of the display and using tools such as color theory and careful consideration of the background colors can improve the performance of a display.

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My research interests are the study of Human-Object interactions and the development of user-centered designs. I plan to pursue a PhD program in product development engineering.

The Relationship of Young's Modulus to Porosity in 3DP Stoneware Ceramic: A Complete Analysis

Alexandra P.K. Gramling

Abstract

Three dimensional printing (3DP), a subfield of additive manufacturing, has experienced many novel advancements by way of innovative material development over the past few years. With the recent expansion in capability, information regarding the mechanical integrity of these new material systems is generally lacking. In an effort to fill this informational void, the present study examined the relationship between Young's modulus and porosity in 3DP stoneware ceramic test specimens. During this experiment, the ceramic specimens or "pucks" were printed using a three dimensional powder printer and measurements of height and diameter were taken to map the variation in subsequent kiln firing operations. The pucks were kiln sintered according to a predetermined schedule, which involved strategically placed ramp rates and isothermal soaks for varying time periods. After sintering, Archimedes Method was used to determine the porosity and bulk density of the specimens. The pucks were then crushed using an Instron Universal Tester resulting in a measure of the 3DP stoneware's stiffness versus porosity. It is expected that as the porosity of the pucks increases Young's modulus will decrease. The aim of this research is to provide the first experimental relationships of porosity and stiffness resulting from sintering parameter modification as well as to investigate the possibility of producing 3DP ceramics that are comparable to those that are conventionally manufactured.

Introduction

Three dimensional printing (3DP) is a form of additive manufacturing that enables users to design solid models that either cannot be made or are more difficult to create using traditional subtractive manufacturing methods. In addition, 3DP also allows utilization of a wide range of materials making it at least, if not more, versatile than other manufacturing methods.

While 3DP is a rapidly growing field, this growth has been limited due to the lack of standardization of the materials that are produced. This research examines stoneware ceramic parts (pucks) printed with a 3D powder printer. The following paper will examine the effect of sintering on pucks when subjected to various hold times during peak sintering temperature. The effects of sintering will be determined

through an examination of the porosity and compressive strength of the post-fired specimen. It is anticipated that as hold time increases the porosity will decrease resulting in an increase of compressive strength and Young's Modulus.

Testing Methods

Test specimens were printed with a 3D powder printer using a stoneware ceramic powder base mixed with sugar and maltodextrine. During printing an alcohol based binder is used that reacts with the sugar and maltodextrine to hold the unfired pucks together, shown in Figure 1. After printing, the pucks were depowered and then grouped into test batches consisting of five pucks each. Once divided into groups the height and diameter of each puck was recorded.

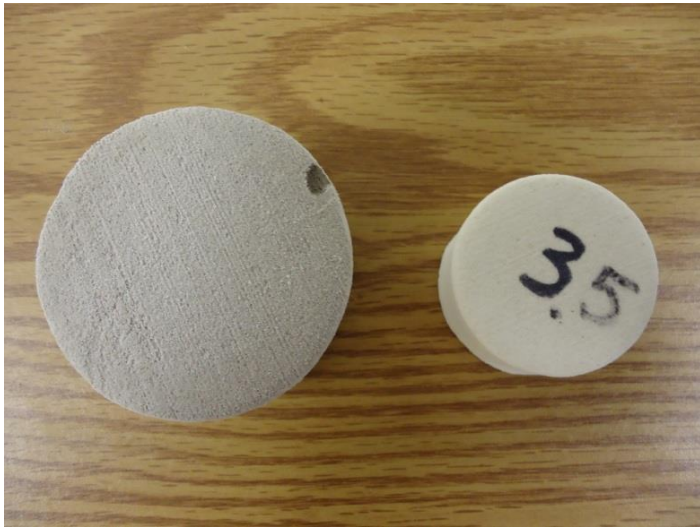


Figure 1. Pre- and post-fired specimen.

When firing the pucks each group was subject to the same sintering schedule until peak temperature at 1200°F is reached. At peak each group was subject to a different hold time ranging from 1 to 12 hours. After completion of the hold the system was allowed to slow cool back to room temperature.

After sintering, following ASTM standards, Archimedes rule was used to determine the porosity and bulk density of the specimen. During this process the specimens are boiled for five hours, and then soaked for a minimum of 24 hours to ensure full saturation. Archimedes rule can then be applied. Using this process the specimen is first weighed

The Relationship of Young's Modulus to Porosity in 3DP Stoneware Ceramic: A Complete Analysis

while suspended in water, then weighed fully saturated. The pucks were then allowed to completely dry out, and their dry mass recorded.



Figure 2. Instron with a puck on the testing platform.



Figure 3. Puck after complete failure during testing has occurred.

Once the pucks were dried and weighed, an Instron Universal Testing System was used to apply compressive loading to the specimen, shown in Figure 2. The system applied compressive force at a rate of 1mm/min. During application, the stresses exhibited by the puck were

recorded using data acquisition software. The force was applied to the puck until complete failure occurred (Figure 3).

Results

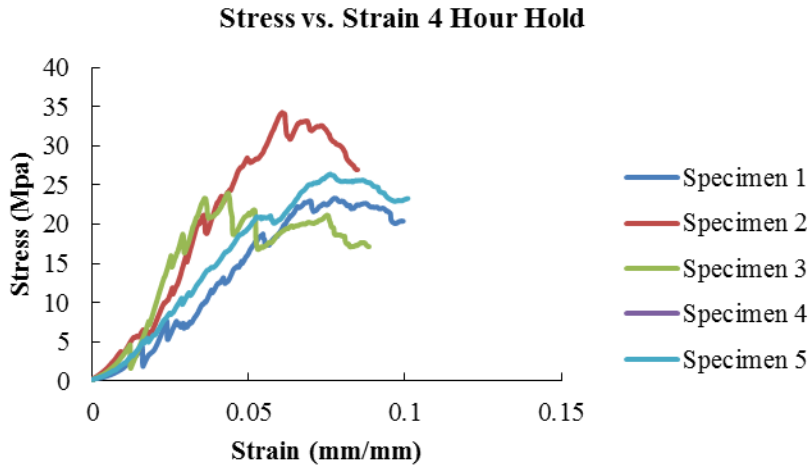


Figure 4. The stress versus strain values exhibited during Instron testing by the specimens subjected to a four hour hold.

The graph shown in Figure 4 displays stress versus strain data for the specimens with a four hour sintering hold. The results shown in Figure 4 have a standard deviation of approximately 1.6 between the maximum compressive stresses exhibited. Similar curves are seen for the other hold periods of 1, 2, 8, and 12 hours with standard deviations of 3.7, 2.04, 2.97, and 9.8 respectively.

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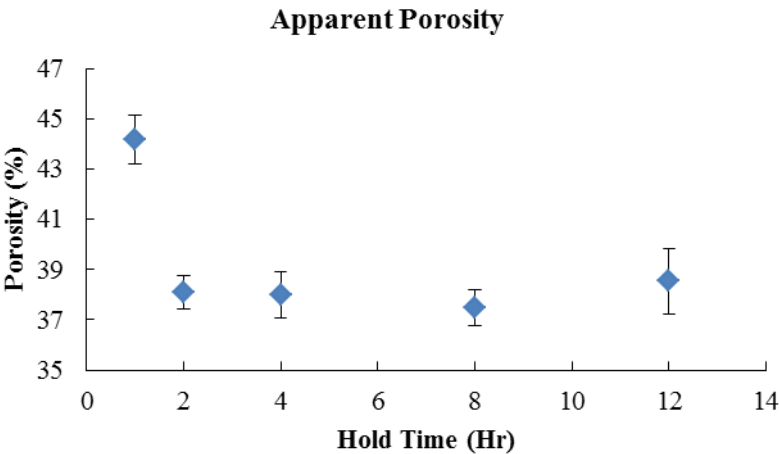


Figure 5. Average apparent porosity values for each of the test groups.

In Figure 5, the average porosity values found for each of the test groups is shown. From the graph it can be seen that the overall fit appears to be exponential. The group with the shortest hold time resulted in the highest apparent porosity at 44.18%. The following four test groups resulted in the ensuing values (in order of increasing hold time) 38.09, 37.98, 37.49, and 38.53, with an overall standard deviation of 0.03.

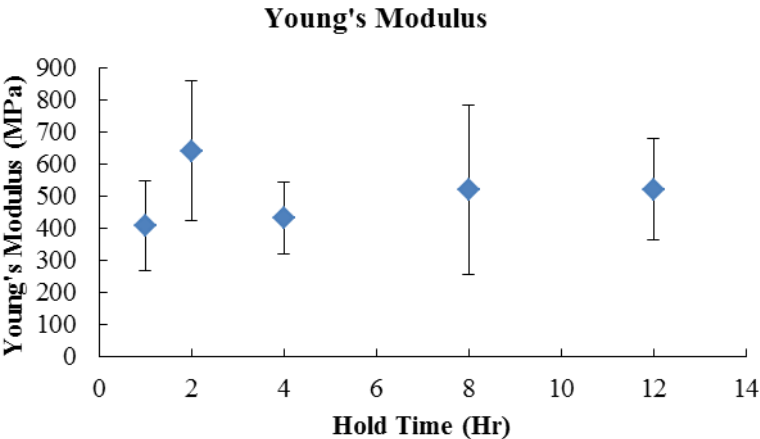


Figure 6. Average Young's Modulus values for test groups.

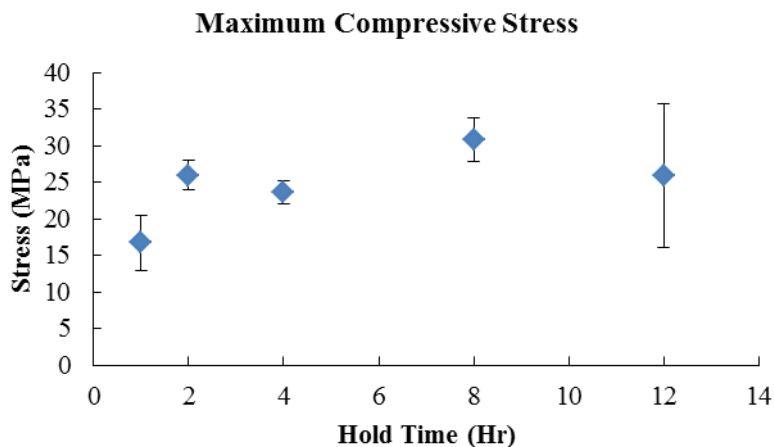


Figure 7. Average maximum compressive strength exhibited during testing for each test group.

In Figures 6 and 7 the average Young's Modulus and the average of the maximum compressive stresses are shown. Unlike the average porosity the results in both of these graphs have a linear fit versus exponential.

Discussion

During Instron testing the resulting stress versus strain curves contained a fair amount of static, which is responsible for the jagged appearance of the graph in Figure 4. Since stoneware ceramics are brittle, and therefore lack the elasticity of metals, a rougher curve was anticipated.

The apparent porosity of the pucks tested, as mentioned in the results, appear to follow an exponential shape. In the initial hypothesis it was anticipated that as hold time increased porosity would continue to decrease. It appears however that porosity is instead reaching the sintering limit, which occurs as early as two hours into the hold cycle according to this data set.

Initially it was hypothesized that both Young's Modulus and the compressive strength of the specimen would increase as sintering hold time increased. In the cases examined here Young's Modulus did not differ significantly between groups, thus failing to confirm the initial hypothesis. The average compressive strength suggests that there is a slight increase in strength as the hold time increases. However for hold

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times of 4 and 12 hours there were decreases in the strength when compared to the previous shorter-hold time groups.

Conclusion

After analyzing the resulting data, the initial hypothesis was not confirmed. Porosity failed to continuously decrease as hold time increased, it instead appeared to approach the sintering threshold. Young's Modulus and the overall compressive strengths of all specimens also did not fully support the hypothesis as there was no significant difference between the Young's Modulus for all test specimens. The compressive strength did show a small increase in strength with a hold increase, however due to variation among the data additional tests will need to be run.

Future Work

In the future additional tests will need to be run in order to improve upon and verify the current results. Testing with both shorter and longer hold times is also necessary in order to verify that the sintering threshold has been met as well as to determine how early this limit is reached.

Additional strength testing is also necessary to determine the shear strength of 3DP materials. It is anticipated that these materials will show a significant decrease in strength when a shear force is applied due to the layer by layer manufacturing of these materials.

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My current research interests involve improvement of our current energy storage methods, particularly those related to renewable energy. In the fall I will begin my first year of graduate school in the Masters of Mechanical Engineering program at the University of Washington.

Proliferation in the Third Ventricle of the Adult Mouse Brain

Vicky A. Herrera

Abstract

Recently, it has been discovered that the mammalian brain is a complex structure that continues to generate new cells throughout adulthood, a phenomenon also observed in the human brain. There are two well-known and characterized anatomically distinct regions that generate neurons throughout adulthood; the subgranular zone (SGZ) in the hippocampus (the region associated with learning and memory), and the subventricular zone (SVZ) of the lateral ventricle. Additionally, there exist other ventricular cavities among which the third ventricle (3V), connected dorsally to the lateral ventricles, is of particular interest as it possesses a structure, cell type composition and neurogenic contribution that are not yet fully understood. For instance, it is undetermined whether there is decreased proliferation in the 3V with age and if such new cells migrate throughout the brain or die.

To resolve these questions, adult one month and twenty month CD1 mice received five consecutive intraperitoneal injections of 5'-bromo-2'-deoxyuridine (BrdU) at 2-hour intervals before being sacrificed 2 hours after the last injection (to identify proliferating cells) or one month later (to assess the survival capacity of the cells). We observed a clear decrease in proliferation with age and reduced survival of the new cells, conceivably due to a selection phenomenon also observable in the hippocampus and SVZ and realized with the natural process of aging. While in the SVZ the new neurons have been realized with olfaction; in the hippocampus new neurons are realized with memory and learning. The function of the generated cells in the 3V, however, remains unclear. Further study of the proliferative and migratory capacity of the cells generated in the third ventricle will help in developing understanding of the role of these new cells.

Introduction

The brain is a complex structure, with hidden mechanisms underlying its functions that have been researched for less than a century. Despite this, this research has never ceased to astound us with its many discoveries about the working phenomena of the human brain. For instance, the process of neurogenesis was only discovered in the 1960s, by Joseph Altman, and is understood to be the process by which neural stem cells or progenitor cells divide and give rise to neurons and glia (Altman et al 1965).

Neural stem cell (NSC) proliferation occurs primarily in two regions of the rodent brain, the subventricular zone (SVZ) of the lateral ventricles and the subgranular zone (SGZ) of the dentate gyrus in the hippocampus (Altman et al 1966, Kaplan et al 1984). These two regions continue to generate new cells throughout adulthood (Altman et al 1966, Kaplan et al 1984, Gage 2000). Neurogenesis in the hippocampus has been correlated to cognitive processes such as long term memory consolidation (Barnea and Nottebohn 1995, Gould et al 1999). In the hippocampus, a subpopulation of astrocytes is responsible for the neurogenesis seen in this region (Stanfield and Trice 1988, Seri et al 2001). This astroglial subpopulation is characterized by radial glial cells that have long extending processes, the main source of neurogenesis in the dentate gyrus, a region important for the formation of memories (Seri et al 2001). Studies have shown astrocytes to continue to proliferate beyond the first postnatal months contrary to previous beliefs (Altman 1967, Seri 2001). The lateral ventricle, the second region where neurogenesis occurs, is a cavity formed during development that provides the pathway for the circulation of cerebral spinal fluid (CSF). In the lateral ventricles, the SVZ, the region located in the anterior portion of the ventricle gives rise to neuroblasts that migrate through the rostral migratory stream (Altman et al 1969, Alvarez-Buylla and Garcia-Verdugo 2002). The neuroblasts reach the olfactory bulb, where they predominately mature into interneurons (Alvarez-Buylla and Garcia-Verdugo 2002).

Aside from the lateral ventricles there exists other ventricular cavities, among them the third ventricle (3V) connected dorsally to the lateral ventricles. The walls of the third ventricle are lined with tanycytic ependymal cells and B1 cells with interspersed expansions that contact the 3V (Flament-Durand et al 1985). Tanocytes are a type of ependymal cell extending from the hypothalamus and are morphologically and functionally similar to astrocytes. Previous studies have revealed that the proliferation in the 3V can be stimulated with specific growth factors like IGF-1 (Pérez-Martín 2010). In vitro, cells from the 3V produce neurospheres when they are cultured in media with EGF and bFGF (Xu Y. et al 2005). However, the nature of the proliferative cells in the 3V remains unclear. While it is known that there are NSCs capable of proliferating, the structure, cell type composition and neurogenic contribution are yet to be fully understood. It is undetermined whether there is decreased proliferation in the 3V with age and if these new cells migrate throughout the brain or die. We aim to deeply analyze the morphological aspect of the 3V. While in the SVZ, the new neurons have been realized with olfaction, and in the hippocampus with memory and

learning, the function of the generated cells in the 3V remains to be elucidated. This study of the proliferative and migratory capacity of the cells generated in the 3V will help in the clear understanding of the role of these new cells.

Materials and Methods

Animal Care and BrdU Administration

Infant male CD1 mice (weighing 30 g or more) aged either 1 or 20 months old were used in this study. All animals were kept under a constant 12 hour light/dark cycle with unlimited access to food and water. Four experimental groups were created to study the proliferation and migration capability of newly synthesized cells in the 3V of aging animals. The groups varied in age and time of sacrifice. Groups 1 and 2 were used to study proliferation. Groups 2 and 4 were used to study migration and survival. Group 1 and 3 mice were dissected one month into the experiment, with Group 1 mice euthanized two hours after their last intraperitoneal (i.p) BrdU injection (n=3) and Group 3 mice being euthanized one month after their last i.p. BrdU injection(n=3); In Groups 2 and 4, mice were dissected twenty months later, with Group 2 mice being dissected 2 hours after their last i.p BrdU injection(n=3), and Group 4 mice being dissected 1 month after their last i.p BrdU injection (n=3). The mice were administered a total of 5 i.p injections each (timed two hours apart) of BrdU(10mg/ml in 0.9% NaCl) at 50mg/kg of body weight. All manipulations were performed in accordance with the University of Valencia principals of laboratory animal care.

Processing Tissue for Light Microscopy and Immunohistochemistry

Before perfusion, the mice were anesthetized with 1.6mg/g of body weight of ketamine and xylazine i.p injected. For light microscopy, animals were transcardially perfused with 10-30ml of saline (0.9% NaCl at room temperature with 0.1 ml heparin/mouse) for 5 minutes, which was immediately followed by 15-20 minutes of a 30-50ml of 4% paraformaldehyde (PFA) in phosphate buffer (PB, 7.4pH) solution. After perfusion, the brains were left in skull for 30 minutes in a fixative liquid before being immersed overnight in a sugar solution containing 4% PFA for post fixation. The next day, they were transferred to a 20% sucrose solution in 0.1M PB for 24 hours. Brains underwent cryoprotection in OCT, and sectioned at 12µm in coronal plane using the cryostat.

Immunostaining BrdU

For BrdU immunostaining, sections were first incubated in hydrogen peroxide in 0.1M PB for 10 minutes in darkness, rinsed 3 times

in 0.1M PB at room temperature (RT) for 5 minutes, incubated in 2M HCL at 37°C for 30 minutes, then rinsed in 0.1M sodium borate (pH 8.5) for 15 minutes at RT. Sections were then blocked for 30 minutes in blocking buffer (PBS-Tx NGS 5%), and rinsed in PBS-Tx before being incubated in primary antibody (1:500 BrdU Antirabbit IgG) overnight at 4°C in blocking solution (PBS-Tx NGS 1:100).

The next day, sections were washed in PBS-Tx for 15 minutes, incubated with secondary antibody (1:400) in blocking solution (PBS Tx NGS 1:100) for 1 hour at RT, and then washed in PBS-Tx for 15 minutes. The sections were then placed in ABC in blocking solution for 1 hour in darkness at RT, rinsed in 0.1M PB, incubated in DAB for 4-6 minutes, and rinsed in 0.1M PB for 15 minutes. All sections were mounted on Superfrost plus slides.

Quantification

Quantitative analysis of BrdU positive (BrdU+) cells was performed on brain sections belonging to all groups 1-4. Cell count was confined to the periventricular zone of the ventral 3V. For proliferation analysis on groups 1-2, BrdU+ cells were counted within 50µm of the outer layer of the third ventricle while BrdU+ cells beyond 50µm were ignored, the range of proliferation in the third ventricle. For survival and migration analysis on groups 3-4, BrdU+ cells were counted within 150µm of the third ventricle outer layer, ignoring cells beyond it, as cells beyond 150µm might not be from the third ventricle. The same areas were studied for all experimental groups. All five sections, with four brain slices per section of each animal, were analyzed if undamaged. BrdU+ cells were counted using a 40x confocal microscope.

Statistical Analysis

The area surrounding the 3V was examined using Image Tool. Data were analyzed using the student t-test for comparison, with values of $p < 0.05$ considered statistically significant. Data are shown as mean values per animal and section if necessary.

Results

Proliferation of Cells in the 3V Diminishes with Age

Comparison of cell proliferation of Group 1 and Group 2 via BrdU+ cell count indicated a higher number of cells per area in the mice treated for 1 month (Group 1) compared with the mice treated for 20 months (Group 2).

We performed a detailed quantitative analysis of both groups and, as depicted in Figure 1A, 1B and 1C, BrdU+ cell count was

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significantly higher in the Group 1 mice than in the Group 2 mice ($P < 0.000018$). In the Group 1 mice BrdU+ cell count by area was 3.67×10^{-5} cells/ μm^2 , while in Group 2 it was 7.98×10^{-6} cells/ μm^2 . In sum, proliferation was 465% percent higher in the younger mice of Group 1. Total area calculated in Group 1 mice was $2,391,337 \mu\text{m}^2$ and in Group 2 mice, $3,506,643 \mu\text{m}^2$. Area was calculated within $50 \mu\text{m}$ of third ventricle,

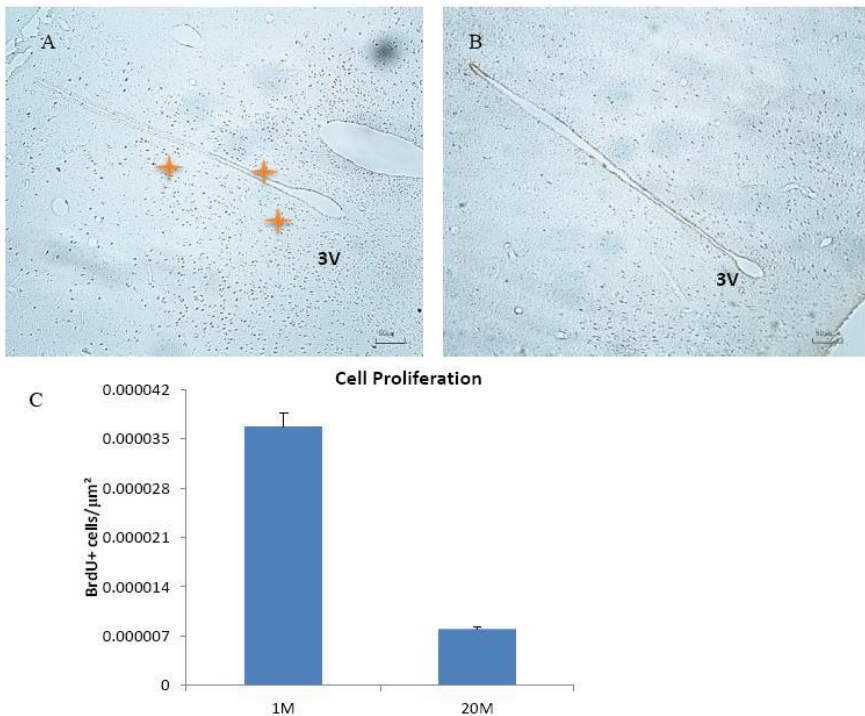


Figure 1. BrdU+ labeled cells in the 3V of a Group 1 mouse (A) in comparison with a Group 2 (B) with no BrdU+ labeled cells. (C) The number of BrdU+ cells generated per area in 1 month versus 20 month mice. Data indicate a higher amount of proliferation in younger mice ($P < 0.05$).

Proliferation is Higher near Medial Eminence, Specifically Ventral Zone

Interestingly, while analyzing proliferation we observed a significantly higher amount of cells in the medial eminence (ME) in the bregma -1.6m ($P < 0.05$). In the Group 1 animals, 67% of the total BrdU+ cells lay near the ME (Figure 2C). In the Group 2 animals, 58% of the total cells lay near the ME. In the animals sacrificed 1 month after the last BrdU injection, the amount of cells near the ME was considerably lower, with Group 3 animals at 20%, while Group 4 animals were at 25%

meaning that the majority of cells lie in the ventral zone as opposed to the dorsal. Quantitative analysis reveals a significantly higher BrdU+ cell count in the ventral area, $p<0.01$ (Figure 2A, 2B). Analysis was performed only on animals with clear and untorn ME.

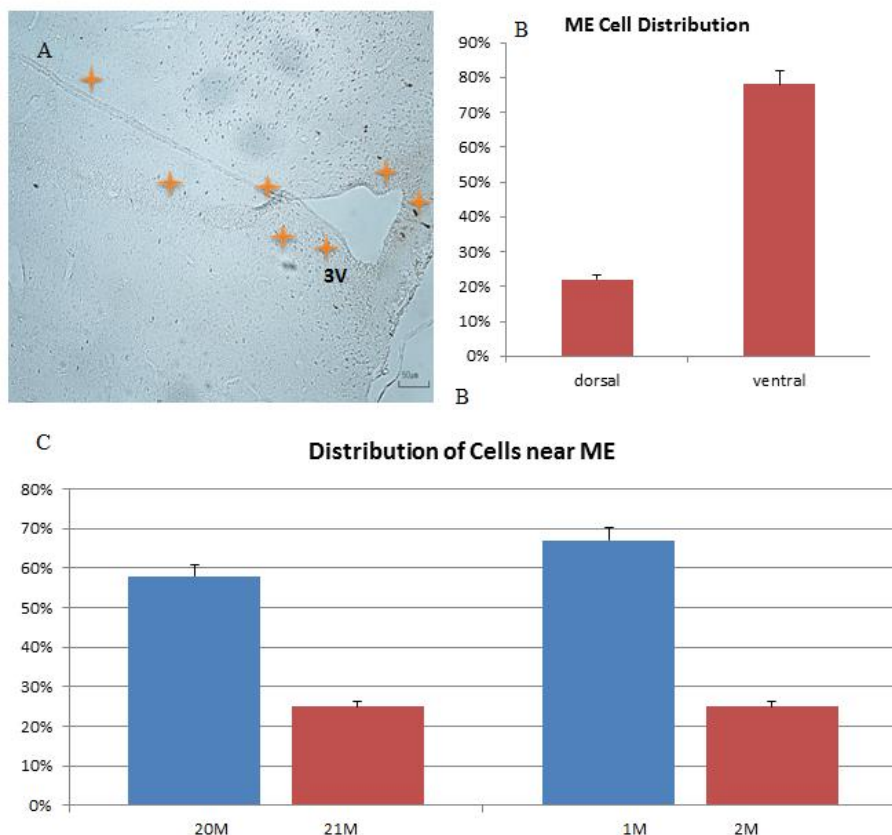


Figure 2. (A) BrdU+ labeled cells in 3V near medial eminence (ME), indicating higher BrdU+ cell count near ventral region (B) The distribution of cells in the 3V near the ME, ventral region has a statistically higher amount of cells in comparison with the dorsal region ($P<0.05$). (C) Percentage of total BrdU+ cells near the ME in Group 2 animals, Group 4 animals, Group 1, and Group 3 animals.

The Survival Capacity of Cells Diminishes with Age in the 3V

To study the survival capacity of new cells in the 3V, we delivered i.p injections to male mice of 1 month (Group 3) and 20 months (Group 4). Mice were sacrificed 1 month after their last injection

Proliferation in the Third Ventricle of the Adult Mouse Brain

in order to study survival capacity of cells; mice were 2 months and 21 months of age total at the time of preservation.

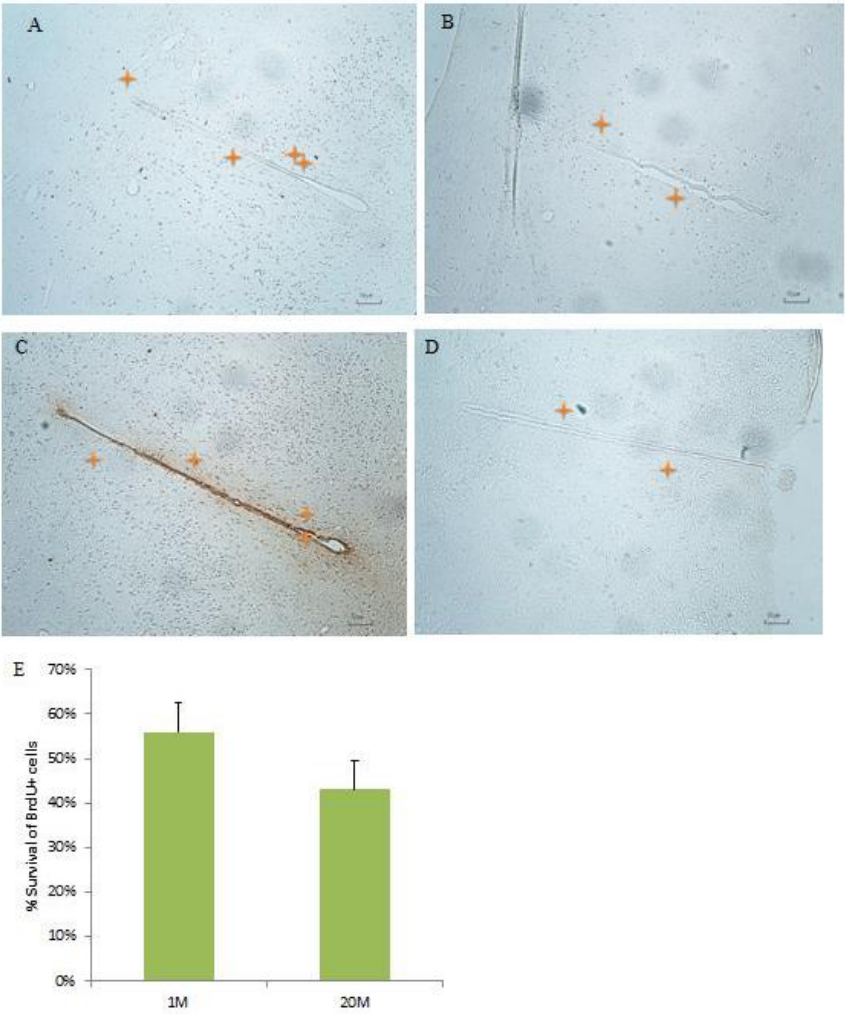


Figure 3. Images showing A) 1 month aged mice sacrificed 2 hours after last BrdU injection, B) 1 month old mouse dissected 1 month after last BrdU injection, C) 20 month aged mouse sacrificed 2 hours after last injection, D) 20 month aged mouse dissected 1 month after last injection. (E) Percent survival capacity cells in 3V of young animals 1 month of age in comparison with animals of 20 months of age.

Results found that survival capacity of cells significantly diminishes with age. In 20 month mice, survival decreased by 57% in comparison to the younger mice. ($P<0.028$). In young mice aged 1 month

at last injection, survival decreased by 43% ($P < 0.05$). Young animals showed a 15% increase in survival capacity than the aged animals. We performed a comprehensive quantitative analysis on both groups as shown in figures 3A, 3B, and 3C. Area was calculated within 150 μ m of the 3V.

Conclusions

This present study has shown proliferation of new cells decreases with age, as does survival capacity of said cells. This study has also shown the ventral medial eminence to contain a higher amount of cells in comparison to the dorsal region. The BrdU labeling and isolation of BrdU+ cells clearly showed higher cell count in young animals compared with the older animals. Half of the animals were sacrificed 2 hours after their last injection for this study in order to see the new cells that had divided. Doing so, we saw that the animals dissected at 1 month proliferated over 400% more than those dissected at 20 months. The reason for this significant difference is unknown.

It is possible, however, that older animals haven't the necessary signals from other sources to produce more cells. It is well established that in young mammals, including mice, cell production is at its highest in the first postnatal months of life in the SGZ and SVZ (Altman and Das 1967). As mice are not considered adults until 3 months of age, our month old mice are not considered adults, as their brains are still forming and developing. In the 3V, proliferation is highest in the first months of life and decreases with age, much like the SGZ and the SVZ, and numerous other regions of the brain that have been more thoroughly studied.

From what we observed in this study, cell proliferation is low in the third ventricle, with 12 cells in a 50 μ m range in the young animals. In older animals, there cell count was up to only 6 cells in the total area. This cell counts are low in comparison to the SGZ and SVZ, both with approximate cell counts of 20-40 (Seri B 2001, Alvarez-Buylla and Garcia-Verdugo 2002).

While observing proliferation, we noticed the ME had the highest BrdU+ cell count. In all the animals dissected in group 1 after last BrdU injection, over 50% of the total cells marked with BrdU+ laid near the ME. The ventral region closest to the ME showed higher amounts in proliferation in both young and aged animals dissected at both 2 hours and 1 month after last injection. Our results indicate the ME could be affecting proliferation but as there are no current studies on proliferation in the ME, further research on the ME and proliferation is needed.

In studying proliferation, of new cells, we wanted to see the survival of these cells that are already synthesized. In order to do so, we dissected the group 1 animals. The animals in group 2 had lower cell survival capacity than the cells in the young animals in group 1. More of the cells that incorporated the BrdU administered 1 month ago survived in the young animals. The cells that did not survive either died or migrated. From the BrdU+ staining, it seems most of the cells died. We did an analysis on the migration, and did not find a significant difference in the number of BrdU+ cells within 50µm of the 3V and 150µm. Indicating most of the cells did not migrate far. This study has provided an understanding of the proliferation and survival of cells in the third ventricle, with both proliferation and survival capacity of cells decreasing with age. This has the potential to lead to the treatment of neurodegenerative diseases in the near future.

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My research interests include neurological disorders and sleep architecture. I plan to attend graduate school and earn my Ph.D. in neuroscience.

Environmental Justice at the Hanford Nuclear Waste Site: Utilizing Local Knowledge to Transform Risk Science and Management

Jacinta Sara Heath

Abstract

Hanford, Washington is home to the first full-scale plutonium production complex and is now the most contaminated site in the Western hemisphere. This study addresses a central question: How have the lived experiences, local knowledge, health indicators, and perceptions of risk in disparately impacted communities affected the practice of risk assessment at Hanford? Community-based action research provides critical insight into the socio-cultural dimensions of the Hanford site needed to understand the complicated processes that shape clean-up efforts. This methodology can also be utilized to critically examine how those decisions impact the experiences and health of the larger community. Archival research, participant observation, discourse analysis and ethnographic interviews were utilized to identify stakeholder groups and analyze current public participation practices in an effort to make risk science and assessment at Hanford more accessible to disempowered communities. This research adds to our collective understanding of the importance and use of cultural resources on the Federal reservation; the contemporary economic importance of the CERCLA (Superfund) site; as well as how Hanford has and continues to affect a diverse range of stakeholders. The study research seeks to foster attention to environmental justice policies; increase involvement of marginalized stakeholders; and facilitate implementation of collaborative sustainable solutions to mitigate threats to population health and safety as well as address impediments to indigenous cultural integrity.

Introduction

In 1943, Hanford, Washington became home to the world's first full-scale nuclear weapons production complex. By 1988, the site had been declared the nation's most contaminated site under the CERCLA's National Priorities List (NPL) and is now widely considered the most contaminated site in the Western hemisphere.

This research and analysis is grounded in the environmental justice framework and the study addresses how differently positioned stakeholders participate in and negotiate the process of interpretation of findings with the Hanford managers and engineering experts as well as

how they cope with the adverse health effects induced by exposure to hazardous wastes such as Iodine-131 (known to induce thyroid cancer). Environmental justice (EJ) calls for the “fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies” (Miller, 2003). EJ also refers to the problem of geographic, organizational, and procedural inequities that comprise part of the construction of environmental racism (see Peña, 2005): People of color and low income communities are more like to live in areas in which they are exposed disproportionately to toxic wastes and other hazardous substances and risks (this is the geographic inequity dimension); They are more likely to be excluded from the organizations that make decisions affecting the siting of hazardous waste and other risk-inducing sites (the organizational dimension); and they are more likely to suffer from unequal enforcement of the nation’s environmental laws and regulations (the procedural inequity dimension). Contemporary environmental justice regulations, established under President Clinton’s 1994 Executive Order 12898 and refined under the leadership of President Obama’s EPA Administrator, Lisa Jackson, require Public Participation Plans to address these issues. This is an aspect of Superfund law, which is one critical focus of this study.

Risk assessment and management is another fundamental feature of contemporary environmental justice regulations and is at the heart of many of theoretical, methodological, and political debates. The analytical methods and materials of risk assessment and management are recognized as a necessary step in arriving at reasoned decisions concerning environmental and public health risks. Dr. Bernard D. Goldstein of the Graduate School of Public Health at the University of Pittsburgh, in his 2005 publication, *Advances in Risk Assessment and Communication*, explores how risk assessment has evolved in the face of newly acknowledged problems such as intergenerational impacts posed by long-lasting radiation pollution. He also explores the communication of risk to citizens and how that influences perceptions of risk.

However, the state of the art in current risk assessment methods, and applied to Superfund sites, has yet to incorporate the impacts of Structural Violence and Historical Trauma on the health of communities and ecosystems. Scholars, such as Dr. Devon G. Peña, have identified the absence of these factors in risk science and have connected it to historic exclusions of people of color from participation in the planning and decision-making agencies and processes that govern environmental planning, protection, management, and regulation (Pena,

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2011). Environmental activists from various communities assert that “we are the most polluted and the *most excluded*” and challenge the systematic exclusion of their people from decisions that impact their land, health and cultural perpetuation. Reconciling these demands with the scientific culture of the experts is not an easy task; but many policymakers and activists alike believe this is indispensable to the attainment of the fundamental equity goals of EJ.

Very few accessible ethnographic accounts of how the Hanford site has affected public health and wellbeing exist. Even fewer sources explain the use of the land before it was designated as Hanford Engineering Works in 1942; there is no deep environmental history of the place, which many scholars believe is required to assess cumulative effects of risk (Goldstein, 2005; Peña, 2011). Another gap that persists involves ethnographic information about the interaction and communication between government agencies controlling the site and the primary stakeholders directly affected. How is the local knowledge considered and utilized within the decision making process at Hanford?

For undetermined centuries, Native American peoples have utilized and had sacred connections to this place. Archeological evidence validates inhabitation and utilization of the land for at least 10,000 years. Native stewards of the Hanford area are connected through the land and river as well as their Sahaptin and Cayuse language. Their descendants are commonly referred to as Cayuse, Palouse, Nez Perce, Umatilla, Walla Walla, Yakama, and Wanapum peoples and/or First Nations. Hanford covers approximately 600 square miles and, despite the technological and environmental transformations since 1942, remains part of a system which has fed, nurtured, and hosted the aforementioned peoples as well as various smaller bands of people and all their relations (plants, animals, resources) for centuries.

Little to no federal emphasis exists on the cultural resources that survive and how the contamination of this land serves as a barrier to the utilization of traditional foods and life ways. For many reasons, local indigenous knowledge systems serve as one of the grounding theoretical foundations for my research and subsequent community involvement.

Due to the cultural, political, economic and environmental contingencies of the ongoing management and clean-up of the Hanford site, anthropologists are uniquely situated to provide valuable insights and knowledge relevant to the development and implementation of more just, equitable, and sustainable policies to address this iconic case of environmental racism. Social scientists including anthropologists have developed considerable expertise in the critical assessment of environmental risk as a scientific and political process. My research

aspires to continue this work as a means to serve the greater public and reduce risk and harm to disproportionately impacted communities.

Methodology

Community-Based Action Research Design: Participatory Inquiry

Engagement with the community is intended to elicit the primary stakeholders' lived experiences, local knowledge, and perceptions of risk in relation to the Hanford site. The sort of information this methodology elicits cannot be collected with traditional quantitative analysis. This suggests a related issue: Given the tendency toward a misguided singular emphasis on quantitative analysis in risk science, to what extent are local knowledge claims of disparately impacted communities legitimized and utilized by site managers? The two communities may not even speak the same language [sic]. The continuous active cycle of observation, reflection, and action could enable the unlocking of hidden knowledge and inspire revelatory conversations between impacted communities and decision-making gatekeepers.

How do the politics of knowledge legitimacy affect the prospects for shared responsibility in the complex processes of planning and decision-making at Hanford? These inquiries will address environmental justice concerns for geographic, organizational and procedural inequities in the risk regime at Hanford.

Archival Research: Lessons in Code-Breaking

One of the great successes of this project is the great wealth of accessible archival material; unfortunately most of the task involves immense expenditure of "code-breaking" because of the excessive use of technical jargon and little effort to make these documents accessible to the general public – itself a violation of EJ regulations and principles. For those interested in the historiography of the Hanford Site, please refer to *On the Home Front: The Cold War Legacy of the Hanford Nuclear Site* by Michele S. Gerber. In the future, I would like to translate this guide into different reading levels so the information can be more readily comprehended by a wide spectrum of interested parties. My hypothesis is that if students and future generations are exposed to easily accessible information about complex issues at Hanford they will increase their involvement and more effectively offer their problem solving abilities.

An important aspect of Community-Based Research is the deliverables. Deliverables are useful materials that anthropologists produce for the community they engaged with, often after the research is completed. Examples of deliverables I have created in the past include: A

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poster for Hanford Challenge to be used for Outreach and Fundraising; curriculum materials for Washington State Physicians for Social Responsibility; and informational handouts for Heart of America Northwest; and blog-posts



Figure 1. Graphics from the Tri-Party Agencies and three non-profit groups who I collaborated with; they are the main source of my archival materials.

Participant Observation: A Cycle of Observation, Action and Reflection

This form of observation is distinct from observational routines typically used in experimental research or clinical practice. Instead of observing only specified things the researcher takes a more ethnographic approach as a means to “better understand the life world of those being observed and an understanding of the way they ordinarily go about their everyday activities” (Stringer, 2003).

This form of participatory qualitative research is well suited to address the challenges posed by primary stakeholder involvement, a crucial yet underutilized aspect of EJ mandates. While observing stakeholder groups, the researcher is enabled to develop context by observing the everyday settings in which participants live and work as well as how these players interact with each other. Observation of these interactions can often lead to invaluable insights about power dynamics and inequities that affect the soundness and rationality of what are often expert-driven processes.

I have found the statement of Ernest T. Stringer in his book, *Action Research*, resoundingly true that “participation in research contexts also provides the researcher with opportunities to engage in interviews and conversations that extend the pool of information available”(77). By volunteering with local non-profit advocacy organizations and attending public meetings on Hanford, I developed a network of people and resources who were the foundation of my research and engagement as well as raised awareness of the issues.



Figure 2. (left) Photograph from Recording of Public Participation Meeting 7/21/2011 by Mike McCormick **Figure 3.** (right) On-campus outreach as part of a course in Spring 2011

Semi-Structured Interviews: The Importance of Rapport Building

Ethnographic interviews are most effective when they evolve as a semi-structured and almost conversational exchange. This leads to unexpected information that might otherwise be missed if the researcher follows too strictly a set of predetermined questions. The ethnographic interview is also a very powerful narrative form because it provides stakeholders with opportunities to describe the situation in their own terms. This is a reflexive process which enables the interviewee to explore his or her experiences in detail and to reveal the many features of that experience that have an effect on the issue investigated.



Figure 4. Images from interview with James Stone Cipher III; Cipher holds the world record for living the longest without a thyroid, which was likely deteriorated by exposure to Iodine-131 during Cold-War peak plutonium production at Hanford. These photos illustrate the birth of our collaborative efforts. Used with permission.

Results: Successes and Failures of Research Model

Participant observation was my most successful initial research method and allowed me to navigate this complex issue with support from fellow stakeholders and collaboration with various groups. By participating in public events while listening, asking, and answering questions, I have learned the most valuable information, gained access to the most valuable research sources, and fostered essential rapport with a variety of stakeholders.

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While participating in primary stakeholder involvement events hosted in Seattle, I collected extensive field notes, informational handouts (which will be analyzed as data), business cards, and long-term interpersonal connections with attending stakeholders.

Interviewing was intended to be the center piece of my research project, but I encountered unforeseen barriers of resistance and fear. This method elicits information that is not accessed by traditional quantitative research. However, due to the sensitive nature of the issues and the on-going culture of secrecy surrounding the Hanford site there is was often a propensity for interview participants to not want their perspectives to be shared with third parties; In could collect data but was not authorized to share it. Tri-Party agencies and their employees need access to this information so they are better situated to make decisions about cleanup that directly affect these stakeholders, but we must first address cultural and political constraints that are currently preventing this exchange of information.

I have also found that this ethnographic research has opened up my mind to the multiple pathways in the transmission of contaminants. Formerly constrained by traditional risk assessment models of thinking, I was failing to see the whole picture. Based on the information I have collected in interviews, I can now see that there are flaws with current risk assessment models because they do not account for cumulative impacts, bio-concentration of contaminants, or intergenerational impacts. Moreover, these models do not even acknowledge issues of disparate impacts to women in their reproductive years, children, or other marginalized populations including Native Americans, migrant farm worker, and individuals from or low socioeconomic status. These constitute serious violations of longstanding EJ principles and regulations.

One key informant, James Stone Cipher III, opened my eyes to differential pathways of exposure through the interview process and led me to identify factors that have consistently been overlooked by the mostly male experts such as prenatal and postnatal practices on health outcomes. Mr. Cipher explained: “I was born during a time of *‘insignificant releases,’* my older sister was alive during the period of *‘significant releases’*...she never had any health problems. She was always inside, I was out on the dirt farm chasing my Dad’s tractor, drawing pictures in the dirt and fishing...I was the only one in my family who ate the fish” (Cipher interview, 2011). He was also exposed to bio-concentrated contamination, “...my Mother couldn’t breast feed. I drank goats milk instead” (Cipher interview, 2011). Goat’s milk is a known source of bio-concentrated iodine-131 from the Hanford site.

James Stone Cipher III experienced extreme symptoms of thyroid deterioration such as weight gain, distorted perception of time, decreased immunity, and finally physical incapacitation. Pre- and postnatal exposure to down-wind contaminants, intergenerational cumulative impacts, as well as other factors may have completely deteriorated his thyroid. “When I got to the hospital I had lower levels of thyroid [sic] than they had ever seen, most people would have been dead. They told me I hold the record for surviving the longest without a thyroid” (Cipher, interview, 2011).

Despite having produced additional valuable findings through this interview process, I am ethically constrained to not fully divulge the ethnographic accounts I collected. What I can report and emphasize is that these interviews collectively suggest how the existence of differential pathways to exposure have been largely overlooked in the technical reports and official risk assessments. Factors such as prenatal and postnatal practices were unexpectedly brought to the surface as were behavioral patterns varying from person to person that also likely influenced their exposure to contaminants, resulting in differential health outcomes. Also, socioeconomic status and ethnicity appear to have influenced the perception of risk and of the impact of exposure on health outcomes and methods of addressing illness.

Conclusions

My participatory action research project began to fill information gaps with the potential to provide valuable historical and cultural insights on how Hanford has affected the health of citizens, which will provide some guidance on how to address long-term issues far into the future. Another aspect I have encountered in my research is how perception of risk influences the experience of illness as well as how individuals may pursue addressing any health issues likely caused by contaminants from the Hanford site and the military industrial processes which occurred there.

Further research of this nature is needed to address issues with current risk assessment methods and models for the management of risk in communities suffering from disproportionate impacts. Concepts of cumulative risk, intergenerational trauma (including possible compounding genomic factors and effects), and disparate damages must be considered and integrated into risk science, management, and communication. A more holistic approach will also integrate inequalities as forms of structural violence that attenuate the effects of disparate impacts – for e.g., barriers to accessing adequate healthcare. Clearly,

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more anthropological data and qualitative perspectives need to be represented in decision-making.

Synthesizing information from relevant archival documents into easily accessible formats will increase overall understanding of the Hanford site and its operations and how these affect primary stakeholders. If primary stakeholders are more informed about the history of the site and its current decision-making and cleanup processes, they will be better situated to make comments and get involved with monitoring and assessing the cleanup. I believe that the re-localization and diversification of research, decision-making and clean-up practices will improve Hanford site operations and stakeholders' perceptions of risk and risk management.

Addressing the Native American Perspective: EJ Concerns

Indigenous knowledge is not integrated into the theory and practice of current risk science and management at the most contaminated lands on our planet, where typically these same people are disproportionately impacted as well as experiencing the intergenerational effects of structural violence – i.e., displacement, loss of ties to the landscape including ceremonial and sacred sites, poverty, lack of access to quality education and health care, and exposure to multiple point sources of long-term industrial pollution including consumption of contaminated fish.

The Columbia River, which has various names in the place-based indigenous languages, once served as a unifying entity which brought together the peoples north and south to honor and celebrate its replenishing flows and served as a summer gathering place for migrating peoples, animals and plants. Modern perceptions of the river as a dividing boundary are alien and yet persist and grow; this is one of the ideological paradoxes I have encountered throughout my study which illustrated the importance of personal and cultural perspective/perception in decision-making processes and about how to best utilize the land. I advocate that a seventh generation model of decision-making should be implemented to address the pitfalls of current short-term contractual planning cost-benefit analysis business models dominating site cleanup.

The pre-WWII history of the Hanford allows us to put this venture into perspective and realize that this land had a long story before it was chosen to be the site of the plutonium production branch of the military industrial complex and that it has an unfathomable future we have a role in creating. It reminds us of the previous stewards of the land and the different worldview, which managed this place more sustainably. Knowledge of the past and a long-term perception of time will assist us

in imagining a future which will be more conducive to human health and safety and ecological restoration. People must have access to this knowledge to open our mind's eye to the wealth of life found in the region and for us to feel compelled to protect and nurture it.

Native American peoples who are promised access to the site are disproportionately at risk. Those who chose to gather and use traditional resources, participate in sacred ceremonies, and fish at "usual and accustomed places" are inevitably exposed to bio-accumulated and bio-concentrated contaminants from the site. The chemical and radioactive leaks are already dangerous and are projected to be high enough to cause 5 percent of Native American children using the groundwater under Treaty rights to die of cancer. Yet we discover another paradox; common cultural perspective hold that to cease this relation with the land, animals and plants, despite its risks, would cause equally grievous damages that have yet to be quantified. Anthropologists have not explored the construction of a comprehensive culturally informed record of the site and other domains of knowledge used to look at the site have also neglected this perspective.

The United States Government is not honoring environmental justice regulations as well as original Treaty fiduciary duties. It is currently dangerous to practice gathering, ceremonies and hunting on the site, but it continues to be done because of the cultural significance of not allowing these life ways to die. Future studies must address the incorporation of a new approach to risk science that draws from local, place-based qualitative data and deepens the historical framework while acknowledging historical trauma and structural violence as compounding factors.

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My main research interest is investigating how the processes engaged by WWII development of the U.S. military industrial complex has impacted human health and reproduction, especially in marginalized populations. I intend on pursuing a Ph.D. in social science concurrently with a J.D. program focused on international environmental law.

Traffic Safety and Ethnicity: Are Our Road Signs Intuitive Across All Cultures?

Sherry Jin Kim

Abstract

Statistically, Asian Americans have significantly lower traffic accidents than any other minority group in the United States. However, there exists a stereotype that Asian Americans are a bigger risk on the road than any other ethnicity. This study explored the perspectives of Asian Americans, specifically Korean American women living in the city of Bellevue. Despite having enough English speaking skills to live comfortably in America, they had either a difficult time understanding roadway signs and posts or it was not intuitive at first glance or within the time span necessary to make a decision on the road. The major problem identified by the subjects was that in their homeland, many traffic decisions were made based on their instincts due to minimal roadway signs, or enforcement was so minimal that conforming to these traffic laws was not a priority. They reported that this mentality was reinforced because even when traffic laws were ignored, accident rates were low. This suggests that Asian Americans, though involved in fewer traffic accidents, make decisions less-rapidly, are confused on the road, or less readily conform to traffic regulations. This study helps uncover a largely untapped field of study involving traffic safety within minority group, and will further contribute to future research in similar topics.

Significance

This project is significant because not only do transportation engineers serve to maintain mobility and accessibility of transportation systems, but also they provide a safe and efficient system that serves the community as a whole without any intentional bias. Through understanding the web of issues related with decreased traffic safety within the minority group of Korean American women, modifications to the traffic control devices, traffic policies, and transportation systems can be made to better suit a wider spectrum of traffic users. Changes can then be made so that our transportation system can serve more people, reduce traffic fatalities, and find effective methods in increasing minorities' awareness of traffic regulations.

Previous research has confirmed that minority groups have a higher risk in traffic collisions (HiltonJudith, 2006), but the kind of attitude and perceptions of traffic regulations minorities have are still vague. It would be a beneficial asset for policy makers and traffic

engineers to know what kind of behavior minority groups produce when interacting on the road. The transportation system would be safer if these safety cultures of minority groups are considered into practice. According to Migration Policy Institute, legal immigration has been on the rise steadily for the last 80 years. (Legal Immigration to the United States: Fiscal Years 1820 to 2010 (in millions), 2010) There will always be immigrants and a heterogeneous mix of cultures and the ability to serve the whole community equally is difficult and doable, but also very important.

Background

There exists a stereotype that Asian drivers underperform in comparison to other ethnicities. According to 'Race and Ethnicity in Fatal Motor Vehicle Traffic Crashes 1999-2004' published by National Highway Traffic Safety Administration (NHTSA), all minority populations had higher percentage of traffic fatalities in all deaths. (Alcohol and Highway Safety: A special Report On Race/Ethnicity and Impaired Driving, 2010) However, the study shows that Asians and Pacific Islanders were an exception to minority populations in non-obedience to basic traffic safety regulations. For example, with the exception of Asians, minorities were more often driving while intoxicated (RomanoEduardo , Voas Robert B., LaceyJohn C., 2010) , less validly licensed, less likely to be wearing seat belts, and less likely to secure children into car seats. The study also shows that Asians were just as likely to abide by the regulations as the white population (HiltonJudith, 2006).

For example, in Washington State, 77.3% of the population is White, 7.2% of the population is Asian American, while the total fatalities percentage for Washington. (Traffic Safety Facts 2006 Data: Race and Ethnicity, 2009) (State & County QuickFacts, 2012)

If Asians are more likely to obey these traffic regulations, why are they overrepresented in the number of traffic fatalities along with the other minority groups? If Asians are just as likely to obey traffic safety regulations as Whites, why do they have a higher fatality rate? Are there behavioral differences that cause more motor vehicle traffic risks? (GlassbrennerDonna & Ye Tony Jianqiang , 2008) Are there differences in safety cultures across ethnicities? Do they convey different attitudes due to their ethnic backgrounds?

One research paper explored that a higher level of vulnerability of immigrants in traffic safety is caused by differences in safety standards that immigrants brought from their home countries. (ChenCynthia, LinHaiyun , LooBecky P.Y., 2011) These differences in

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safety standards evidently result in various patterns of behavior, but what causes these behavioral differences?

Behavior is most often executed from an attitude or thought, conscious or not. Exploring what they think will be good indicators of their behavior. (SteinbachRebecca , EdwardsPhil, GreenJudith, GrundChris, 2007) Asians, along with many other racial groups, may have different perceptions of what is “right” and “ethical” on the road. For example, changing lanes last minute for an exit or changing lanes with minimal use of blinkers, merging later down the road vs. early on, and so on. Immigrants may assume that selective obedience and “part time” compliance is acceptable, as they may be used to using their instincts to make decisions on the road. They may have a different perception of traffic safety policies than natives. (RaglandDavid, 2005) Some might feel comfortable violating traffic laws as long as they are “safe” and do not comply to regulations when they feel like their judgment is just. (BernardStephanie J. , PaulozziLeonard J., WallaceL.J. David , 2007)

Behavioral differences encompass their perception of traffic safety regulations. Do they utilize all available traffic signs? (WestBethany A. & NaumannRebecca B., 2011) Are they adamant about their rights on the road, or are they willing to yield their rights to be safe? How attentive are they to temporary traffic control measures? Communication issues between flaggers and drivers are a major source of collisions and can be a barrier for Asian Americans in driving. What do they think a good following distance is, and do they adhere to “recommendation” signs such as recommended reduced speeds at roundabouts and corners? Do they intuitively understand channelization and other visual devices?

Some of these perceptions and attitudes can deepen our understanding of what kind of mindset Asian Americans have of utilizing the road, and thus can explain some risks generated by them. By understanding their mentalities and attitudes of the road in correlation with their time of arrival, the rate of assimilation to US traffic standards can be estimated.

Research Questions

Images in popular media portray drivers as relying on instinct more heavily than on traffic control measures in their home countries, making it hard to assimilate to standards in the States. (references) To determine whether this assertion is supported, I propose the following research questions:

1. How do Asian Americans perceive traffic regulations and policy?
2. What kinds of safety regulations did they bring from their native country?
3. What kinds of “ethics” of the road are important to them?
4. How much are they utilizing the traffic regulatory signs and channelization?
5. Do Asian drivers of the same cultural background behave differently? If so, Why?
6. How long do assimilation to standards of the States does it take?

Sampling Design

I first set some control variables to eliminate other factors that may skew our results. I hoped to use 10 Korean American individuals who migrated to the United States and who live in various parts of the Eastside (so they have experienced similar road conditions and traffic signs and regulations). Age range was from their 40s to 50s with a mixture of those exposed to driving in Korea and those who first started driving in the States.

My design was structured to eliminate too much culture variance, impacts of age (since adaptation gets harder as you get older), and geographical variances. These may be factors that change attitude and perception of traffic regulations and could skew the results to overestimate impacts of background culture.

However, kept a variety of income levels, education levels, gender, and living history. Though history of living in Los Angeles or New York or Alaska may greatly change behavior and attitude, it is still important to see the general assimilation rate and perception differences. All of these external and uncontrollable or unaware factors may be excavated, explored and retained during the research procedures.

Research Method Overview

I worked with Scott Rutherford Ph.D. from the Civil and Environmental Engineering Department. His research focuses on transit planning, transportation planning and policy. I used the method of “purposeful sampling” to self-select the most useful and representative few individuals to interview, conduct focus groups and do field observations. I chose 6 Korean Americans I know from the general Korean Community with the above specifications who participated in a two-part research methodology.

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Interview – With the interview, I delved into each individual's perspective of traffic safety regulation attitudes, their honest attitudes on the road and cultures they individually brought to the States. I asked them some general questions and included open discussion.

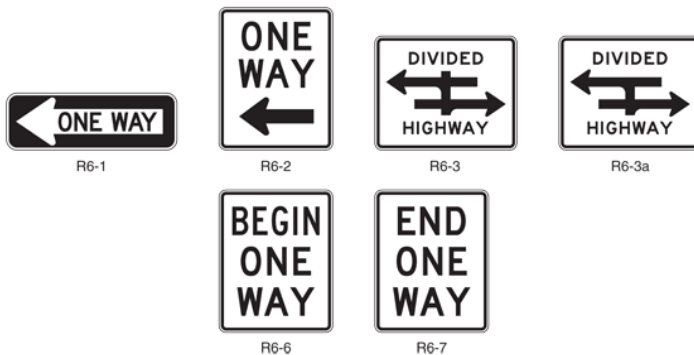
Focus Group – With the focus group, I hoped to see how individuals interact with their opinions of traffic safety regulations. I also hoped to get a general consensus on their level of understanding of traffic control measures (traffic signs, traffic lights, channelization, etc.) and communal ideas of traffic problems. This method is valuable because ideas of different individuals bring a greater variety of ideas to discuss.

Because the City of Bellevue does not keep a database of all the implemented traffic signs, I made field visits to various parts of the city to note which signs were the most common or seemed important. This qualitative judgment was calibrated by reading the MUTCD (Manual on Uniform Traffic Control Devices). I also identified the traffic signs that are intended to protect the viewer from potential conflicts. Additionally, I chose other signs that could pose the most confusion on the road for any user.

For the interview and focus group questions and signs, please refer to the Appendices.

Results

With the traffic signs chosen, we filled out the handouts I created and discussed the handouts together. During the hour or two, the members observed the signs in scrutiny and wrote what they believed the sign meant, why the sign would be useful, where and when would this sign be crucial and how quickly would other ethnic travelers be able to comprehend these signs.



***Figure 1.** ONE WAY and Divided Highway Crossing signs.*

In Figure 1, the first signs we identified were R6-6 and R6-7. This traffic sign would be observed quite often in downtown parts of cities where only one direction of flow is permitted. This can pose high risk when not obeyed and will be crucial in protecting travelers.

Everyone in the focus group was able to understand what this traffic sign meant. It was also easy to understand what sort of situation this would be placed in. They were able to fully understand that when the “End One Way” sign was posted it was now permitted to travel in the opposing direction from the sign on.



Figure 2. Passing, Keep Right, and Slow Traffic signs.

The two signs I discussed from Figure 2 are the R4-1, R4-3, R4-17, and R4-18. The first traffic sign, R4-1, is more often seen on one-lane highways and freeways. It is important because it protects the traveler from choosing to pass on a segment with limited site distance, causing a potential conflict with oncoming traffic. The second sign, R4-3 can be seen more often on multi-lane highways or freeways where there

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can be variable travel speeds (i.e. a lot of interchanges, presences of freight trucks etc.) R4-17 and R4-18 are used often when there is a lot of right of way on the shoulder.

Everyone was able to intuitively understand what R4-1 meant. They recognized what the literal meaning was, but were unsure of the context. Some were unfamiliar with the act of passing itself. They were shocked that it was allowed to travel on the opposing traffic lane to pass a car when specific channels were laid out. Most members were able to recognize what the R4-3 meant, but were somewhat unsure in what context the sign meant. If this sign was observed where it was implemented, it may have been more meaningful and substantive, but I recognize that this is the shortcoming of my research. One thought that the sign meant “slow down and move to the right lane.” She reasoned that perhaps it was intended for some sort of merging section ahead on the left that needs volumes concentrated on the right. After some discussion, we came to the conclusion that this sign was intuitive enough across for the ethnic groups. R4-17 and R4-18 were easy to understand by all members. Initially, I thought the term “shoulder” might not be intuitive for them because of the literal meaning, but everyone said that they have become accustomed to the terminology. They said that a lot of these words have created meaning in them because of context and repetition.

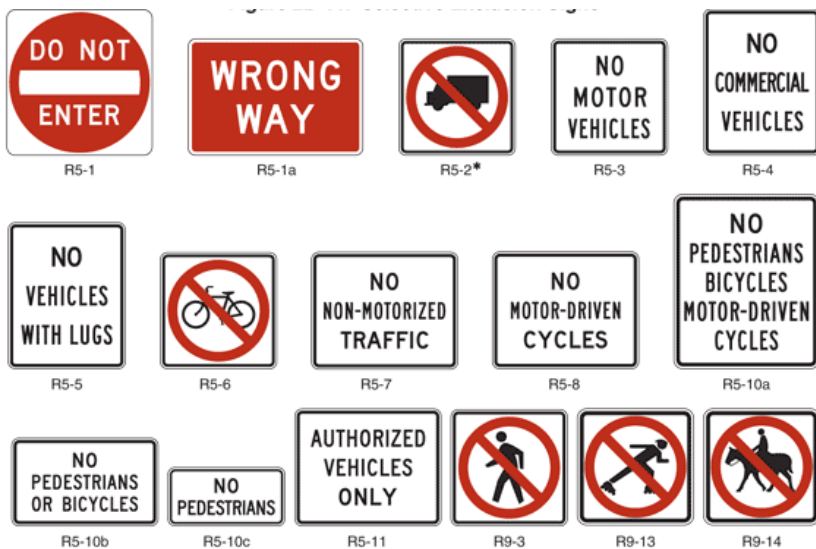


Figure 3. Selective Exclusion signs.

The signs that will be discussed from the Figure 3 above are R5-1a, R5-7, R5-10c, R5-1, and R5-11. These signs are categorized in the Selective Inclusion Type signs. These signs are regulatory and are very important to keep traffic circulating well and divert potential conflict.

All but one knew what the R5-1a sign meant. They recognized that the sign prohibited further access and that they should not enter where the sign was posted. One thought that the sign meant that it indicated the “incorrect road.” She thought that the marked road was not recognized as a road for cars altogether. R5-7 was a little more confusing for everyone. The sign was definitely not intuitive. Many were confused on what sort of traffic could be non-motorized. It seemed that many did not consider foot or bicycle as a form of traffic. It was interesting to discuss that in the United States, any form of travel can be a form of traffic. The word “traffic” translates to Gyo-Tong in Korean, and the Google Korean Dictionary defines Gyo-Tong with automobile, boat, and plane. This may have an impact. Results from R5-10c were interesting. In contrast to my expectations, many recognized what the word “pedestrian” meant. However, many recognized it after scrutiny; they required longer than 1-2 seconds to understand the sign, which is the time period a driver needs to make a reflexive decision on the road. However, this was not a huge concern because a person in a motorized vehicle would not need this sign. The R5-1 sign was the one that everyone recognized immediately and alertly. They knew what it meant and where it was found and expressed that they knew how to handle a situation when they saw it. The R5-11 generated a heated discussion. Some expressed that we should avoid approaching places with these signs at all costs to play it safe. Some believed that if they were permitted it was okay, but others believed that some sort of proof had to be shown. A general consensus of the sign was that to avoid the extra hassle of dealing with getting permits or authorization, it was best to just avoid this space at all. It seemed like the members all did not like grey area signs, and preferred a Yes or a No.

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Figure 4. Pedestrian signs.

Hitchhiking is one of the most culturally particular aspects of the American traffic culture. R9-4 and R9-4a above in Figure 4 shows the signs of prohibiting hitchhiking. The first sign is an image and the second is written in words. Most who knew the meaning of hitchhiking preferred the bold words on the sign. Those who did not know what hitchhiking was said that it was not actively part of the culture back in

their home country, South Korea. They were not aware that the hand motion meant that word. There is no original Korean word that translates “hitchhiking,” which shows why it wouldn’t be intuitive.

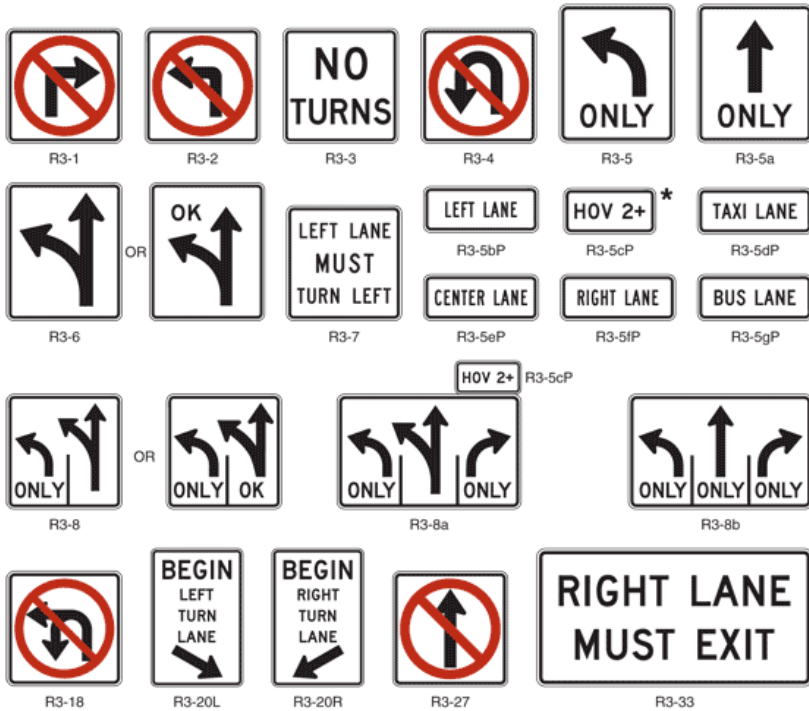


Figure 5. Parking and Stopping signs and plaques (R8 series).

Figure 5 above shows R8-3, which is the no parking sign. This sign is important in showing compliance and tendency to abide by traffic laws when given a choice.

Everyone instantly knew what this sign meant. They were fully aware of what the “P” stood for and they were 100% up to comply with the regulation. When they were told that if the sign was accompanied by more information such as “Except SUN, HOL” or something similar, they said that these signs were at times too small to read, causing them to slow down to comprehend the directions, which in many cases made cars behind them to honk or swerve around them, which increased stress. They identified parking as one of the most stressful aspects of driving after merging and diverging on highways.

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★ The diamond symbol may be used instead of the "HOV" word message. The minimum vehicle occupancy level may vary, such as 2+, 3+, 4+. The words "LANE" or "ONLY" may be used with this sign when appropriate.

Figure 6. Movement Prohibition and Lane Control signs and plaques.

Figure 6 above shows R3-3 and R3-4 signs which we discussed in our focus groups. They are important because a lot of locations have cross-prohibiting medians that require u-turns at times.

All recognized what the meaning of R3-4 sign meant, and they initially believed they meant the same thing. However, when reminded that there is a difference between a turn and U-turn, they were astounded that it wasn't as intuitive at first glance, because the R3-3 sign has a simple and plain language. They also noted that back in Korea, it wasn't often enforced. Many drivers never complied with these signs, and seeing random u-turns on huge arterials was common and not notable. They recognized that it was crucial to abide by this traffic regulation and failure to do so may result in a citation, but they identified this as one they may sneak if "all clear."

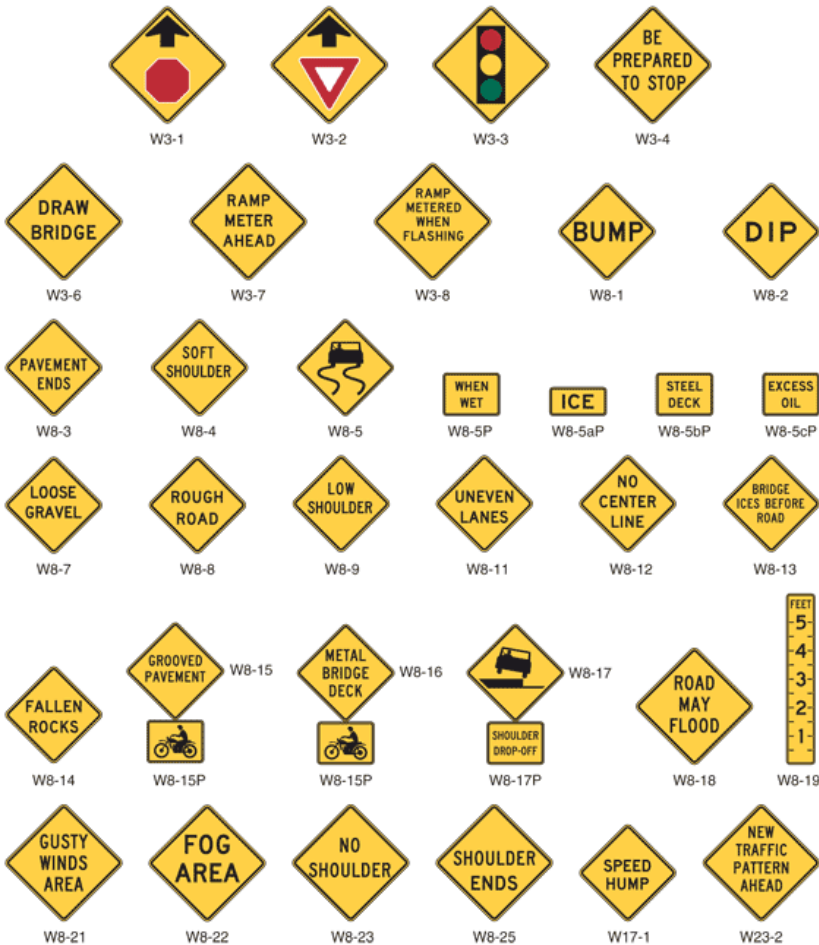


Figure 7. Roadway and Weather Condition and Advance Traffic Control signs and plaques.

The traffic signs discussed, shown in Figure 7, were W3-1, W3-2, W3-4, W3-7, W3-8, W8-3, W8-4, W8-7, and W8-9. These traffic signs are under the umbrella of current conditions. These traffic signs are important because it lets the traveler know some of the potential hazards that may arise. These are advisory precautions that can benefit the driver if they choose to adjust to the conditions.

The W3-1 and W3-2 signs were easily identifiable. While discussing whether the missing words in the signs could potentially be hard to comprehend for immigrants, they identified that these signs were used back at home as well, making it a very easy adjustment. Also, the

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shape and design is more the identifier than the words itself, they reported. The W3-4 sign was easy to understand. They knew they were posted in locations where they should be on the lookout to slow down or stop. The W3-7 and W3-8, signs that warn drivers that a signal control allowing one car per green light is ahead, were identified as among the most difficult signs to understand. When they saw the word “ramp” they immediately imagined some form of grade change. The term “ramp meter” was alien to all except one member. She identified that the two signs were a “sign at freeway entry” and at a “freeway entry, slow down, one car per green light.” All other members identified them as, “a streetlight ahead will be turned on,” or “an uphill road is coming up” or “temporary situation,” or “roadwork in freeway,” or “temporary construction work on freeway” When explained that the W3-7 sign was not a temporary sign, but a rather permanent warning sign that notifies unexpected conditions so that people are alert of conditions that may need speed reduction or measures of safety, they were surprised. W8-3, W8-4, W8-7, and W8-9 were discussed collectively to explore whether the diamond orange signs were recognizable as warning signs as discussed previously.

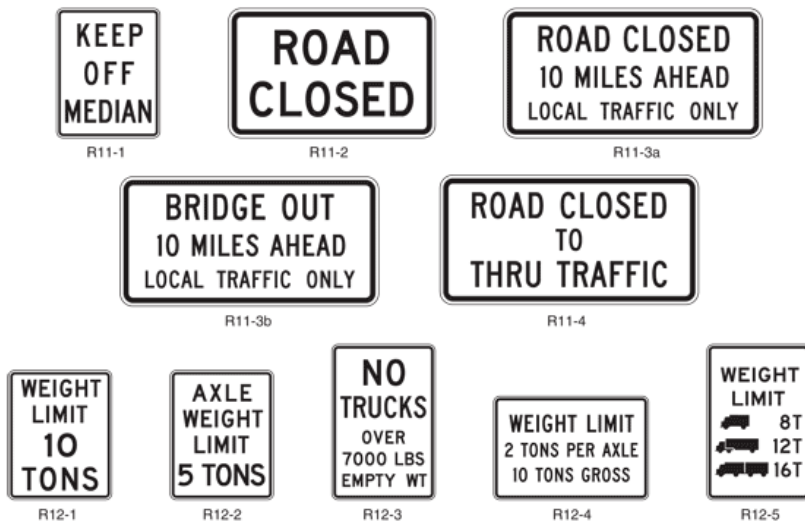


Figure 8. Road Closed and Weight Limit signs.

The observed traffic signs from Figure 8 were R11-2, R11-3a and R11-4. Road closure signs are not as impactful as safety measures, but it is important to avoid a pricy citation.

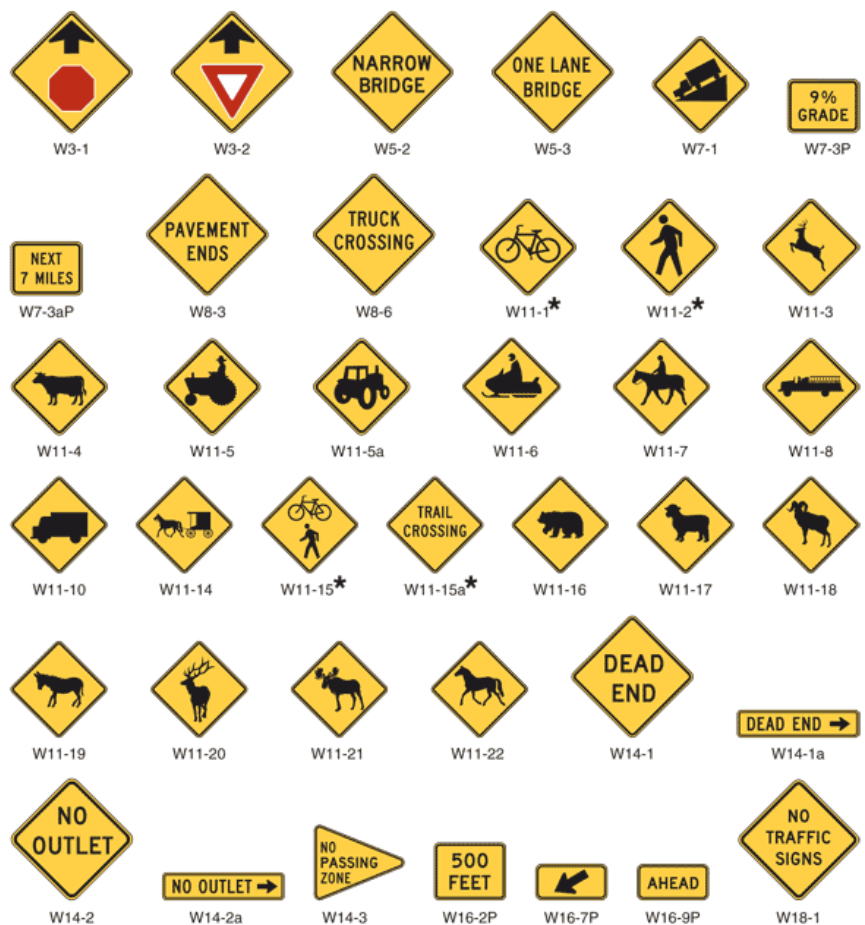
The road sign R11-2 was obvious for all participants. They were fully aware of where this sign would be used and how this would affect their choice on the road. R11-3a was expected to be more confusing, but on the contrary, the sign was very intuitive and easy to understand. “Local traffic” was a term that everyone understood quickly. R11-4 was less intuitive. Some participants took much longer to realize what “thru traffic” was and this delay in recognition could pose a risk on the road, as indecision or delay in reflexive driving can be a risk to other drivers. Many members acknowledged that at times they were unable to make a quick judgment or decision because of the inability to comprehend some things fast enough, which will be vital to consider in future research.

The traffic sign to be discussed in Figure 9 was W14-2 which is a permanent warning sign. This sign can be used interchangeably or simultaneously with “Dead End” or “No Thru-Put” signs. This sign was very intuitive for all participants and they understood that they could be simultaneously used with the mentioned signs. Participants identified this sign as useless, unnoticed and pointless. Whether they are actually so, it is unknown, but they named this one as something that probably will go unnoticed when they are on the road.

The traffic sign discussed from Figure 10 was W7-1. This sign signifies that the upcoming corridor can be steep and large vehicles should use extra caution. This sign is at times implemented at locations involving a large grade change where there have been accidents in the past

Most participants were able to identify this sign immediately. However, one member believed this sign to be one that only allows trucks on the upcoming hill. We came to the consensus that this traffic sign would be relatively easy to grasp at first glance. Also, it was noticeable that many prefer symbols and images to words, but at times, words are more explicit.

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* A fluorescent yellow-green background color may be used for this sign or plaque

Figure 9. Other Warning signs and plaques on low-volume roads.

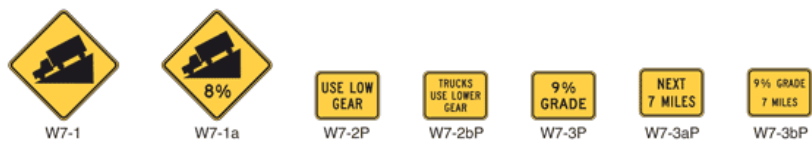


Figure 10. Vertical Grade Signs and Plaques.

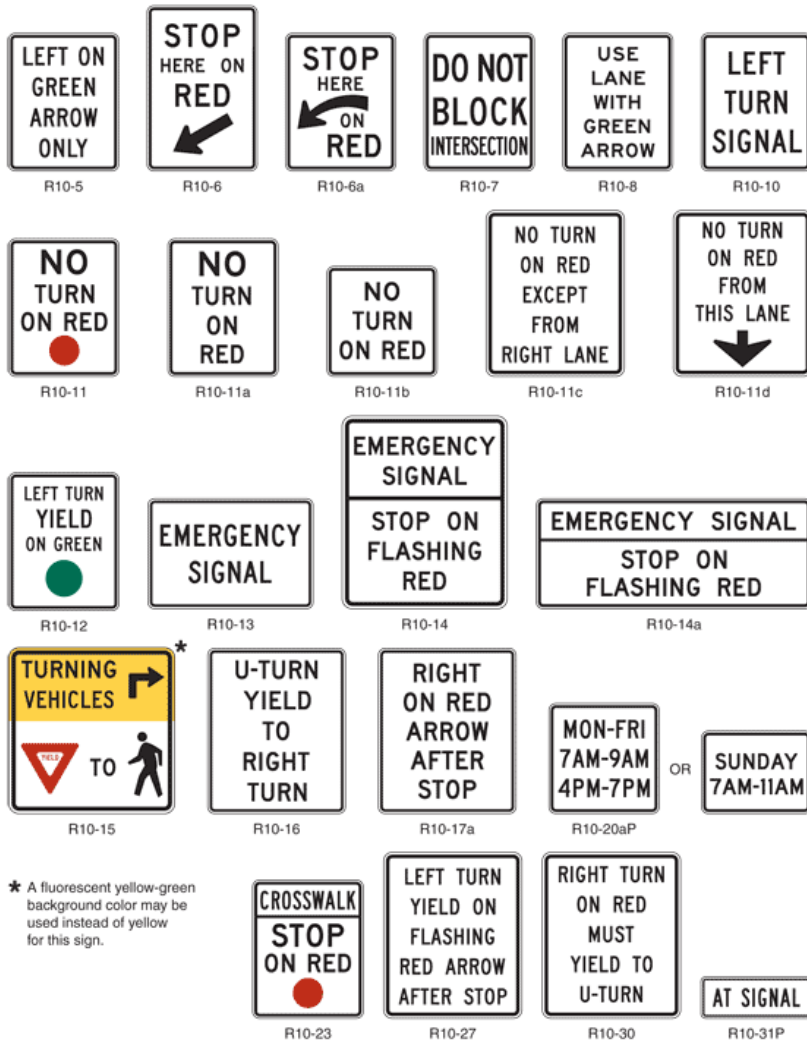


Figure 11. Traffic Signal signs and plaques.

Some enforcing traffic signs at intersections or locations of high conflict can be of high interest for drivers. The discussed traffic signs were from Figure 11. They are R10-6, R10-6a, R10-7, R10-11, R10-11a, R10-11b, R19-14, R10-16, R10-17a and R10-30.

Observation of arrows was also observed. R10-6 and R10-6a can be used interchangeably. They identified that the arrows were insignificant in preference, but they identified that they were both readable. If one had to be chosen, symmetry was sometimes easier on the

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eye, some said. But others thought that asymmetry didn't take anything away at all. The highly disputed traffic sign R10-7 is a hot topic within city departments with traffic engineers and with drivers who see them. Some love its implementation; some despise it for ineffectiveness. The participants were able to identify the literal meaning of the sign, but had a hard time seeing it in context. They were unsure in what situation would they "block the intersection." It was explained that these are posted on the arms of the traffic signals at intersections and that they serve as a barrier to not enter the intersection if the queue in front of you extends into the intersection and blocks other phases and flow of movement. They identified this issue as one of the biggest annoyances while driving. When a queue in another direction blocks the path of travel for other movements, it creates congestion and also is a perfect way to land a high priced citation. This sign brought in mixed feelings. Many expressed that they had experience being the culprit as well as a victim.

The next traffic signs, R10-11, R10-11a and R10-11b were compared for easier understanding. They identified that R10-11 was highly preferred and that the red dot left a stronger impression than the other versions in enforcing the importance. R10-14 is found often near fire stations or police department, and many identified this. However, some said it would be okay to treat it as a stop sign and can proceed if nothing occurred for a while. We discussed that they should only proceed once the flashing stops. R10-16, R10-17a and R10-30 were discussed more in depth about the wordiness of the sign than the actual meaning. The signs, they said, were a bit too text heavy. They understood that there was no really other way to represent this using symbols and images, but they said when approaching a white sign (in comparison to orange or red) with many words without bold "NO" or enforcing words, they would be prone to bypass this sign without too much thought. Many were even unfamiliar with these signs and were unsure where they would be implemented. This shows that having text heavy signs can result in an insignificant impact to their decisions and may go unnoticed. This can cause confusion on the road when keeping order on the street and knowing who has the right of way and can be a safety hazard.



Figure 12. Merging and Passing Signs.

Figure 12 shows one of the traffic signs discussed: W9-2. This is an important sign because it explores the highly stressful merging and diverging actions, and sees how it can pose potential safety hazards. Another is the W4-1.

The participants identified that the merging and diverging sections of highways were the most stress-inducing parts of driving. Making lane changes or moving into various spaces between various car speeds and driver attitudes can create a high level of stress. Communication between drivers of whether a merge is allowed or not was not always easy. When the signs above are visible, many feel a bit of anxiety in needing to make movements that require quick reflexives and rapid decision-making skills. The sign was completely understandable. For the W4-1 sign, most preferred the explicit words than the symbol because it explicitly mentioned that the lane ends.

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Figure 13. Warning Signs and Temporary Traffic Control Zones.

Traffic signs of concern in Figure 13 are W1-8 and W1-4c. These give warnings of temporary traffic control measures. They are important because even for familiar road users, the current conditions may be unfamiliar.

W1-8 and W1-4c mean basically the same thing, but one may be implemented one well in advance while one may be implemented at the

actual site. This difference was noticed only by a few. They understood that the road was turning, but did not differentiate relatively where they would plant them. It is not too crucial and, because the lack of context was a barrier to their understanding, it was interesting to see the simplicity in which they observed the traffic signs. Simplicity is, and obviously it is, the most important factor of making signs.

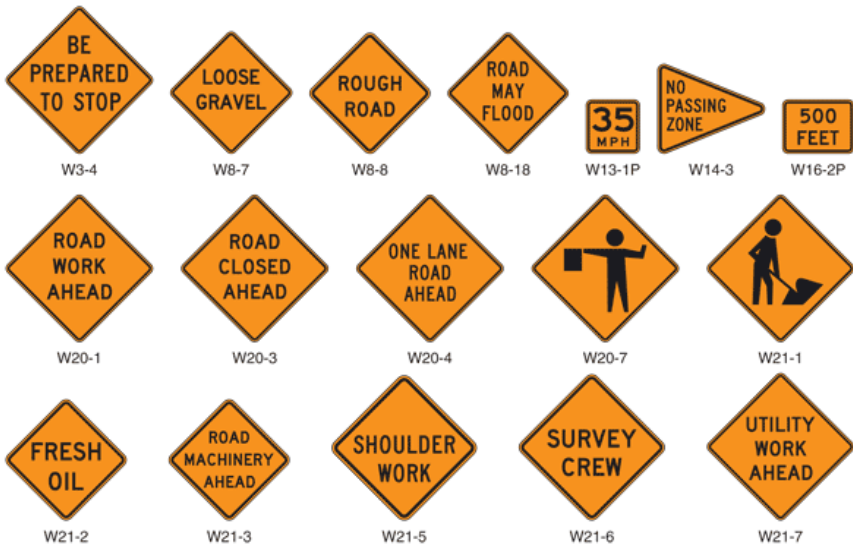


Figure 14. Temporary Traffic Control Signs and Plaques on Low-Volume Roads.

Temporary construction traffic control is one of the most unsafe locations with high numbers of injuries and fatalities of construction workers. Alert and keen attention should be given especially in areas of utility work. We wanted to focus on W20-7, W21-1, and W21-7 from Figure 14.

The participants actively understood that W20-7 meant that there would be a flagger. Although flaggers nowadays do not use the same equipment in the image, they were able to identify they were actively controlling the traffic. Also, the participants said they expected delays or understood the need to possibly slow down in the area where they would see a W21-1 sign. Some said that W21-7 was not very intuitive because they were unsure of what “Utility Work” was and assumed some form of delay would occur ahead. When informed that they were usually much smaller than actual construction projects and would require little extra traffic control, they were surprised how specific certain terms can be.

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Conclusions

Despite having enough English speaking skills to live comfortably in America, the subjects had either a difficult time understanding roadway signs and posts, or when they did understand, it was not intuitive at first glance or within the time span necessary to make a decision on the road. The major problem that these Asian Americans felt was that in their homeland, many traffic decisions were made based on their instincts due to minimal roadway signs, or enforcement was so minimal that conforming to these traffic laws were not a priority to them. For example, signs that regulate traffic activity were at times viewed as recommendations. They reported that this mentality was reinforced because even when traffic laws were ignored, accident rates were low. Also, because English was not their first language, they were prone to take a longer time to fully understand the traffic signs than what is needed behind the wheel. This suggests that Asian Americans, though involved in fewer traffic accidents, make decisions less-rapidly, are confused on the road, or less readily conform to traffic regulations.

Future Research

Traffic accidents make up a large portion of the fatalities in the United States. One death is one too many, and measures to control or stop traffic accidents and fatalities is top priority for public policy administrators, automobile manufacturers, and traffic engineers. When we find new factors that influence the causes of traffic accidents, they must be exploited, explored and extinguished.

This research was a preliminary exploration to open up new fields of study that correlate traffic safety with ethnicity. Equity in serving traffic safety measures across the holistic population of the United States is necessary, and methods to calibrate these measures must be found. Future research may include finding certain vulnerabilities in recognition of street networks and looking at ways to explore “traffic culture” and behavioral perception differences. Additionally, in order to reach sustainable modes of transportation in the United States, we can explore ways to encourage safe, sustainable travel in ethnic groups and identify what motivates sustainable, more mindful utilization of the roadways by immigrants residing in the United States.

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- *** Note: All figures (images of traffic signs) were provided by the MUTCD.

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I am interested in researching sustainable transportation, urban transportation planning and policy, and traffic safety, often in correlation to ethnicity. I plan to further my education with pursuing graduate studies in the Civil and Environmental Engineering department at the University of Washington.

Autonomous Planning and Control of a Robotic Vehicle

Bao An Le*

Abstract

Autonomous control systems are critical for the operation of aerial vehicles and spacecraft. This project focuses on the development of an autonomous control system for a robotic vehicle by simulating the model of the vehicle using computer software. This model will then be used for testing various control schemes. In particular, variation of the proportional-integral-derivative (PID) controller will be used and tested. The main goal of this research is to implement the autonomous control system on the vehicle and compare the response of the vehicle to those generated by our computer simulation. Specifically, the research will focus on the development process of the PID controller. Our results will then verify whether the developed mathematical model is accurate for the purpose of predicting actual system response. The objective of the analysis is to confirm the advantages and disadvantages of each control scheme and to develop an autonomous control algorithm for the vehicle. In-depth analysis will also provide insights into the difficulties and challenges of developing a mathematical model that accurately simulates all states of the system, as well as the complications involved in creating a system that precisely controls the vehicle as desired by the user.

Nomenclature

e	=	error
K	=	proportional constant
R	=	radius of Frisbee [m]
r	=	radius of wheel [m]
t	=	time [sec]
U	=	control output (subscript P, I & D are Proportional, Integral & Derivative, respectively)
V	=	velocity of Frisbee [m/s]
v_L	=	velocity of left wheel [m/s]
v_R	=	velocity of right wheel [m/s]
$\dot{\psi}$	=	rotational speed of Frisbee [rad/s]

Introduction

Autonomous control systems are critical for the operation of aerial vehicles and spacecraft. The field of control is still under heavy development and research. This paper will specifically look into the process of how an autonomous controller is developed for a physical system based on its mission requirement. This process involves developing a model of the physical system. The modeling process is done by mathematical means and serves to predict the real life output of the system through simulation. The modeling process is important due to the benefit it provides. In real life, autonomous controllers are designed for multi-million dollar systems, and like any computer program, the control system is subjected to bugs and human errors. With no guarantee that the control algorithm will function as intended, it is not wise to implement it directly onto the actual system without first testing out the controller to determine if it is functioning properly. The mathematical model of the system serves the purpose of allowing the control code to be tested on computer simulation of the system first to ensure that the controller is functioning as desired. The control algorithm is written to satisfy the desired functions of the system. Common examples of controllers are in virtually all electronic mechanical devices from the robot vacuum cleaner to unmanned aerial vehicles. A commonly used type of autonomous controller is the PID controller, which will be the focus of this paper. The benefits and drawback of a PID controller will also be discussed.

This paper serves to look into the process of how a control system is developed and implemented on a robotic vehicle. A two-wheel vehicle, called the Frisbee, is used for this purpose. The Frisbee objective is to be able to move to a location that the operator desire autonomously. A mathematical model of the Frisbee is development and used in the simulation process to predict the movement path, as commanded by the feedback controller, of the Frisbee. A PID type controller will then be developed for the Frisbee bot to control its path and eventually have it perform formation routing. The main mission of the Frisbee is to be able to autonomously reach a destination as intended by the operator without requiring low-level commands. The main software that will be used for code development is MathWorks MATLAB and Simulink. The embedded controller, an Arduino chip, will be running on a language based primarily on C.

Frisbee Bot

The Frisbee bot is a two-wheel robotic vehicle, whose 3-D model is shown below in Figure 11.

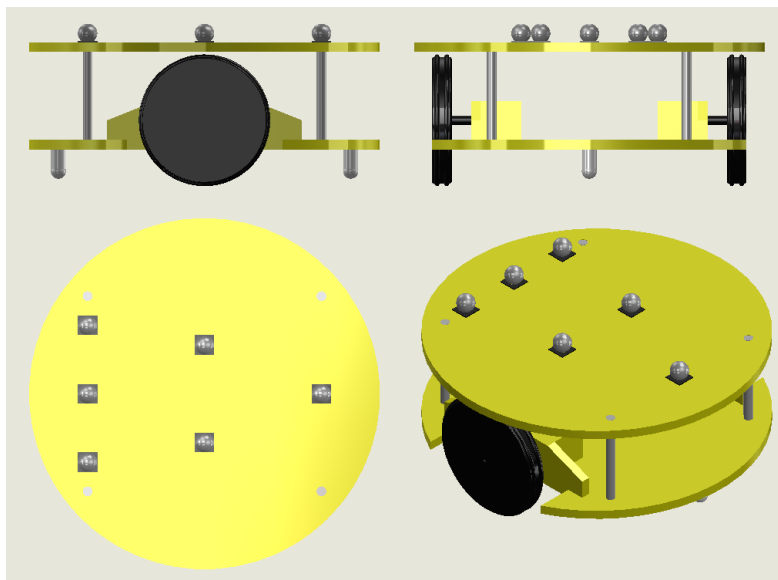


Figure 11. Frisbee Bot 3-D model.

Note that the model just shows the bare Frisbee without any hardware attachment beside the motors (Figure 1). The Frisbee has two point of support at the front and back to keep it level and balanced. It is a circular bot capable of conducting a 360° of movement from rotating to going straight ahead to curve trajectory. Both its wheels are directly opposite of each other and contained within the diameter of the bot. Its top cover can be removed and electronics hardware component can be placed inside. The top is flat and hosts the Vicon markers for the Vicon system to track. The markers and Vicon system purpose and use are further discussed below in Section 0. The Frisbee is approximately 18 cm in diameter with a wheel diameter of 7 cm.

Hardware and Software

The Frisbee uses two servos as its propulsion system. The servo is capable of rotating the wheel in both directions, i.e. clockwise and counter-clockwise, and has a higher torque than an equivalent DC motor. This allows frictional forces and slipping conditions effect to be further reduced on the Frisbee and hence can be safely ignored entirely for the purpose of the Frisbee objectives.

The embedded system that runs the Frisbee Bot's hardware is the Arduino Duemilanove. This microcontroller serves as the onboard computer that receives and convert control signal to hardware output for the Frisbee. The Arduino microcontroller is equipped with the Xbee

shield which receives and sends communication wirelessly from the Frisbee to the host development PC. The Frisbee control its motor through an H-Bridge, which receives logic command from the Arduino microcontroller and covert that signal to voltage for motors output (Figure 2).

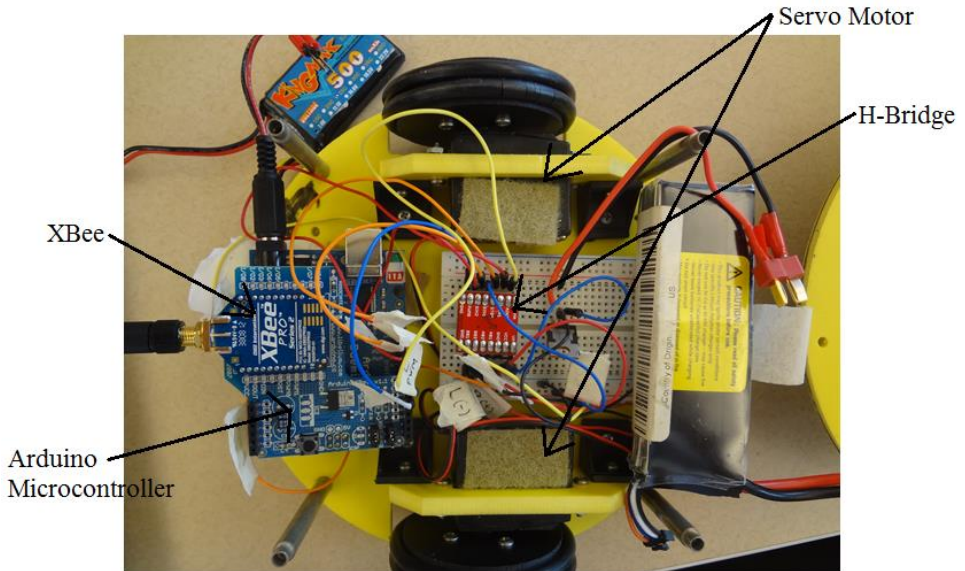


Figure 12. Hardware installation.

The software that will be used to develop the controller algorithm will be MathWorks MATLAB and Simulink. The Frisbee will be modeled in MATLAB through a function. The controller will also be developed and simulated through MATLAB. The physical hardware test will be done through the Distributed Space Systems Lab (DSSL) architecture that integrates the Frisbee Bot into a subclass of DSSLVehicle. This integration allows the Frisbee controller to receive data from the Vicon system, which it needs to compute commands, as that is its main source of feedback from the Frisbee. For further details on the DSSL Vehicle integration, refer to “A Rapid-Development Multi-Vehicle Tested Architecture for Control Systems Research” ^[1]. A schematic of the DSSL system architecture is shown below in Figure 13^[1].

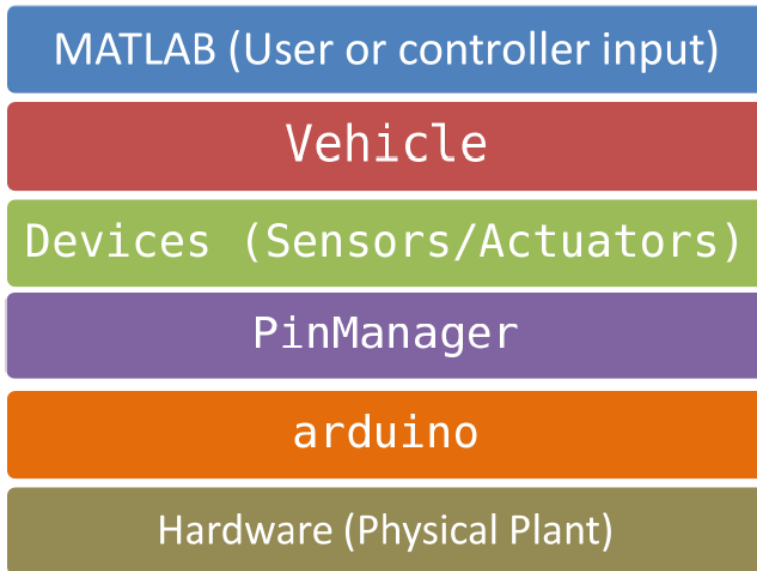


Figure 13. DSSL architecture.

The architecture shown above in Figure 13 enables the developer to ignore the low level details and work on designing the autonomous controller. The low level details includes interaction between the high level hardware, i.e. MATLAB code, to low level commands, i.e. such as voltage to motors and converting from MATLAB language to the Arduino language. The software integration process is done within the architecture, thus allowing the developer to bypass those details, which can hinder the development process. The architecture also enable engineers who are do not process familiarity with varioubs embed system language such as C to be able to work on developing the controller on a higher level language such as MATLAB. This enables the user to focus more of the tasks at hand instead of having to deal with the low level software and hardware integration.

DSSL has in place the Vicon system, which is a set of special cameras setup around the room to track a distinctive type of markers that reflect infrared light. The camera than translate the position of the markers back to the host computer, which then provide the data to the user. In this case, the Vicon will track the Frisbee's location data, which will be used as the feedback for the autonomous controller. This will explained in details later on in the paper.

The hardware's physical limitations and specifications are then tested and recorded to be used as parameters for the simulation model, which will be discussed further in Section IV. Some limitation, such as

the servo, for example, was put under a variety of voltages input to determine the wheels angular rate of rotation. The test created data for a “lookup table” for which the user can specify a desired velocity, rather than having to specify a voltage to the servo, which is much more convenience and useful to the developer.

Modeling & Simulation

This Frisbee is modeled using a kinematic model of the vehicle rather than a dynamic model, which is typically used for this process. The kinematic model is chosen for simulation because it is able to produce the desired result of the Frisbee behavior, its path. It is also a much simpler model to develop and implement, and since it is capable of producing the desired prediction of the Frisbee behavior, the kinematic model is thus chosen for the simulation process. Although the model lacks the ability to predict the dynamic behavior of the Frisbee, the kinematic model is well suited to be able to predict the path of the Frisbee, which is adequate for the purpose of testing the controller. As the kinematic approach is being used to model the system, the dynamic of the Frisbee will not be taken into account during the simulation (Figure 4).

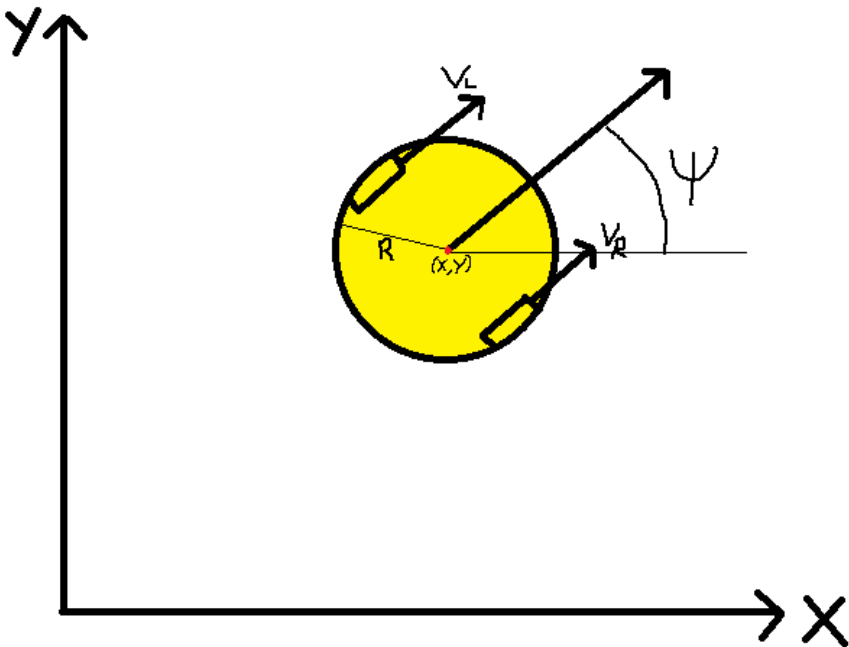


Figure 14. Frisbee kinematic.

The control of the Frisbee is the velocity of the right and left wheels, hence the kinematic equations will have the position of the Frisbee as the output and will be dependent on the velocity of the wheels, its variables. Since the direct control input of the Frisbee is the angular velocity of the wheel, the position of the Frisbee will be a function of the angular velocity.

The velocity of the vehicle is related to the right and left wheels velocity by:

$$\text{Eq. [1]} \quad V = \frac{v_R + v_L}{2}$$

The rate of rotation, i.e. the rate at which the orientation direction changes, of the Frisbee is given by:

$$\text{Eq. [2]} \quad \dot{\psi} = \frac{v_R - v_L}{R}$$

The position of the Frisbee bot is determined by kinematic to be:

$$\text{Eq. [3]} \quad x = \frac{V}{\dot{\psi}} [\sin(\psi \Delta t) \cos(\psi_0) - (1 - \cos(\psi \Delta t)) \sin(\psi_0)] + x_0$$

$$\text{Eq. [4]} \quad y = \frac{V}{\dot{\psi}} [\sin(\psi \Delta t) \sin(\psi_0) + (1 - \cos(\psi \Delta t)) \cos(\psi_0)] + y_0$$

$$\text{Eq. [5]} \quad \psi = \dot{\psi} \Delta t + \psi_0$$

The 0 subscript indicates initial value. Substituting equations [1] and [2] into equations [3], [4], and [5] produces the kinematic equations for the Frisbee Bot.

Eq. [6]

$$x = \frac{R(v_R + v_L)}{2(v_R - v_L)} [\sin(\psi \Delta t) \cos(\psi_0) - (1 - \cos(\psi \Delta t)) \sin(\psi_0)] + x_0$$

Eq. [7]

$$y = \frac{R(v_R + v_L)}{2(v_R - v_L)} [\sin(\psi \Delta t) \sin(\psi_0) + (1 - \cos(\psi \Delta t)) \cos(\psi_0)] + y_0$$

Eq. [8]

$$\psi = \frac{v_R - v_L}{R} \Delta t + \psi_0$$

Equations [6] – [8] are used as the kinematic mathematical model for the Frisbee Bots. In depths details of the derivation can be found in “Simple Path Planning Algorithm for Two-Wheeled Differentially Driven (2WDD) Soccer Robots” [2]. The outputs and inputs of the model are:

Eq. [9]

$$X = [x; y; \psi]$$

Eq. [10]

$$U = [v_L; v_R]$$

As equations [9] & [10] show, the kinematic model will not be a time invariant model, but rather a time varying model which means that time will be an input needed by the Frisbee Model. This Frisbee model is coded into a MATLAB file and tested by giving the model various control input and checking if the output is appropriate. A set of test inputs are tested and shown below in Figure 15.

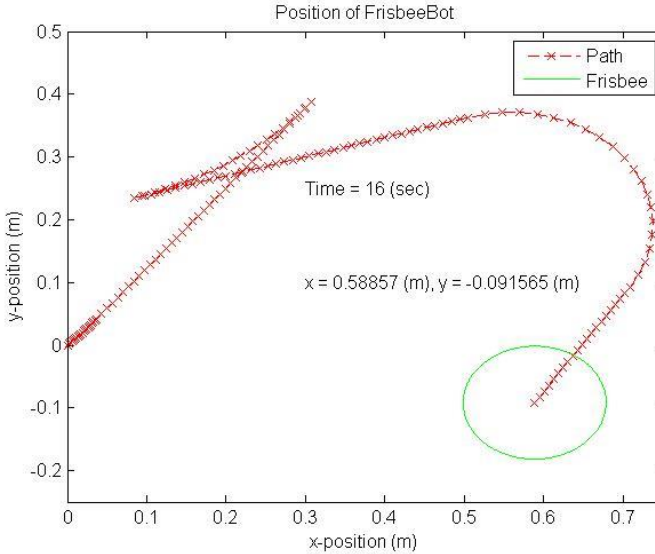


Figure 15. Frisbee Model Test.

A series of control inputs to both v_R and v_L are inputted into the Frisbee Model which produced the trajectory shown in Figure 15. The

objective of this is to see whether the Frisbee model produces the expected output for a given input. If the model produces the result expected, then it will prove that the mathematical model is correct. An example, as seen in Figure 15, is to give the Frisbee model a constant velocity input for both wheels, and then observe if the Frisbee is moving in a straight path, which is what one would expect if the velocity of the right and left wheel are identical and constant. The model did indeed produce a straight path for the Frisbee with the previous commands given to the model. This test affirmed that the kinematic model of the Frisbee bot is indeed accurate as the output shown is the expected from the input given to the Model. With a good model of the Frisbee, the control system could now be designed.

Controller Design

The purpose of the Frisbee Bot is for it to autonomously travel to a location specified by the user. For this system, a PID controller, a type of feedback controller, is used due to its simplicity and effectiveness for this sort of system (Figure 6).

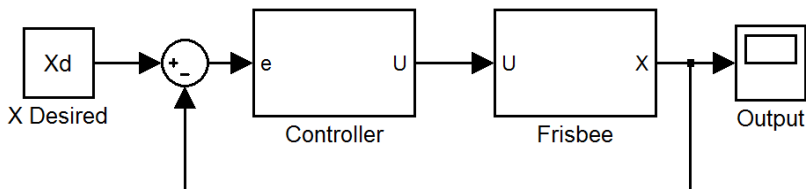


Figure 16. Block Diagram of a Feedback Control System.

A feedback controller works by taking in the current state of the system and calculating an error value based on how different the current state of the system is from the desired state. Figure 16 shows that the only input needed from the operator is the desired destination for the Frisbee, and the controller will then handle all the necessary low level commands to get the Frisbee Bot there. Feedback controller compute the error between the user input and the current state of the system, which in the Frisbee case, are the desired location and the Frisbee current location, respectively, and output a control commands that will drive the error to zero. This process is repeated until the error is reduced down to zero or a user specified hysteresis.

The Frisbee Bot will have two feedback controllers. The first controller will correct the Frisbee orientation, i.e. the controller will ensure that the Frisbee is facing in the direction of the desired location. The second controller will correct the distance between the Frisbee and

the desired location, i.e. the controller will move the Frisbee from its current location to the desired location. Since a kinematic model is being used for simulation, the dynamic aspect of the physical Frisbee, such as its mass and various other forces cannot be accounted for. Hence, the controller will not be able to enable the Frisbee to “smoothly” travel from point A to point B, meaning it will not be able to travel in a trajectory where the absolute speed of the wheels are not equal. This is why the Frisbee controller will be split into two continuous controllers, one that will correct its orientation while the other will correct its distance. This method, albeit is not the most efficient method for the Frisbee to travel from point A to point B, is sufficed for this project as the main objective is to have the Frisbee travel autonomously from point A to point B.

I. Proportional Control

A PID controller is a relatively simple controller consisting of three different parts. Its mathematical equation is shown below.

$$\text{Eq. [11]} \quad U_{PID} = K_P e(t) + K_I \int_0^t e(\tau) d\tau + K_D \frac{de(t)}{dt}$$

Equation [11], whose derivation and detail can be found in “Feedback Control of Dynamic Systems” [3], has three separate terms added together. The PID controller is a combination of three different controllers, Proportional, Integral, and Derivative. The proportional controller is the first term on the right hand side of Equation [11].

$$\text{Eq. [12]} \quad U_P = K_P e(t)$$

The proportional (P) controller consists of a constant term, the proportional constant, which multiplies the error signal, $e(t)$, to produce the control output. The larger the error, the greater the control output, and vice versa, the smaller the error, the smaller the control output. The proportional constant term in the controller, K_P , is determined through simulation to obtain the best result. The best result is a value that allows the controller to respond appropriately to allow the Frisbee to complete its objective of reaching the desired destination. Various values for the proportional constant will result in different responses from the controller. The smaller the proportional constant values, the “slower” the response of the controller. The opposite is also true: the larger the constant, the “faster” the controller will response to get the Frisbee from point A to point B. The formula for the proportional controller, Equation

[12], is implemented in simulation by implanting it in the controller block of the overall architecture as shown in Figure 16. The controller block is the location of the MATLAB algorithm that equates to Equation [12]. The Frisbee model will simulate a square formation through five different waypoints. The controller has several parameters attached to it to better account for real life conditions. One parameter is the maximum and minimum control command that can be sent to the wheel, 0.875 (rad/sec) and 0.2 (rad/sec), respectively. The maximum output is determined by the maximum amount of voltage that the Arduino board can supply to the servo while the minimum output is determined by the minimum amount of voltage that the servo must have to produce sufficient motion for the Frisbee Bot. These values also have a safety margin to ensure that the Arduino is not supplying 100% voltage capability at all time to ensure that the system function below its maximum performance. A margin of error is included for both orientation control and forward control of the Frisbee to account for a P control issue, which will be discussed in the next section. The orientation control margin of error is set to be $\pm 2^\circ$ and the forward control margin of error is 1.0 (cm). The error limit is set to provide the controller with a reasonable amount of leeway to decide whether it should operate or not. This means that if the error falls within the margin set, the controller will see it as zero and shut off. This simulates real life condition as it is physically impossible to achieve 100% reduction of error in this situation due to various factors such as hardware limitation. Further discussion on error margin will follow later in the paper.

Figure 17 shows the simulation from the starting location of the Frisbee to all five waypoints to complete the square pattern path. Simulations determined that a K_p value of 5 for the forward controller and K_p value of .00042 for the orientation controller will produce an appropriate response from the Frisbee Bot. An appropriate response for the Frisbee Bot means that it is able to carry out its objective within the margin of error set as well as complete it in a reasonable amount of time (small settling time). Note that the controller sends commands at a rate of 10Hz.

The Frisbee simulated paths shown in Figure 17 are relatively straight, which is an expected result for an orientation error margin of $\pm 2^\circ$. Each red x represents a time frame when the Frisbee Bot receives a new control command from the controller. The concentration of red x can be seen to increase as the Frisbee approaches a waypoint set in the square pattern. This shows how the proportional controller operates, as mentioned above. As the Frisbee approaches the set waypoint, its “error”

is reduces, which by definition means that the control signal also “weaken”, i.e. the velocity command sent to the Frisbee’s wheel is

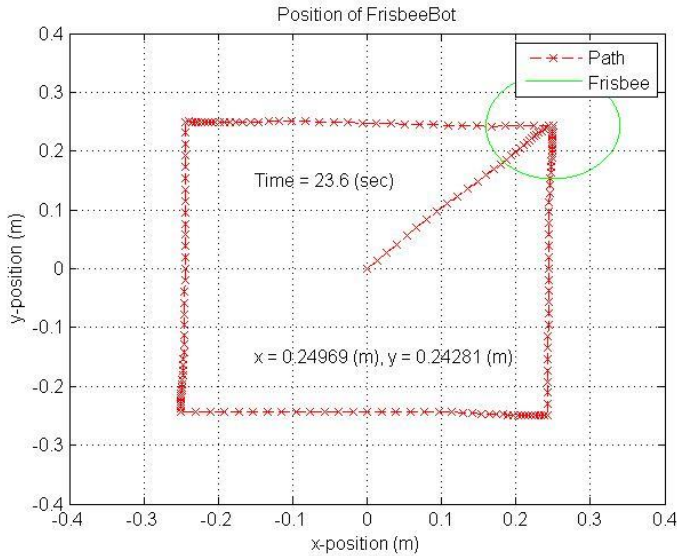


Figure 17. Proportional control simulation.

smaller. This means that the Frisbee speed reduces, as needed to ensure it doesn’t overshoot its target, resulting in more control command to reaches it in smaller distance interval. The cluster of red x near each corner of the square trajectory demonstrates this.

The simulated path in Figure 17 also shows that the Frisbee does not completely reach any of its five waypoint destinations of $(.25, .25)$, $(-.25, .25)$, $(-.25, -.25)$, $(.25, -.25)$ and back to $(.25, .25)$. Rather, the Frisbee stops short of its destination each time and continue onward to its next waypoint. Recall that the proportional controller is only a constant term multiplied by the error signal. As the error approaches zero (the Frisbee closing in on its target), the P control signal also approaches zero. This result in the controller strength becoming infinitely small as the error approaches zero. This is the reason why an error margin is implemented on the P controller. A P controller alone cannot reduce the error signal down to zero. Beside physical accuracy issue, discussed later, the inherent steady state error that accompany the proportional controller requires a margin of error to be added on to the controller to ensure that the controller can move on to the next waypoint once it comes within the desired range of its current target. Otherwise, the Frisbee will be stuck infinitely in attempting to reach the first destination.

Despite the controller inability to reduce the error signal completely down to zero, the Frisbee is still able to accomplish achieving a square pattern with adequate accuracy, which means that the controller is working properly. The successful simulation result allows the controller to be implemented on the physical Frisbee. The implementation and validation process of the controller will be discussed in Section 0.

II. Proportional-Integral Control

To account for the steady state error that accompany the proportional controller, an integral controller is added on. The integral controller is the middle term on the right hand side in Equation [11], shown below in Equation [12].

$$\text{Eq. [12]} \quad U_I = K_I \int_0^t e(\tau) d\tau$$

The purpose of the integral controller is to eliminate the steady-state error that caused the proportional control to never reach its waypoint as described previously. The integral term, when added on to the proportional term, turns the controller into a proportional-integral (PI) controller, Equation [13].

$$\text{Eq. [13]} \quad U_{PI} = K_P e(t) + K_I \int_0^t e(\tau) d\tau$$

The integral, I, controller works by integrating over all the error over the time that the controller has been running. This integral term, Equation [12], will then be the dominant force in the PI controller if the error signal is persistent. When the Frisbee is close to its destination, the proportional controller strength becomes “weak” to the point where it is no longer capable of producing adequate commands to move the Frisbee, thus allowing the error signal to accumulate as time goes on. As the error accumulates overtime, the integral terms grow larger. This allows the integral term to become large, hence allowing the controller strength to become “strong” enough to allow the Frisbee to reach its target. The integral terms then die out when the Frisbee arrive at its destination as that is when the error term becomes zero. The result of the simulation for a PI controller is shown below in Figure 18.

From Figure 18, it can be seen that the Frisbee does indeed reaches its target waypoint closer than that of Figure 17, where only the proportional control is implemented. The Frisbee does not reaches its target completely again, due to the margin of error included in the controller to account for various other influences that physically

handicap the Frisbee from achieving zero error. A side effect of the PI control is that it increases the settling time of the system, which is seen

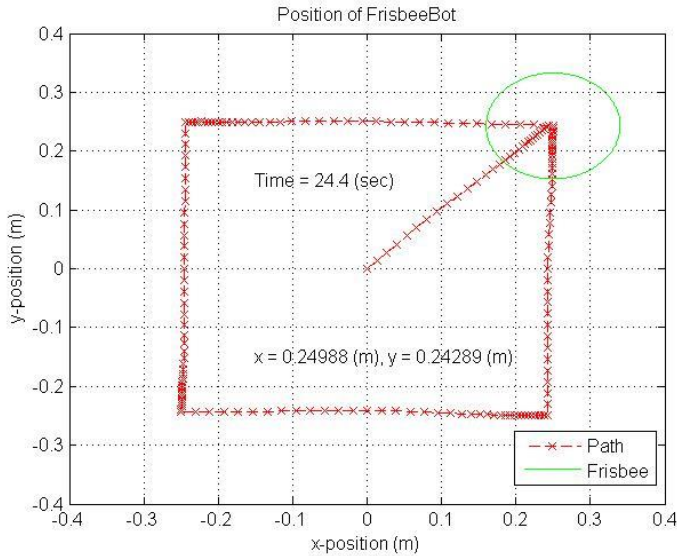


Figure 18. Proportional Integral Control.

in Figure 18 where it takes the Frisbee about a second longer, 24.4 (sec) to complete the course that a P controller took 23.6 (sec) to complete.

The final term of the PID controller is the derivative term, D, shown below in Equation [14].

Eq. [14]
$$U_D = K_D \frac{ds(t)}{dt}$$

The derivative term serves to improve the control by taking the derivative of the controller to determining the control output. The derivative of the error verses time gives the slope of the error signal. By taking this into account, the controller is then able to take into account strong variation in error. The D control becomes the dominant force during the period in which the slope of the error is large. A large error slope occurs during the process where the system experiences a very fast change to its state, such as the error going from about zero to some value. This occurs when the system overshoots its desired control input. The derivative controller hence serves to reduce the amount of overshoot caused by the system. For the Frisbee, the derivative term is not needed as the Frisbee controller is already equipped with a hysteresis band that prevents the system from overshooting its target. Hence, the D term is

not applied as the Frisbee is adequately controlled with a PI controller as shown above in the two simulations. The I term does not improve the controller significantly in this case, but is implemented to show how adding on additional terms can benefit the PID controller.

Implementation and Validation of Control System

Once the controller developed is successfully tested and produces desirable results in simulation, it can then be implemented on the physical hardware. The P controller is first tested after desirable simulation results were obtained along with the proportional constant. Using the DSSL architecture described previously, the controller is implemented. The error hysteresis band is increased to $\pm 10^\circ$ to account for any discrepancies (noise, time delay, etc.) between the Frisbee's actual location and the location the Vicon system relays to the controller. The increase in error margin is implemented as the system feedback, the Vicon system, is unable to reliably determine the exact coordinate of the Frisbee Bot (Figure 9).

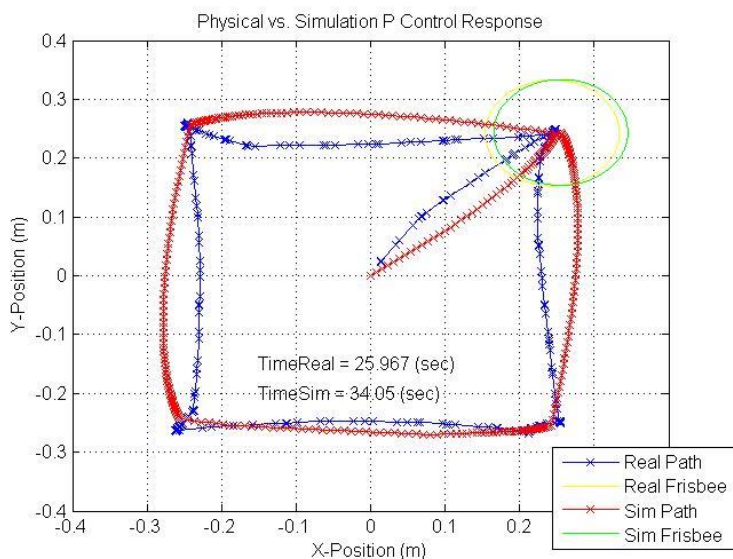


Figure 19. Physical Response of System vs. Simulated Response for P Control.

From Figure 19, the Frisbee's actual path can be seen by the blue line, where each x indicates the point at which the system receives a control input command from the controller. It also features the simulated result, for the new margin of error of $\pm 10^\circ$, in red. The Frisbee's actual path closely mirrored that of the simulated response. The only difference

is that the Frisbee Bot's actual path curves in a different direction than from the simulated result. The settling time is also about 25% faster than predicted. The deviation can be attributed to the fact that a Kinematic model was used for simulation, which means the simulation should only be accurate enough to predict the path of the Frisbee, which is sufficient for this particular controller output. Dynamic effects that were neglected are attributed to the deviation between the simulated and actual path of the Frisbee. With the P controller producing the result that simulation predicted (completing a square pattern), the integral terms can then be developed and added on to form the PI controller.

Once the PI controller produces satisfactory result in simulation, it is then implemented on the physical Frisbee. The result of which is shown below in Figure 20.

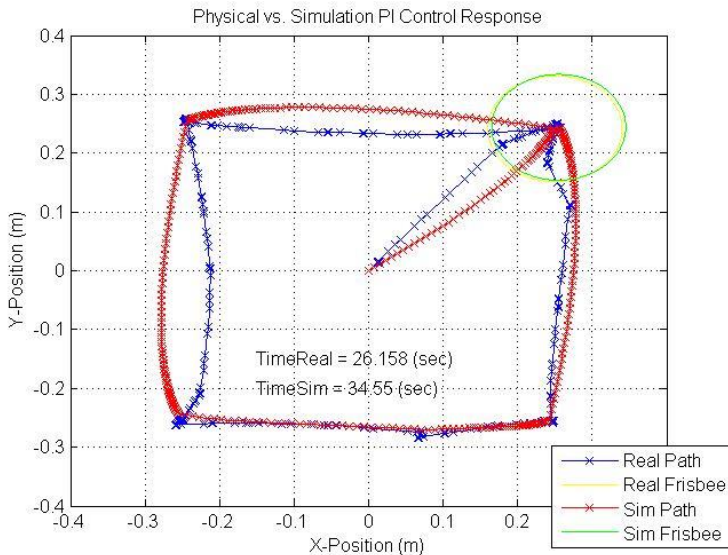


Figure 20. Physical Response of System vs. Simulated Response for PI Control.

The PI controller helps improve the performance by eliminating the steady state error, which is difficult to see here due to the allowable error setting installed in the controller. It can be seen by the Frisbee's actual path being more accurately predicted by simulation than with just a P controller. The settling time did increase as expected, however, due to the nature of the integral term as well as the from the simulation prediction. The different in curvature of the path as evident in both the P and PI controller is predicted to be the result of physical force that only a dynamic model may be able to simulate. These issues involve frictional forces and vehicle dynamics that are not taken into account in the

kinematic model. Hardware issue is also another probably cause as both servo might have different performance due to the manufacturing process.

Discussion of the Overall Process of Developing an Autonomous Controller

The main goal of this paper is to observe the development process of an autonomous controller, in this case a feedback type controller. The project looked into issues between modeling development as well as the many different factors that the developer must take into account during the initial and final stages of development.

The modeling process for the Frisbee Bot had many different routes that the developer can take. Many types of model can be used depending on the type and accuracy of the result desired. For the Frisbee case, a kinematic model is chosen since the Frisbee main objective is autonomous path planning, which only requires the path of the Frisbee to be predicted. The kinematic model is able to produce satisfactory prediction of the Frisbee path based on commands sent to the left and right wheel of the Frisbee. As mentioned earlier, a kinematic model cannot take into account any real world effects such as dynamic forces that cause the Frisbee to deviate from its known reaction. A dynamic model will also allow linear control theory to be put into place where method such as root locus and frequency can be used to determine the constants to produce desirable performance from the system. Further details about these control design methods can be found in “Feedback Control of Dynamic Systems” [3]. Without a linear model, the constants of the controller must be determined experimentally through live implementation. Simulation will help determine a starting value for these constants, from which live testing can then fine tune it into a suitable value for the physical system.

Establishing a model of the system for simulation is a critical process. As mentioned, in the real world, physical system in which control systems are designed for can be very costly. Hence, it is not very desirable to implement a piece of untested software on the physical hardware prematurely. The code should first be validated through simulation to ensure that it function as desired. This is also why the simulation model must be validated. If the model is faulty or grossly inaccurate, the simulation result it produces will also be worthless. This is where the saying “Garbage comes in, garbage comes out” is especially true. A simple way to validate the model is to compare its simulated result with known results. For the Frisbee, this is done by prompting the model with input commands where the output is known. Figure 15,

shows the validation of the model as it was able to produce the expected response of the vehicle base on the commands input.

Periodically testing each components of the system to ensure that it is working properly is very essential to improving efficiency and quality of the system. Unit testing is used in this project to ensure that both the hardware and software perform as desired. Unit testing is where each component of both the software and hardware is tested, to ensure that the each part perform as expected. Testing is done each time additional parts are added on. This method enable root causes of problems to be easily identifiable, as oppose to testing on a finished assemble system where root causes analysis will be much more difficult depending on the complexity of the system.

Conclusion

In conclusion, this paper served to provide insight into the development process of an autonomous controller. Future work can involve using a dynamic model for the Frisbee rather than a kinematic model. This allows various methods of control theory to be applied once the model is linearized, providing the developer with many more options and approaches to developing a PID controller. This includes the LQR controller, which finds the most efficient way to complete its objective. For the Frisbee, the LQR controller can allow the Frisbee Bot to go in the most efficient path, rather than its current movement that consists of first turning, than going forward. A dynamic model will also be able to account for various dynamics that may affect the vehicle's performance.

The derivative terms can also be added on in future work to determine how much more efficient and effective it makes the controller in this case. A full PID controller might be able to better account for the noise signal and hence produce better results. Also, issues with PID controllers can be explored for deeper insight into some of the drawbacks of a PID controller. These issues involve the integral wind-up problem associated with the integral term, and also the derivative saturation problem associated with the derivative terms. Details about these issues can be found in "Feedback Control of Dynamic Systems"^[3].

Autonomous control systems serve many purposes and applications in our daily life. This paper explores the process of how these control systems are developed. Applications for autonomous control systems can range from military applications to civilian use. The future relies on these control systems to enhance the standard of living for humanity. These autonomous control systems can be applied to enabling cars to travel autonomously from point A to point B, thus reducing the amount of car accidents that can occur due to driver's error.

It also serves to allow humanity to focus on more important tasks, rather than the low level tasks, to improve productivity. With that, the future of autonomous control systems is still under research and development, a process that this paper seeks to provide insight to.

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Determining the Density of Transiting Extrasolar Planets: The Hunt for Exomoons

Laura Mayorga

Abstract

In the search for habitable planets, density is crucial in allowing us to determine whether a planet is terrestrial or gaseous. We explore the method of measuring the flux from a star during a planetary transit to constrain the density and the mass of the planet. This method depends on our ability to detect a moon in the transit and to chart minor fluctuations in moon velocity and moon position with respect to the planet. To determine the precision with which we can measure the density of a planet, we have created a model which produces a synthetic light curve from which we can attempt to extrapolate planet parameters. However, due to the fact that moon detection itself is a difficult task, we have found that the accuracy of planet density calculations is highly dependent on the noise of the sample. We present our technique for density determination as well as those for exomoon detections. It may be necessary to combine our efforts with other methods, such as spectra analysis of Doppler shifts, to confidently differentiate potential life-bearing planets from those which are obviously not habitable.

Introduction

In the search for habitable planets, density is crucial in allowing us to determine whether a planet is terrestrial or gaseous. We began our project hoping to use infrared photometry to directly image a planet and understand its properties. Since then great leaps and bounds have been made with such techniques despite the failures of many infrared operations, such as Terrestrial Planet Finder (TPF), which were never launched. With NASA conducting a hunt for life within our own solar system, the race was on to find a habitable planet elsewhere. To this end, scientists have looked closely at our own planet and have attempted to use this knowledge to unravel the mysteries of other celestial bodies orbiting the sun and its planets. With the first discoveries of extrasolar planets, planets around stars other than our Sun, hardware and software was refined and improved to deal with the difficulty of detecting these distant bodies.

These first discoveries were made by measuring the radial velocity of a star. As a planet orbits its host star, the gravitational interactions between them cause an equal and opposite reaction visible in the star. This star wobble can be measured and thus the mass of a planet

can be determined, but its size and therefore density is still unknown. Density is classically defined as $\rho = \text{mass}/\text{volume}$, thus radial velocity alone cannot manage it since it provides no information about the radius or volume of the planet. As it stands, the planet must also transit the star. By passing between us and its star, the planet blocks a portion of the light from that star in proportion to the square of the planet's radius. A measure of the amount of light, flux, from a star over time is called a light curve. An example of a transit light curve can be seen in Figure [1].

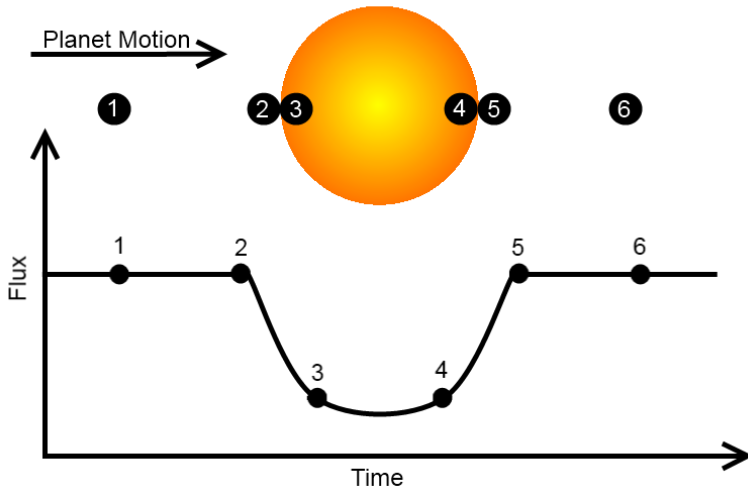


Figure 1. A simplified transit light curve of a planet across a solar disk is shown above.

The transit method of detection is a delicate art that requires advanced optical hardware and due to this has been generally done using ground-based telescopes, which have a size advantage over their space-based counterparts. However, the launch of the Kepler Space Telescope in 2009 gave astronomers access to thousands of light curves. Kepler stares at approximately 100,000 stars continuously and has been doing so since its launch. It was specifically designed to detect Earth-sized planets and, as of the day I write this, has discovered 61 planets and boasts 2,321 other planet candidates.

Using Kepler's photometric precision, we can begin to detect smaller and smaller planets, which draw our attention to the smaller bodies of the universe, moons. Moons can have a very large effect on the habitability of a planet. In addition, since most planets discovered tend to be large and close to their stars, we begin to wonder if a moon can be habitable thanks to the shield provided by the magnetic field of its large host planet. Though these moons are not intrinsically habitable on their

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own, with their large protectors they may be and thus the moons of Jupiter and Saturn are heavily studied.

These moons should also be detectable in a light curve and via the extraction of their orbital parameters they should provide us with a density estimate for their host planets. An example of the effects of a moon on the transit light curve can be seen in Figure [2]. It was shown mathematically by Kipping in 2009, that it was possible to use transit data and no radial velocity data to determine the density of a planet. The density is then given by Eq. [1] $\rho = (3\pi a_m^3)/(GP_m^2)$, where a_m is the semi major axis of the moon's orbit scaled by the radius of the planet, G is the gravitational constant, and P_m is the period of the moon. We have simulated such systems in an attempt to create a method with which this can be reliably done for the planets and planet candidates in the Kepler data.

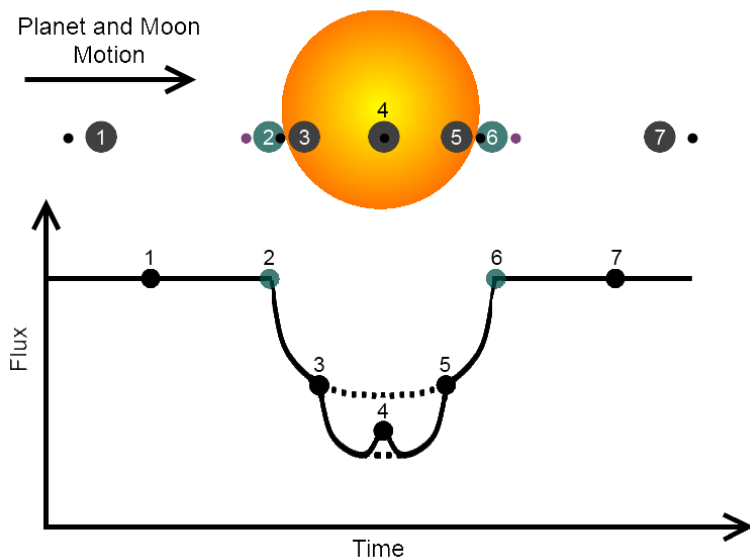


Figure 2. A simplified transit light curve of a planet and a moon across a solar disk is shown above. The system can be quite complex where the moon can pass in front of the planetary disk and no longer block the light from the star.

Our Model

For our studies, we created synthetic light curves for various moon-planet-star systems, both known and fictitious using Interactive Data Language (IDL). To simplify this we have assumed a number of things. Firstly, that stars have the same characteristic limb-darkening. This is not necessarily true for all stars since each type of star has

different layers with different behaviors. Nevertheless, stars are brighter towards their centers and dimmer towards their edges. Thus as a planet crosses the solar disk, it is blocking different amounts of light over time. Secondly, we assume that the planet and moon are not inclined with respect to each other. This means that the moon orbits within the plane defined by the planet's equator. We have also assumed that the planet and moon are in circular orbits. This is not true in all cases or a requirement for system stability, but it appears that most stable systems will evolve into circular or near circular orbits.

Our simulation first generates one light curve for the planet and one for the moon using *occultquadfaster* (Mandel and Agol 2002) for a specified number of transits. These are then combined to form a composite light curve. To mimic Kepler data, we set the exposure time to have a one-minute cadence and bin up accordingly to reach 30 minutes when requested. We then normalize the baseline flux to unity and convert all distance measurements into units of solar radii. We define the size ratios Eq. [2] $w_p = r_p/r_\odot$ and Eq. [3] $w_m = r_m/r_\odot$, where r_p is the radius of the planet, r_m is the radius of the moon, and r_\odot is the radius of the host star. We scale all appropriate distances by these ratios to maintain unitless numbers. We can also then add random errors to mimic the noise levels of Kepler and for our own analysis purposes. An example of a synthetic light curve for a Jupiter and moon that is eight times the mass of the Earth around our sun is shown in Figure [3].

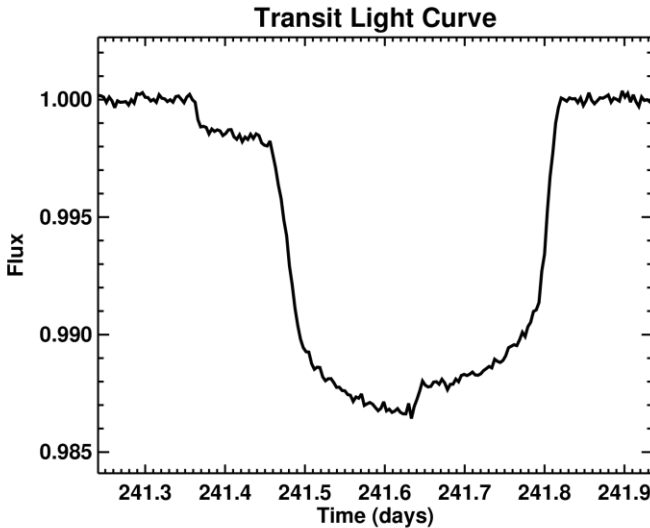


Figure 3. A synthetic transit light curve of a Jupiter and an 8-earth-mass moon across the sun is shown above with a relatively low level of noise. We can see that the moon leads the planet across the solar disk.

Determining the Density of Transiting Extrasolar Planets: The Hunt for Exomoons

Fitting for Density

We attempt to fit our synthetic curves by fitting each transit individually. We first estimate the impact parameters for both the planet and the moon i.e. the heights at which they cross the solar disk, their velocities across the disk, their size ratios, and their central times of transit. These are all human provided except for their central times of transit that we have automated. This is done using our light curve bisector analysis.

We then employ *mpcurvefit*, a Levenberg-Marquardt least squares fitting routine to improve the parameters in sequence. If for some reason *mpcurvefit* fails to converge, we apply *amoebafit*, which is based off a multidimensional minimization that uses a downhill simplex method (Nelder and Mead 1965). We can then use the optimized parameters to determine the density of the planet.

Light Curve Bisector Analysis

Our light curve bisector analysis is a neat little algorithm which provides us with the central times of transit for the moon and the planet and is capable of differentiating the differences between when the moon is transiting first and when the planet is transiting first. We identify the depth of the transit and break up the light curve into flux slices with a height of $w_m/3$. This ensures that we register the moon's signal with enough certainty. We then interpolate the intersection points between the slices and our light curve. Finally, we calculate the midpoints of the resulting lines in time. These midpoints correspond to the central times of transit (after accounting for factors of 2) of both the planet and the moon. These midpoints form a bulge shape, whose direction corresponds to the moon's direction relative to the planet. An example of the algorithm can be seen in Figure [4].

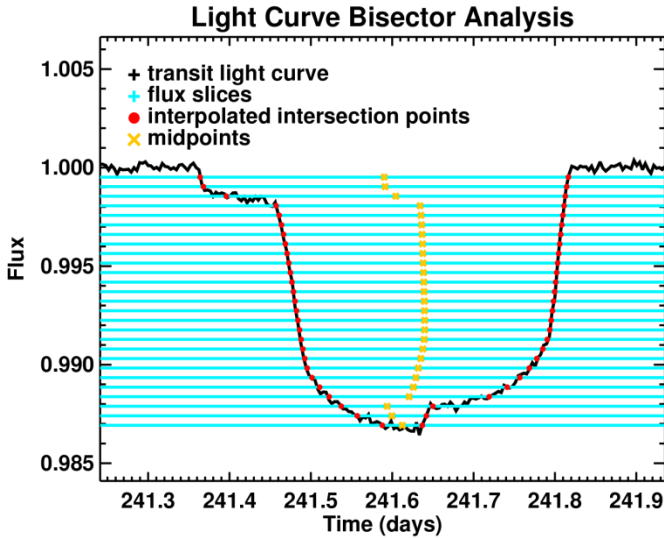


Figure 4. The blue horizontal flux slices intersect the transit light curve at the red circles. The yellow xs are the midpoints, showing the moon as leading.

Density Determination

From every transit we have now obtained velocity and central times of transit values. We can take the difference between the velocities and of the planet and moon as well as the difference between their central times of transit Eq. [4] $\delta v_i = v_{p,i} - v_{m,i}$ and Eq. [5] $\delta t_i = t_{p,i} - t_{m,i}$ and solve for the semi major axis of the moon and the period of the moon. Each transit will reveal a different a different δv and δt . These can be plotted over time and then when folded over the correct period of the moon, they will appear sinusoidal. This can be seen in Figure [5] and Figure [6] for the time separation.

There is some ambiguity in determining the period of the moon since the data could also be fit with an alias. Regardless, we do not seek to use this period we seek the amplitude of these sinusoids. With a simple distance = rate x time calculation the semi major axis of the moon can be determined, Eq. [6] $a_m = \delta t_{amp} v_{p,avg} / w_{p,avg}$. We take the average velocity of the planet since the planet is not expected to wobble much due to the gravitational interactions of its small moon companion. Then the period of the moon is calculated with the distance = rate x time calculation assuming circular geometry, Eq. [7] $P_m = 2\pi a_m w_{p,avg} / \delta v_{amp}$. These can be plugged into Eq. [1] to determine the density of the planet.

Determining the Density of Transiting Extrasolar Planets: The Hunt for Exomoons

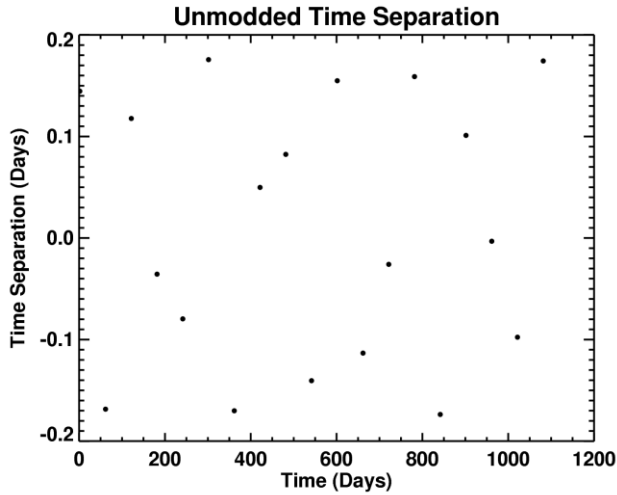


Figure 5. The plot shows the time separation, δt , vs. time for each transit of a planet and moon.

Analysis of Density Determination

We have tested multiple systems multiple times to determine the precision with which we can determine the density of a planet. The largest factor that determines our accuracy is the error of the data in the light curve. This is demonstrated in Figure [7].

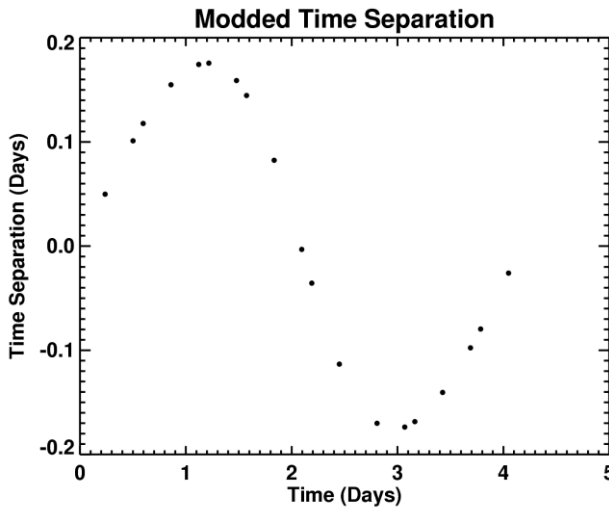


Figure 6. The plot shows the time separation, δt , vs. time for each transit of a planet and moon modded by a period of ~ 4 days.

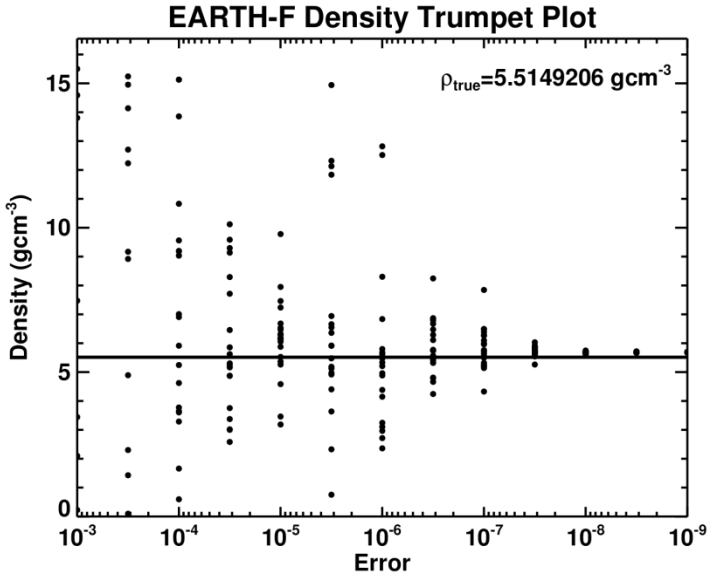


Figure 7. The Moon-Earth-Sun system fit 20 times at various noise levels. Each dot is the density determined by the fitter for that particular attempt. The scatter increases with higher error.

For detection purposes, the signal from the smallest body must be larger than the error level. In the Moon-Earth-Sun case, the scatter is small until we stop detecting the Moon at around 10^{-6} and then incredible large when we stop detecting the Earth at around $10^{-4.5}$. This is reasonable when the Moon's signal is on the order of $10^{-5.2}$ and the Earth's signal is on the order of $10^{-4.1}$. Our density determination will improve for larger bodies with signals larger than our errors.

Exomoons

In order to detect these exomoons, they will have to have signals which are larger than the detector's error levels. For typical moons in our solar system this seems to be very unlikely. The largest moon in our solar system is Jupiter's moon Ganymede with a signal on the order of $10^{-4.8}$. Compared to Jupiter's monstrous signal of $\sim 10^{-2}$, Ganymede's signal will be dwarfed. For our hopeful use of Kepler data, Ganymede's signal is not large enough since Kepler's error are on the 10^{-3} level.

Masking

Ganymede will likely fall through most detection algorithms which rely on least-squares or reduced chi-square routines. These types

Determining the Density of Transiting Extrasolar Planets: The Hunt for Exomoons

of algorithms aim to fit for the broad large scale differences and the small scale features tend to be fit less accurately. However, it is possible to facilitate the detection of large moons like Ganymede by first fitting the light curve for the planet and then removing the planet from the light curve. The residuals are composed of noise and the moon. Then the moon can be fit more accurately without the overbearing presence of the host planet.

Quasi-Periodic Automated Transit Search (QATS)

There also may exist systems where the moon and the planet do not transit the solar disk at the same, i.e. the moon may enter and leave the solar disk before the planet even enters or vice versa. These non-overlapping systems would be especially useful for the technique listed above where one runs the risk of accidentally including part of the moon's signal in the planet mask. This also opens up the system to use *QATS*. Initially developed to find planets which were being greatly affected by the gravitational interactions with other nearby planets in a system, *QATS* looks for transits which are quasi-periodic, meaning they do not occur exactly every x number of days. These moons appear quasi-periodic and *QATS* can search specifically for these transits once the planet has been masked out. An example transit light curve for a non-overlapping system is shown in Figure [8].

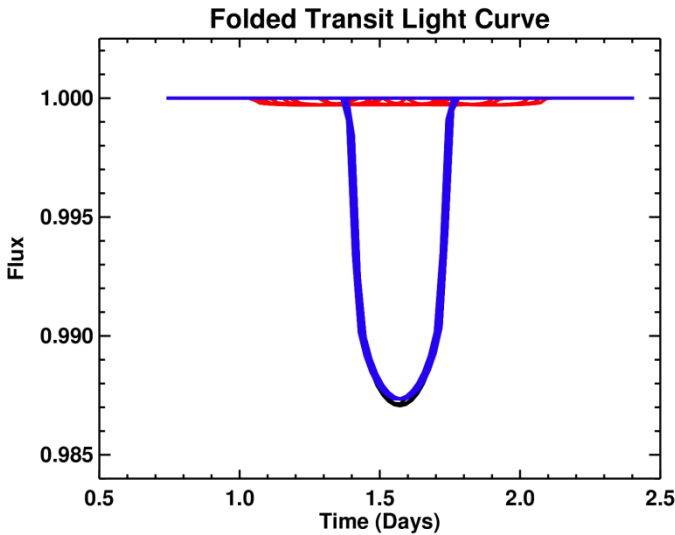


Figure 8. A non-overlapping system folded over the period of the planet. The composite light curve is shown in black, the planet's contribution in blue, and the moon's contribution in red.

Conclusion

Our simulations have shown that the density of a planet is determinable via Kipping's method given an instrument with high enough photometric precision for the signals of the bodies in the system to be distinguishable from the noise. We have presented two techniques with which we may facilitate the detection of exomoons for which we can then use to determine planetary densities. Until exomoons are discovered, our routine will continue to improve and adjust to more complicated and realistic systems, which will allow us to better determine the habitability of extrasolar planets. Though these planets have multiple internal and external factors that determine their habitability, life as we know it requires rocky ground on which to stand. The density of a planet is an indication of its composition and even a rough estimate of a density will help determine whether the planet is terrestrial or gaseous.

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I would like to thank Michelle Minato, my early project partner who helped this project get moving again as well as my research advisor Eric Agol for pulling us out of the weeds when necessary. I would be remiss in not thanking Carlos Chavez who first introduced me to research at the University of Washington and without the funding and community support of the Washington NASA Space Grant Consortium and the associated Summer Undergraduate Research Program I would be a very sad undergraduate. I would also like to thank the Louis Stokes Alliance for Minority Participation (LSAMP) for providing me the opportunity to participate in conferences across the country as well as the Ronald E. McNair Program for funding me back home.

Determining the Density of Transiting Extrasolar Planets:
The Hunt for Exomoons

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I will begin my graduate studies at New Mexico State University in June 2012. I am particularly interested in extrasolar planets and moons and habitable zones, as well as a variety of instrumentation and observational projects underway at NMSU within the planetary and the solar & stellar research groups.

Rethinking the Path to Online Education and the Quality of Student Learning: Education Modules Focused on Topics in Materials Science and Engineering

Elizabeth M. Merten

Abstract

Online education is an effective and efficient electronic source for students to gain knowledge in a variety of educational fields. Online education modules allow educators to bridge the gap between theory and practice for their students. The educational modules created during this project tackle several topics in Materials Science & Engineering. The modules are formatted to combine several modes of student learning in order to create a constructive and blended approach to teaching these topics. They are designed to make students think critically, form questions and work through the scientific method in order to solve complex problems. This creates a learning environment that benefits the students immediately in that they will learn how to apply knowledge in education, research and industry. The educational modules are evaluated several times in order to perfect the lesson plan. In having the modules evaluated by current educators and individuals in industry, we can gain a better perspective on what the learning outcomes should be in order to focus on specific points. These modules are already widely used in advanced high schools, technical schools, community colleges and four year educational institutions.

Introduction

Online education is the most effective and efficient electronic source for students to gain knowledge that is applicable in areas of science, technology, engineering and math (STEM). This is the latest trend of educational delivery. Education modules are a hands-on approach to teaching students about complex and often difficult topics that are primarily gained through in-class lecturing and textbooks. These modules offers a new approach to education in a way that will not only teach students the fundamentals of the subject but give them the experience in how it is utilized in industry and research. They are already widely used, and can be tailored to advanced high school, technical schools, community colleges and four year educational institutions.

These modules are designed to make students think critically, form questions and go through the scientific method in order to solve complex problems. These modules can be used alone or as a tool for innovation in learning, discovery, and engagement, that high school,

colleges and universities offer alongside classes. (EDUCAUSE Values: Innovation, 2010). By formatting the modules to combine various modes of student leaning, we are essentially creating a constructive and blended approach to teaching. If the equipment and the necessary supplies for a specific module are available, the students and the instructor can work hand-in-hand on equipment via demonstration or experimentation. If not, instructors will be given an option to show students videos links that will be available online at the materials education website that were created specifically for the module. This allows students to gain information and become knowledgeable in various topics that relate to their area of focus.

This project tackles several topics that will combine various methods to teaching students which will ultimately serve as an aid in making online education become more effective and efficient in teaching focused areas of Materials Science & Engineering.

Methodology

Multiple modules were prepared on varying topics in Materials Science & Engineering. Each module was sent to educators, technicians and researchers to be reviewed. Feedback from reviewers was documented and the module updated accordingly. Once the module was complete, a final draft was sent for publication/copyright. Once modules are approved for publication they are made available on the materials education website. Modules include an evaluation section for student and instructor for feedback. Feedback will be documented and if needed the module will be updated accordingly.

Module Format

Modules are available online. They consist of a document that highlights student learning objectives, competencies covered, suggested prerequisites, targeted grade level, supplies needed, and an instructor overview with a background on the topics being covered as well as a power point presentation for the students. The modules are set up so the instructor has the option of running a demonstration in front of the class or to run it as an experiment with the students, depending on availability of equipment and supplies. Evaluation section targets the student and instructor in order to further revise and create more efficient modules. Modules are found on the website: www.materialseducation.org.

The following Ceramic: Slip Casting paper, is one of many modules developed and placed online for instructors.

Ceramic: Slip Casting

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Abstract

Ceramic materials play an important role in the world around us. Many industries utilize ceramics for both industrial and consumer products. Some examples of ceramics that can be found in the home are fiberglass insulation, TV screens and glass articles of all kinds as well as coffee mugs, dinner place settings and decorative knickknacks. Slip casting ceramics is relatively simple and inexpensive compared to making parts with metals. In addition, slip casting is easy to demonstrate and can be incorporated as an experiment in the classroom or lab. This module focuses on the slip casting method using a gypsum plaster mold and making an alumina or clay-based part; it also demonstrates the limitations of slip casting relative to defects and voids that can alter the properties of the final product. This module is appropriate for advanced high school or college level programs. Depending on the availability of equipment and supplies this activity can be applied in a classroom demonstration or lab experiment for the students.

Module Objectives:

This demonstration or lab provides an introduction to the slip casting method and how basic ceramic parts can be created. It also provides the background information required to understand how internal defects and imperfections alter the properties of ceramics.

Student Learning Objectives:

- Describe the general properties of ceramics
- Demonstrate the slip casting process
- Identify the limitations of slip casting
- Discover how slip cast materials can have defects and small voids that are not readily visible on the surface
- Understand how defects and imperfections can alter the properties of ceramics

MatEd Core Competencies Covered:

- 0.B Prepare Tests and Analyze Data
- 0.D Demonstrate General Technical Competence
- 1.C Demonstrate Laboratory Skills
- 4.A Demonstrate Effective Work with Teams
- 7.E Describe the General Nature and Behavior of Ceramics and Glasses
- 8.A Demonstrate the Planning and Execution of Materials Experiments
- 15.A Describe Structure, Properties, and Processing of Ceramics

Key Words: Slip Casting, Ceramics, Material Properties, Material Processing

Type of Module: PowerPoint presentation with lab or in-class demonstration, dependent upon availability of supplies and equipment

Time required: two 50 min sessions

Pre-requisite Knowledge: Basic Chemistry

Suggested prerequisite: none

Target grade level: Advanced High School, Introductory College/Technical School

Rethinking the Path to Online Education and the Quality of Student Learning: Education Modules Focused on Topics in Materials Science and Engineering

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Module data	2
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Equipment and Supplies Needed:

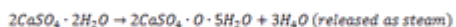
- PowerPoint projection system
- Electric Furnace
- Plaster of Paris*
- Ceramic powder*
- Binder and Deflocculant*
- Trimming tool*
- Small item or yogurt cup to be used as a model for the molding*
- Ceramic samples for discussion*
- Medium square plastic container(s)
- Spatula/mixing sticks
- Large mixing bucket(s)
- Measuring cups
- Small scale
- 1 liter plastic bottle with cap
- Funnel

*materials can be found in most art and hobby stores

Curriculum Overview and Notes for Instructor

In studying the slip casting method we can gain a better understanding of how materials can be utilized to create simple or more intricate parts for various industries. It is important to learn about the various components that make up the slip casting method as it is one of the most widely used today for the production of ceramics in industry.

First and foremost, it's necessary for the students to have a greater understanding of the basic technique in which gypsum-plaster molds are created. Gypsum, plaster, or Plaster of Paris is one of the most commonly used materials for the production of porous molds for slip casting. It is used because it has the property of absorbing water into the porous plaster from a particulate-water suspension called a slurry or slip. For example with a clay-based slurry, removal of the water leaves behind a relatively strong clay object. The plaster mold reproduces fine details in molds that can be easily trimmed and manipulated. Gypsum plaster is made by heating gypsum to approximately 300°F (150°C) in the following reaction:



It's very inexpensive since it is found all over the earth and is quite abundant in supply. The name Plaster of Paris comes from a large deposit at Montmartre in Paris. Typically, Plaster of Paris can be found in art hardware and hobby stores. When the Plaster of Paris powder is mixed with water, it re-forms into gypsum.



Figure 1: gypsum in powder form **<http://www.famousscholars.net>

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One important thing to know is that the ratio of water to gypsum in the mold suspension will have a direct effect on the time it takes to remove water from the cast. The advantage of this technique is that it's inexpensive and time-efficient for casting complex parts when compared to other conventional methods. When Gypsum is mixed with water it hardens. The reaction is very exothermic, the mixture heats up quickly.



Figure 2: mixture of plaster and water ** neoborninatures.blogspot.com

BE SURE TO MINIMIZE HANDLING OF MATERIAL WITH BARE HANDS AS IT CAN CAUSE SEVERE BURNS

It is important to wear safety goggles in gloves while mixing the gypsum and water suspension. The chemical reaction is exothermic and may cause skin irritation. Wash hands if some of the mixture comes in contact with skin. The increase in the temperature of the mixture is due to the physical and chemical changes the gypsum undergoes when it interacts with water and starts to harden.

There are three parts to the slip casting method, which will be covered in detail in the following sections.

Making a Gypsum Mold

After the water and gypsum have been mixed thoroughly it is poured into a container and allowed to sit until it is firm. Two techniques are given here to make a plaster mold to replicate a model. Mold soap is used to prevent the plaster from sticking to the container or the model.

1. Place the model into the bottom of the container and carefully seal the edges around the model with plastic clay so the plaster cannot run under the model. Pour the liquid mixed plaster over the model to obtain at least 1 inch plaster thickness all around the model. Once the plaster is set, remove it from the container and remove the model.

2. Pour the mixed liquid plaster into a container and watch carefully as it sets. At the point that the plaster begins to become firm, press the model into the surface and hold it there for a little while as the mix hardens. Once the mold is set, remove the model carefully so as not to disturb details that will remain.



Figure 3: Plaster mold with model and final cast piece **uacanvas.com

Wait until the gypsum is completely dried. This can be achieved by placing the mold in a dry environment for several hours. A dry oven can be useful at this point but do not exceed 120°F or you will destroy the plaster mold. Be sure to check to see if there are undercuts, areas in the mold that can cause the green body ceramic to catch during removal. If there is an undercut, details and possibly the entire ceramic piece can be ruined. Use a trimming tool or sand paper to remove any undercuts or specific details that you want to eliminate from the final cast.

Preparing a Ceramic Slip/Slurry



Figure 4: Pouring ceramic slurry into a plaster mold

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A slip/slurry is a ceramic suspension. Depending on the type of ceramic you want to create the ceramic suspension will vary. This is mainly based on the type of kiln or furnace that will be used to fire the ceramic cast piece. Additional chemicals are required to maintain a uniform consistency of your slip as well as being free of clots. Binders and deflocculants are often used to increase the strength of the ceramic, and prevent settling, clotting of the ceramic particles and by thinning out the suspension. (A recipe for one type of ceramic slurry is found in the appendix)

Prepare the slurry using water, alumina (or another ceramic powder), a binder and the deflocculant using a spatula or hand mixer to ensure complete mixing. A ready-mix clay slip can be obtained at hobby or pottery supply shops. Slowly pour the ceramic suspension into the mold (Figure 4). The ceramic particles will start to settle against the plaster as the water is drawn from the suspension into the plaster mold. Additional slurry can be added as needed. The ceramic particles left behind will form a thin skin that will gradually thicken as additional slurry is added. Once the desired wall thickness is achieved pour off any remaining fluid and then allow the ceramic particulates time to become dry enough to handle.

Ceramic Final Product Pre and Post Firing

Once the ceramic green body is firm and mostly dry, remove it carefully and let it air dry. Later in the day or the following day, depending on the dryness of the ceramic, place the piece(s) in the electric furnace to be fired. The ceramic green body can be glazed pre or post firing. The temperature and times will vary depending on the ceramic mixture used. During the next class period display the cast pieces along with ones that are pre-fired.

This exercise can be carried out as a demonstration, individually, or in groups. If used in a demonstration, emphasize safety and if there is time, prepare various mixtures changing the ratio of water to powders for the ceramic mixtures. Encourage the students to be involved by visually inspecting the samples to determine differences, as well as to make predictions on how the material properties would be affected by the different variations of mixes.

The overall set-up, fundamental concepts and analysis are summarized in the PowerPoint presentation.

Module Procedure

First Session

1. Discuss what makes something a ceramic. (see definitions and PPT)
2. Display identical samples of ceramics that were purchased and discuss the importance of slip casting and the varying factors that are involved. Be sure to show the students samples of a ceramic material.
3. Ask the students if they can find any defects on the sample(s) and if they can predict if the material has other defects internally. How they would go about finding this out and how they would eliminate the defects?
4. Obtain or prepare samples that are broken into sections. Display the sectioned/broken pieces of the sample to the students as this will allow them to see that sometimes there are imperfections in materials that are not apparent on the surface.

TAKE CARE TO NOT HAVE STUDENTS HANDLE THE BROKEN PIECES. CERAMICS CAN BE VERY SHARP AND CAUSE CUTS THAT ARE NOT INITIALLY VISIBLE.

5. Show the PowerPoint presentation and discuss each slide.
 - a. Slide 1: Introduction to slip casting
 - b. Slide 2-4: Definitions for words associated with slip casting
 - c. Slide 5: Key Concepts
 - d. Slide 6: Equipment and supplies needed
 - e. Slide 7: How to choose your model (part to be duplicated)
 - f. Slide 8-14: Method
 - g. Slide 15-16: Safety and Pictures of various ceramics
 - h. Slide 17-20: Q & A, Summary and Definitions
 - i. Slide 21-22: Acknowledgements and Contact Information
6. Perform demo/lab

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Demonstration

Have students gather around as you prepare a mold and the ceramic slip/slurry. Detailed instructions for each step in the slip casting method can be found in the appendix

Class Experiment

Prepare a shortened handout or place the instructions on the board. Have students (groups of 3-5) make a mold, prepare a ceramic slip/slurry and make a cast part.

Once the ceramics have been cast and are removed from the molds, place them in a safe place that is free of humidity so they can dry before being fired.

As an additional activity and to help students understand the concept of slip casting of ceramics, have them compare cast samples to samples that have been fired. Do this by dropping samples on a hard surface. This will show the students the toughness of the fired samples compared to the ones that are not fired.

Ask the students to identify possible variables that can affect a final casting of the material and have them explain what effect the variables in the slip casting method have and why they are important.

If various (identical) castings were made, ask students to compare them for flaws or differences, ask them what they would do in order to prevent these flaws from occurring in future castings and why.

Conduct a class discussion on the exercise to determine what the students have learned. Were their predictions correct?

Repeat the PowerPoint in order to solidify/emphasize specific concepts. Have your students answer the experimental analysis questions and to identify variables that could possibly cause the results to change.

Supporting Materials and References - Please see accompanying PowerPoint

Optional:

Lab report - Have students report, presenting their final product and discuss any variables involved in differences in the slip cast ceramic in order to reiterate the key concepts involved in the slip casting technique covered in this module.

Acknowledgments

The author wishes to thank the Professor Tom Stoebe, Professor Fumio Ohuchi, and Professor Bill Scott for assistance in developing and editing this module, and the suggestions from all the reviewers. The Materials Science & Engineering Department at the University of Washington provided the equipment needed for the development of this module.

Student evaluation (discussion/quiz)

1. If castings were made, did you find the process to be difficult? Was it what you expected? If not, please explain.
2. Is there a difference in each casting if you used an identical mold? Explain.
3. Why is it important to have the model placed into the gypsum mold before it solidifies?
4. How does sample preparation affect the final casting?
5. Can you name a few examples of ceramics that have been produced commercially?
6. Could you see or feel any differences in the molding material after it was mixed? If so, why do you think this occurs?

Instructor evaluation

1. What grade level and class was this module utilized for?
 2. Were the students able to grasp the key concepts introduced in the module?
 3. Was the level and rigor of the module acceptable for the grade level of the students? If no, how can it be improved?
 4. Was the demonstration/lab work as outlined? Did it help the students in learning the material? Were there any problems encountered?
 5. Was the background on slip casting sufficient for your understanding and for the discussion with the students?
- Any comments and/or suggestions on improving this module are encouraged.

Rethinking the Path to Online Education and the Quality of Student Learning: Education Modules Focused on Topics in Materials Science and Engineering

Course evaluation questions

1. Was the demonstration/lab clear and understandable?
2. Was the instructor's explanation comprehensive and thorough?
3. Was the instructor interested in your questions or concerns?
4. Was the instructor able to answer your questions thoroughly and to your satisfaction?
5. Was the importance of slip casting made clear?
6. What was the most interesting thing that you learned about in regards to slip casting?

Definitions

Ceramic – inorganic, nonmetallic solids generally made by mixing clay, earthen elements, powders, and water and shaping them. Once shaped, it is fired in a high temperature oven known as a kiln/electric furnace.

Binder – polymer additive that helps to increase the material properties of the ceramic.

Deflocculant – Chemical additive used to prevent particles from coming out of suspension as well as thinning of suspensions in order to prevent flocculation.

Exothermic – Reaction that releases energy in the form of heat, light and or sound.

Green body – Ceramic created from slip casting prior to being fired or sintered.

Gypsum – Soft mineral composed of calcium sulfate dehydrate. Mined in quarries then ground into powder for a variety of uses. Gypsum plaster is made by heating gypsum to approximately 300°F (150°C).

Slip/Slurry – Watery mixture of water, clay and other chemicals that keep the suspension uniform and clump free such as deflocculants and binders.

Slip Casting – Technique used to create ceramic parts by pouring specialized (slip) liquid into plaster molds. A green body piece is made from the ceramic particles settling and forming a thick layer. Once settled the piece is removed and allowed to dried before firing.

Undercuts – Features in a mold that cannot be produced by a single mold (makes it difficult to remove a green body ceramic without causing damage to the piece)

Plaster Preparation

Typical plaster consistency for slip casting is 70. This means its 70 parts by weight water to 100 parts by weight of plaster. If unsure you can find detail instructions online. Be sure to use room temperature water. The setting process begins when the mixing starts. The faster you mix it the faster it will harden.

Materials required:

Plastic bucket

Safety Gloves

Stirring Stick or Spatula

Room Temperature Water

Milk Carton

1. Place a volume of room temperature water that is slightly greater than the desired mold volume in a clean plastic bucket. A good weight ratio of water to plaster is 70 parts water to 100 parts plaster.
2. Sift the appropriate amount of plaster powder evenly into the water until you can visibly see it on the surface of the water.
3. Allow it to soak 2 minutes before mixing.
4. Stir the mixture with a paint stick or spatula slowly without agitation in order to avoid entrapment of air. Stir it for approximately 5 minutes or until the mixture becomes creamy and there is about an eighth of inch coating that remains on a stir stick when it is dipped into the mix.
5. The mix should have a nice creamy consistency.
6. Pour the mixture slowly and evenly into the mold without entrapping any air.

The molds have to be thoroughly dried before use. Depending on the size and wall thickness of the mold, drying at room temperature may take several days. You can use a drying oven. Be sure not to exceed temperatures that are over 120 °F.

Plaster will harden in place. In order to dispose excess plaster, pour it into a disposable container such as a milk carton. Allow it to harden. If the plaster has hardened in the mixing bucket just flex the walls, it will break off. Clean out the bucket. Dirty mixing containers should not be used to mix additional plaster.

Do not clean any implements and containers by rinsing plaster down the drain. It will harden in the drain.

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Choosing a Mold and Model

There are alternatives methods that can help demonstrate slip casting.

Cup shaped models are used. The cavity is filled with slip, allowed to build up to a desired wall thickness, and then excess slip is poured off leaving a thin walled container. Small household items may be used as well as long as they are free of undercuts.

Once plaster is prepared you have two options in creating your mold.

Option 1:

You can do one of two things to create your mold.

You can use a hollow shape such as a yogurt cup and pour around it. Hold it in place by using sand or a stick in order to reduce buoyancy. Be sure to keep the cup in place until the plaster begins to harden.

Ask students if they would use a Yoplait shaped cup, or not. Why?

Or

Pour plaster into a square plastic container or Tupperware. Wait until the plaster is semi firm and place the model firmly into the plaster. Once plaster is set carefully remove the model to ensure that the details will not be disturbed.

Option 2:

Before the plaster is prepared build a mold box. A mold box is created by making a box comprised of four sides that are held together with external cords on a flat bottom base. The sides and bottom joints of the mold box are sealed with ordinary plastic clay.

Place the model upside down on the box base seal the edges with clay and cover the outside lightly with soap. Mold soap or any ordinary house soap can be used to prevent plaster from sticking to the box and the model.

Prepare the plaster then pour it over the model carefully until the mold box is filled.

Why is it important to use a regular yogurt cup and not a cup like a Yoplait container in this type of mold preparation?

Clay Based Suspension (Slip)

Clay base suspensions, called slips can be obtained from pottery supply or hobby stores. Get assistance to choose a slip that is appropriate for your firing equipment.

Alumina Slip recipe

This can be adjusted to however much slip is needed for the demonstration or experiment. Follow these steps in order or the slurry will not mix completely

1. Dissolve about 1wt% Darvan (or other deflocculant) into a prepared container of water
2. Add 1wt% PVA (or other binder)
3. Once the binder and deflocculant have been fully dissolved, add in 30wt% alumina.
4. Mix until homogeneous
5. Place the slurry using a funnel into a plastic container and seal it with a cap

The slurry should look bright white and little thicker than the consistency of milk. If mixed correctly following the instructions above the alumina particles should stay suspended and not settle on the bottom of the container. If it starts to settle immediately add a little more deflocculant.

Wt% means that it's based on the amount of liquid you are using. You want for 5% of saltwater, you'd mix 5 grams of salt into water that will end up being a total volume of 100ml.

Additional information

Here are some helpful sources that offer tips, instructions, and information that can aid in the demonstration, and experimental portion of the module.

<http://www.usg.com/rc/data-submittal-sheets/industrial-plasters-cements/usg/usg-no1-pottery-plaster-data-en-IG1366.pdf>

The Essential Guide to Mold Making & Slip Casting by Andrew Martin 2007

There are power point presentations that accompany the modules. Figures 1-5 are the particular power point associated with the Slip Casting module in the figures above.

Rethinking the Path to Online Education and the Quality of Student Learning: Education Modules Focused on Topics in Materials Science and Engineering



Figure 1. Power point presentation for Ceramic: Slip Casting module, slides 1-4.



Figure 2. Power point presentation for Ceramic: Slip Casting module, slides 5-8.

Rethinking the Path to Online Education and the Quality of Student Learning: Education Modules Focused on Topics in Materials Science and Engineering



Figure 3. Power point presentation for Ceramic: Slip Casting module, slides 9-12.

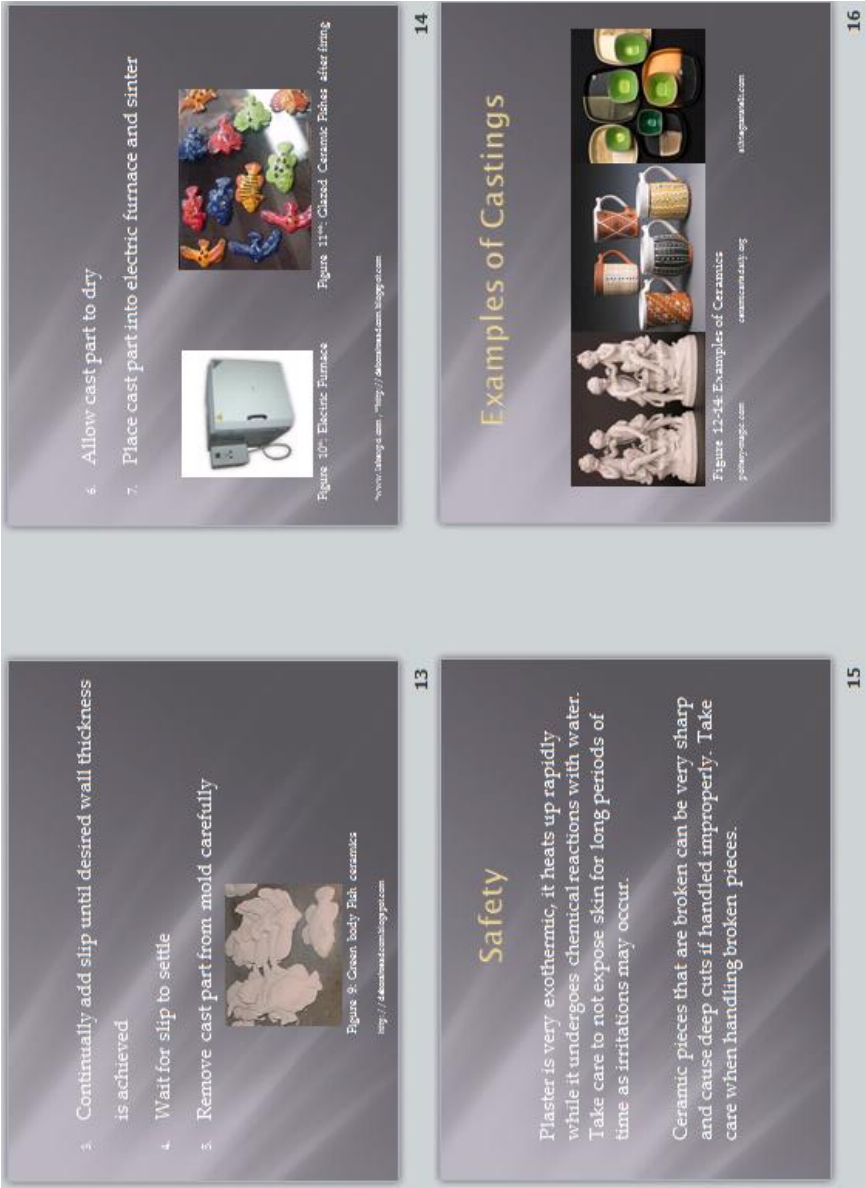


Figure 4. Power point presentation for Ceramic: Slip Casting module, slides 13-16.

Rethinking the Path to Online Education and the Quality of Student Learning: Education Modules Focused on Topics in Materials Science and Engineering

Discussion & Questions

- Why is it important to wait 2 to 3 minutes slowly stir the water after plaster is added to it?
- Why do internal and external imperfections occur in molds and cast products?
- Can you think of other alternatives for the mold materials? Why would they be better?
- What are some of the advantages and disadvantages of slip casting?

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Basic Terms

- Green body - a ceramic created from slip casting prior to being fired or sintered.
- Exothermic - A reaction that releases energy in the form of heat, light and or sound.
- Undercuts - Features in a mold that cannot be produced by a single mold (makes it difficult to remove a green body ceramic without causing damage.)



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Recap

- Slip Casting is an inexpensive technique used in industry to make identical parts.
- Even though it's labor intensive the molds can be reused to make identical pieces.
- Examples of ceramics can be seen everywhere.

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Acknowledgments

Professor Tom Shoebe and Professor Fumio Ohuchi for assistance in developing and editing this module, as well as the feedback and suggestions from Tuesday Kuykendall. The Materials Science & Engineering Department at the University of Washington provided the equipment needed for the development of this module.

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Figure 5. Power point presentation for Ceramic: Slip Casting module, slides 17-20.

Summary and Future Work

Educational modules serve as an aide for instructors that aim to educate their students in a variety of engineering fundamental concepts by implementing multimodal teaching via, reading, lectures and hands on demonstrations or experimentation. Modules can be developed and tailored to target specific age groups or grade levels. The following modules were completed during the research period: Ceramics: Slip Casting and Sand Casting. Future work includes continuing to develop modules covering the basics of corrosion alongside a module on how to perform data analysis on experimental findings.

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Elizabeth's interests are in atmospheric corrosion in marine environments, high temperature metals, corrosion prevention, and current education standards for teaching the fundamentals of engineering taught in high school, technical schools, community colleges and four year universities. She is currently seeking work experience in related fields in order to gain the necessary skills and knowledge that can be applied towards a graduate program in the future.

Conversi sed non Perversi: Contextualizing the Twelfth Century Gilbertine Lay Petition

Dustin Neighly

Abstract

A monastic reformation movement swept through Europe in the eleventh and twelfth centuries resulting in increased access to the religious life for peasants and noble women. The introduction of these new elements caused tension and anxiety among existing ecclesiastical elites. A prime example of these tensions is the Gilbertine Order, a monastic sect founded in England ca. 1131 that provided for the needs of these newly active populations. Originally created to serve a group of cloistered nuns, the Gilbertines soon began to include lay brothers to oversee the external governance of the monastery. At some point after 1147, the Gilbertine Order introduced Canons, monks of socially elite backgrounds, who usurped the lay brethren's position of authority. This usurpation created tensions that resulted in the Gilbertine lay brothers filing a formal complaint with the pope ca. 1161. Existing research on this topic generally relegates the lay brothers' actions to a marginalized extreme and scholars have often described the brothers' actions using terms originally employed by the lay brothers' adversaries, such as "rebellious" and "violent." There has been little attempt to understand the lay brothers' intentions nor to situate the petition in relation to the larger social, political, religious, and economic movements sweeping throughout Western Europe in the mid- to late-twelfth century. My research has found that their actions represent an attempt, albeit frustrated, to integrate themselves within a larger, society-wide discussion of rights, duties, and relationships between the period's various social hierarchies, both ecclesiastical and lay. A comparison of the language and procedures outlined in letters surrounding the Papal investigation of the lay brothers' petition indicates that, rather than being an attempt to upend prevalent social hierarchies, the lay brothers' actions serve to illustrate their attempts to integrate themselves within these power structures.

The eleventh and twelfth centuries ushered in an era of dramatic religious reformation and cultural revitalization within Western Europe. This renaissance of the twelfth century, as Charles Haskins dubbed the period in his book by the same name,¹ is most visible in its physical

¹ Charles Haskins, *The Renaissance of the Twelfth Century* (New York: Meridian Books, 1957).

legacies, such as the sweeping arches of Chartres Cathedral and the vivid windows and statuary of Saint Denis. In addition to these physical artefacts, the twelfth century renaissance included a host of cultural and sociological shifts. These movements, though more obscure to our eyes, remain equally important for the role they played in laying the foundations of modern society. For example, these changes included an increased monetization of the economy and expanded trade networks, typified by the birth of the Hanseatic League; the reintroduction of Aristotelian logic into western philosophy; the foundation of Universities in Paris, Bologna, and Oxford, as well as the concomitant application of reason to theology, known as scholasticism; and a monastic revitalization movement, spurred on by reformers such as Robert of Arbrissel, Bernard of Clairvaux, and Gilbert of Sempringham.²

Perhaps one of the unique aspects of these reform movements was the idea that new segments of the population were to be granted access to a religious life previously reserved for nobility. The novel idea that women and the laity could not only be saved, but that they should have an active engagement in their own salvation included with it the equally novel problem of how to incorporate these individuals into the existing ecclesiastical structure without disruption.³ Robert of Arbrissel, one of the vanguards of the new religious movements, took the unusual step of making the religious lives of women central to his new monastic house of Fontevraud in France.⁴ Conversely, the Cistercians, while distancing their nascent order from any involvement in women's houses, opened the religious life to the uneducated laity in the form of the lay brethren (known in Latin as *conversi*). It is somewhere between these approaches that Gilbert of Sempringham situated himself and his order, the Gilbertines.

Gilbert of Sempringham was born sometime before 1089. The majority of the information pertaining to Gilbert's life and the early years of his Order comes from the *Life of St. Gilbert*. This hagiography, authored by an anonymous Gilbertine canon, includes a collection of miracle stories, a dossier containing the letters relating to the Gilbertine lay brothers' petition, and a collection of letters pertaining to Gilbert's

² For a detailed investigation into this reform movement see Giles Constable, *The Reformation of the Twelfth Century* (New York: Cambridge University Press, 1996).

³ See Colin Morris, *The Papal Monarchy: The Western Church from 1050 to 1250* (Oxford: Clarendon Press, 1990).

⁴ For additional information see Jacques Dalarun, *Robert of Arbrissel*, trans. Bruce Venarde (Washington: Catholic University of America Press, 2006).

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canonization. The author compiled this hagiography shortly before the translation of Gilbert's relics following his canonization in 1202.⁵ As a member of Lincolnshire's lesser nobility, the future saint trained at either the local parish school or perhaps, as Foreville suggests, nearby Crowland Abbey.⁶ Following this initial rudimentary education, Gilbert travelled abroad and studied in France with the financial assistance of his family and friends. The exact whereabouts of Gilbert's education in France are unknown, though Golding persuasively argues that the cathedral school of Laon represents a distinct possibility.⁷ Regardless of where he studied, Gilbert earned the title of *magister* prior to his return to England.⁸ At this point he began educating "the boys and girls of the countryside."⁹

The Gilbertine order was founded in 1131 in Sempringham, England, and originally served a small population of women.¹⁰ Gilbert had sequestered these women in a cloister built along the northern wall of a church, "with an enclosure sealed on every side."¹¹ The author of the *Life* tells that their withdrawal from the world was so severe that "only a window was preserved" for necessities such as food and clothing to pass through.¹² In an effort to shield these nuns¹³ even further from the outside world, Gilbert enrolled several impoverished, young girls to serve them. These young women were "dressed in secular attire" and transferred goods to and from the nuns through the cloister's window.¹⁴ The master of the Order required that these servants live an austere life,

⁵ Golding argues that the author was the Gilbertine sacrist Ralph de Insula; see Brian Golding, *Gilbert of Sempringham and the Gilbertine Order* (Oxford: Oxford University Press 1995), 7.

⁶ Ed. Raymonde Foreville and Gillian Keir, *The Book of Saint Gilbert* (Oxford: Clarendon Press, 1987), xvii. N.B. Future references to *The Book of Saint Gilbert* will only include Foreville when citing passages written directly by her; primary source citations will not include this information.

⁷ Golding, *Gilbert of Sempringham*, 12.

⁸ *Book of St. Gilbert*, 14-15. Date unknown.

⁹ *Ibid.*

¹⁰ *Ibid.*, 30-35.

¹¹ *Ibid.*, 32-33.

¹² *Ibid.*

¹³ It should be noted that the term nun may be an anachronistic application at this early date of the order, see Golding, *Gilbert of Sempringham*, 18-22. However, such debate is beyond the scope of this essay and the term "nun" shall be used to avoid unnecessary confusion regarding the evolution of the women's status in the Order.

¹⁴ *Book of St. Gilbert*, 34-35.

so as to not negatively influence the already enclosed nuns. After a year of rigorous novice-hood, they adopted the religious life and habit, entering the order as lay sisters.

Sometime afterward, Gilbert took on men to serve both nuns and lay sisters. He recruited these lower class men from his household servants, freed serfs, and “destitute beggars,”¹⁵ and charged them with overseeing “nuns’ external and more arduous tasks.”¹⁶ The men eventually requested entrance into the religious life, which Gilbert granted after a period of novice-hood similar to that of the lay sisters. Upon officially entering the Order, these men became lay brothers, known in Latin as *conversi*.

The introduction of the lay brothers and the expansion of Gilbert’s Order during the 1130s required the *magister* to begin considering methods to oversee the spiritual health of the nuns, lay sisters, and lay brothers. Gilbert journeyed to Cîteaux, France in 1147, seeking to “entrust the responsibility for his religious houses”¹⁷ to the Cistercian Order. The Cistercian abbots demurred, stating that their Order was not allowed to oversee the spiritual lives of women.¹⁸ Gilbert was “forced by this crisis to summon men to share pastoral care who were educated and distinguished by ecclesiastical orders.”¹⁹ He recruited these clerks from primarily upper-class nobility and organized them under the Augustinian rule. These clerks entered the order as canons regular. In contrast to the lay brethren, the canons regular were charged with performing the sacraments, reading and copying texts, and singing the liturgical hours. In addition, the canons were “set to govern all those [Gilbert] had gathered together.”²⁰ The introduction of Augustinian canons altered the fundamental structure of the Gilbertine Order by subverting the traditional powers and responsibilities of the *conversi*. Tensions soon arose between the canons and lay brothers.

Beginning ca. 1165, the Gilbertine order was wracked with scandal – two lay brothers, Ogger and Gerard, had approached Pope Alexander III and Archbishop Thomas Becket, both in exile at Sens, France, with charges against Gilbert and their order. The nature of these charges was manifold – they accused Gilbert of altering their original

¹⁵ Ibid., 38-39.

¹⁶ Ibid., 36-37.

¹⁷ Ibid., 40-41.

¹⁸ Cf. Foreville, *Book of St. Gilbert*, xl-xlii and 40-43; and Golding, *Gilbert of Sempringham*, 25-33.

¹⁹ Ibid., 44-45.

²⁰ Ibid.

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profession contrary to when they first entered the order, of excommunicating any Lay Brother who did not take this new oath, of the mixing of men and women within the order, and of the relaxation of discipline amongst the monks and nuns.²¹ Upon hearing these accusations, Alexander III and Becket sent letters to Gilbert demanding immediate reform of his Order and an appearance before the archbishop in February of 1166.²² Ogger was to deliver these letters to Gilbert, but the *magister* never received them.²³ It appears that Ogger attempted to give the letters to Gilbert and a quarrel broke out between the two that resulted in the letters being left undelivered.²⁴ Because Becket's letter never reached Gilbert, he did not fulfil the archbishop's summons. This caused Becket to write a second, more sternly worded letter, under his new title of papal legate in mid-1166. Becket's second letter makes clear that the lay brothers visited him at least twice.²⁵ The charges against Gilbert and the Gilbertines soon became known throughout England, prompting a concerted campaign of support for the religious leader.

Gilbert's supporters included King Henry II, Bishop William of Norwich, Bishop Henry of Winchester, and others. These letters of support were collected in the same Gilbertine codex containing the *Life of St. Gilbert*; as such, they represent the institutional memory of this event. The content of these letters varies, but the main points remain the same: Gilbert was considered a holy man and any allegations against his order were patently false, and the pope should rescind his demands for reforming the Order immediately. However, there is a drastic difference in the letters written by Henry and those written by Gilbert's

²¹ Ibid., 134-137, letter 1.; N.B. when referencing the letters compiled within *The Book of St. Gilbert*, both page and letter number will be given.

²² Pope Alexander's letter unfortunately has not survived, while the letters from Becket were not included in the Gilbertines' compilation. These letters have been reprinted in ed. and trans. Anne J. Duggan, *The Correspondence of Thomas Becket, Archbishop of Canterbury, 1162-1170* vol. 1 (Oxford: Clarendon Press 2000), 180-183, letter 44 and 358-361, letter 89.

²³ *Book of St. Gilbert*, 136-137, letter 1.

²⁴ Foreville gives as a possibility the interception of the letter by Henry, who was preventing all communication to and from Becket. This is extremely unlikely, as there is no evidence to suggest that Henry prevented subsequent letters from being delivered, namely those establishing the papal inquests. Moreover, Henry's letters to the papacy make no mention of such an interception. Cf. Foreville, *Book of St. Gilbert*, lv, Golding, *Gilbert of Sempringham*, 43.

²⁵ *Correspondence of Becket*, 360-361, letter 89; "you have either defied or neglected our mandate, as the oft-repeated complaints of your brethren show."

ecclesiastical allies. The churchmen's letters were focused on refuting the charges against him while the king's letter relied upon threats of secular retaliation, such as removal of rights and charters, if the lay brothers received any support from the church.²⁶ Although these letters did not cause the pope to cease his calls for reform immediately, they did move him to establish two formal papal inquests in 1166-1167 to look into the matter.

The inquests were divided by region and were headed by Bishop William of Norwich and Archbishop Roger of York. In addition to investigating the lay brothers' initial allegations against Gilbert, they also looked into a new charge, that he had excommunicated Ogger after the attempted delivery of the pope's letters. Gilbert, some of the canons, and the lay brothers were all given an opportunity to present their evidence. Both inquests found in favour of Gilbert, although the pope ordered the monks and nuns to be separated further. Finally, Pope Alexander III issued two privileges to the Order in 1169.²⁷ Most of the lay brothers involved in the dispute were reconciled with Gilbert and re-joined the Order, although they requested a relaxation in the rigorous application of their rule; a request that appears to have been granted some twenty years later.²⁸ Some, however, were transferred to other Orders. It seems that Ogger alone was entirely unwilling to return to the religious life.²⁹

The Gilbertine lay brothers' petition was perhaps the first, though certainly not the last, of its kind.³⁰ As such, it has elicited a plethora of comment in the century following Rose Graham's initial treatment of the order in 1901.³¹ Graham's narrative overview of the Gilbertines was quite extensive and her chronology of the lay brothers' petition has much to commend it; however, her book is now somewhat dated and her analysis leaves much unexamined. The next scholar to discuss the Gilbertine lay brothers was Dom David Knowles. Writing in 1935, he claimed that the *conversi* were a source of "calumnies and

²⁶ Golding, *Gilbert of Sempringham*, 45.

²⁷ Cf. *Book of St. Gilbert*, 134-139, letter 1 and 150-153, letter 7; see also, Golding, *Gilbert of Sempringham*, 48-51.

²⁸ *Book of St. Gilbert*, 116-119.

²⁹ Cf. *Ibid.*, 80-83 and 152-153, letter 7.

³⁰ Golding, *Gilbert*, 40-41.

³¹ Rose Graham, *St. Gilbert of Sempringham and the Gilbertines* (London: Elliot Stock, 1901)

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attacks,”³² and that its members were “degenerated,” “extravagant, dishonest, and immoral.”³³ Knowles views the resolution of this episode as a display of the “vigilant care exercised by the pope and the good sense of the English bishops.”³⁴ Nowhere in his analysis does he attempt to situate the uprising within the cultural milieu of the period, nor within the rapidly changing responsibilities of the Gilbertine lay brothers themselves. However, Knowles’ contributions to reconstructing the chronology of the brothers’ petition, the campaign of support, and the subsequent inquest have proven quite invaluable.

Following closely on Knowles’ work was that of Raymonde Foreville. Initially publishing a study of Gilbert’s canonization in 1943, Foreville’s work on the Gilbertines was interrupted by the Second World War. Foreville never lost interest in the Gilbertines and published a fully translated and annotated version of the *Life of St. Gilbert* in 1987. This edition arose from her monumental discovery of the complete *Life* during her doctoral research.³⁵ Its discovery has had a profound effect on Gilbertine scholarship; the debt owed to her work is immense. Foreville argues that the legal contest between Gilbert and the lay brothers extended until ca. 1178.³⁶ In doing so, Foreville posits an alternative sequence of events that required a second hearing before the Roman court itself. Her chronological account of the crisis differs significantly than that detailed above and the accounts rendered by both Knowles and Golding, the most recent and thorough of the Gilbertine scholars.³⁷ Although Foreville’s analysis of the lay brothers’ petition is demonstrably more even-handed than Knowles’ work, it continues to overlook the lay brethren’s active and engaged participation within the affair, as well as perpetuating the biases of the opponents of the *conversi*.

³² M.D. Knowles, “The Revolt of the Lay Brothers of Sempringham,” in *The English Historical Review*, Vol. 50, No. 199 (Oxford: Oxford University Press, 1935), 465.

³³ Knowles, *Revolt*, 469.

³⁴ Knowles, *Revolt*, 474.

³⁵ Foreville, *Book of St. Gilbert*, lxiii-lxxi.

³⁶ *Ibid.*, lx-lxii and 344.

³⁷ See Golding, *Gilbert of Sempringham*, 458-462 for a detailed analysis of the problematic nature of Foreville’s reading. In short, the dossier of letters regarding the lay brothers’ petition differs between the two extant manuscripts (London, BL, MS Cotton Cleopatra BI and Oxford, Bodl. Lib. MS Digby 36). The major difference between these codices is the composition of Henry II’s letters to Pope Alexander III. This essay relies upon the Oxford reading of these letters.

Brian Golding's monumental analysis of Gilbert and the Gilbertine order rectifies the patronizing tone of Knowles' scholarship, while simultaneously correcting the errors of Foreville's chronological account. Unlike Knowles, Golding recognizes the inherent bias of the Gilbertine sources, noting that "the *Vita*³⁸ and associated documents paint a very black picture of the lay brothers."³⁹ His examination of the lay brothers' appeal attempts, in some small way, to rehabilitate this picture. He does this first by situating the petition within the uprisings at other monastic houses, such as one in the Cistercian house at Schönaun in 1168 and the Grandmontine uprisings of the 1180s. In doing so, Golding notes that the *conversi* took these actions because of "a belief, real or mistaken, that the powers of the *conversi* were being restricted."⁴⁰ Unfortunately, Golding's approach remains positivistic in nature and focuses almost exclusively on issues of chronology and does not integrate contemporary evidence from outside the Gilbertine order itself. There is little interplay between his analysis of the lay brothers' petition and his economic analysis of the early Gilbertine houses, though his investigation of the Order's economic base is considerable in scope.⁴¹ Golding uses his economic discoveries neither to investigate potential motivations for the lay brothers' petition nor to contextualize it. Golding's book does provide an exemplary overview of the specifics involved in the lay brethren's appeal, while correcting the errors of Knowles' and Foreville's previous works; but although Golding makes significant strides toward correcting these misconceptions of previous generations of scholars, the primary aim of his investigation into the lay brothers' actions is not the *conversi* themselves. His interests lie in the way the brothers' petition affected the evolution of the Order in the late twelfth century. While a commendable study, Golding's work still leaves quite a bleak image of the Gilbertine *conversi*.

As noted above, the Gilbertine Order was far from unique in its experience of protesting lay brothers and several scholars have attempted to examine and contextualize these various events. The most notable examples come from the study of the Cistercian lay brotherhood. The Cistercians were the most widely spread monastic Order to incorporate lay brothers and given the similarities between the Gilbertines and

³⁸ *Vita* is the Latin word for "Life" and the word came to be associated with the hagiographic "Saints' Lives" stories of the medieval period. Golding is here referring to the *Life of St. Gilbert*.

³⁹ Golding, *Gilbert of Sempringham*, 41.

⁴⁰ Ibid.

⁴¹ See Golding, *Gilbert of Sempringham*, 392-441.

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Cistercians a brief analysis of the overlapping historiography would seem to be in order. Scholars of Cistercian *conversi* petitions generally focus narrowly on the circumstances and particularities of the Cistercian lay brotherhood while continuing to silence the brethren's voices. For example, in his work, *Decline of the Cistercian Laybrotherhood*, James Donnelly argues that the root of lay uprisings was "the indignity of [the lay brothers'] task."⁴² He does not discuss the particular circumstances which may have caused the lay brothers to lodge complaints. He puts forth the notion that the 1181 general chapter ruling prohibiting *conversi* from being present during the election of abbots was, in part, a response to the crises at Grandmont and Sempringham.⁴³ However he leaves unquestioned whether the lay brothers were able to vote prior to 1181, claiming that such an investigation would be entirely insignificant. Furthermore, he continues the tradition of maligning the lay brothers by describing their petition at Sempringham as "the sad experience of St. Gilbert."⁴⁴ Donnelly accepts, at face value, the statements of Gilbert and the other elites involved in the experience while not accounting for the motivations behind the lay brethren's actions.

The most ambitious attempt to counteract these silencing efforts came in the form of Megan Cassidy-Welch's article, *Non Conversi sed Perversi*.⁴⁵ In this essay Cassidy-Welch examines Cistercian literature surrounding the various monastic "rebellions" of the thirteenth century and seeks to provide a "more complex understanding of the Cistercian *conversi*."⁴⁶ She claims that "the historiography of the Cistercian lay brotherhood has accepted the 'fact' of the deviant lay brother, focusing on manifestations of violence and reasons for discontent."⁴⁷ She argues that Donnelly's focus was "primarily quantitative,"⁴⁸ and, pointing out that Donnelly's criteria for "rebellion" are not entirely consistent,⁴⁹

⁴² Donnelly, James, *The Decline of the Cistercian Laybrotherhood* (New York: Fordham University Press, 1949), 22.

⁴³ *Ibid.*, 24-25.

⁴⁴ *Ibid.*, 26.

⁴⁵ This title translates to "Not lay brothers, but perverse men."

⁴⁶ Megan Cassidy-Welch, "Non Conversi sed Perversi: The Use and Marginalisation of the Cistercian Lay Brother" in *Deviance & Control: New Perspectives in Medieval Studies* (Parkville: University of Melbourne, 1997), 46.

⁴⁷ *Ibid.*, 38-39.

⁴⁸ *Ibid.*, 39.

⁴⁹ Cassidy-Welch states that Donnelly's criterion for defining rebellions was collusion, but, citing the uprising of Baudeloo in 1226, she points out that not all of the incidents he reports involve a conspiracy. However, if we examine

argues that his work furthers and exacerbates this trend. She states that analysing records of disturbances leaves “unquestioned the fundamental assumption that the lay brothers were exceptionally violent and disruptive.”⁵⁰ She argues that the “recalcitrant lay brother is essentially an invention of the thirteenth century.”⁵¹ She does so by breaking down the linguistic structures used to describe the lay brothers in literature and chapter statutes, coming to the conclusion that the lay brothers’ actions are “a threat to the carefully erected systems of hierarchy and power that characterise the monastic milieu.”⁵² In this light, the rules drafted in chapter, such as the inability for lay brothers to vote for abbots referenced by Donnelly above, reflected “a need for the institutional superstructure to more precisely define, and express the reasons for renewed interest in discipline.”⁵³

Although Cassidy-Welch focuses solely upon thirteenth century Cistercian monasteries, in order to accept her conclusion that the lay brothers’ actions constituted a “threat” to the ecclesiastical hierarchy it is necessary to ignore the historical aspects of lay brothers of Sempringham’s petition. The lay brothers’ decision to petition the papacy formally and their ultimate acceptance of the inquest’s findings demonstrate their desire to remain within the hierarchy of the Church. Rather than overturn the existing order of the “institutional superstructure,” the Gilbertine *conversi* were explicitly operating within this hierarchy and using its existing methods of appeal. Their actions demonstrate that they were operating under the presumption that their involvement in the nascent monastic reform movement as administrators entitled them to a voice, however confined and limited it may have been. Rather than being “rebellious,” the Gilbertine *conversi* appealed to the papal court utilizing existing channels and accepted modes of petition. In order to successfully argue this point two questions must first be addressed – how did the Gilbertine lay brothers manage to pursue their claims all the way to the papal court and why did they choose to pursue this particular course of action when they did? While a successful answer to these questions will not necessarily completely repaint the

Donnelly’s own explanation of his criteria we will see that he is relying upon the fact that “those who were pyromaniacs or thieves, or those who struck the abbot, or repulsed official visitors, or revealed the secret affairs of the Order to others all come under the same sentence ‘of conspirators.’” – Donnelly, *Decline*, 23.

⁵⁰ Cassidy-Welch, *Non Conversi*, 42.

⁵¹ *Ibid.*, 34.

⁵² *Ibid.*, 42.

⁵³ *Ibid.*, 46.

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existing picture of the lay brothers, it may at least allow for a fuller comprehension of it.

One aspect which previous Gilbertine scholars have left unexamined is the role that economic factors may have played in the execution of the lay brothers' petition. This absence is especially striking given that Gilbert accused the *conversi* of accumulating "possessions for themselves by theft"⁵⁴ and Henry II claimed that the brethren were not only guilty of "secretly carrying away [the Order's] possessions," but that they had also attempted to bribe him with "300 silver marks."⁵⁵ While Golding makes note of both of these accounts, he merely states that the former is "according to Gilbert's account" and that the latter was "surely an exaggeration,"⁵⁶ offering no further examination of either. Conversely, Foreville did not acknowledge the biased nature of the sources when she claimed that the lay brothers "tried to lay hands on the goods of the Order, and even engaged in brigandage and murder,"⁵⁷ whilst Knowles makes the assertion that the lay brethren were "dishonest, and immoral, and this estimate is corroborated by the letters of the king and others."⁵⁸ It is clear that, although Golding treats the financial aspects of the lay brethren uprising the most even-handedly out of these three, his analysis is ultimately lacking; the question of how the lay brothers were able to gather and deploy the resources necessary to carry out their petition has yet to be answered.

Prior to discussing the particulars of Henry and Gilbert's accusations and the exact details of the lay brethren's economic situation, it is first important to establish a baseline understanding of the overall economic atmosphere of the latter half of the twelfth century. Foremost in this understanding is a working knowledge of currency. It is important to not erroneously conflate the value of the medieval pound-sterling with the currency of the same name in use in the present day United Kingdom; throughout the medieval period the British pound (£) was equivalent to 20 shillings (*s.*) which, in turn, was equivalent to 240 pennies (*d.* for *denarius*). A silver mark was the equivalent of 2/3 of one pound-sterling. Therefore, the 300 marks which Henry II claims he was offered would equal £200.

In addition to having different denominations, the medieval pound-sterling differs dramatically from its modern counter-part in terms

⁵⁴ *Book of St. Gilbert*, 78-79.

⁵⁵ *Ibid.*, 142-145, letter 3.

⁵⁶ Golding, *Gilbert of Sempringham*, 41-42.

⁵⁷ Foreville, *Book of St. Gilbert*, lvii.

⁵⁸ Knowles, *Revolt*, 469.

of the amount of labour it represents. For example, while the modern pound-sterling is roughly equivalent to one-sixth of an hour's wages at minimum;⁵⁹ Miller and Hatcher approximated the daily wages of a craftsman in the thirteenth century to 3*d.* – 4*d.* and assessed a labourer's wages somewhere between 1.5*d.* – 2*d.*⁶⁰ A mid-thirteenth century expense list from the Gilbertine priory of Malton demonstrates that they spent between £9 7*s.* 8*d.* and £13 10*s.* in wages for paid labourers, indicating the degree to which they required their services.⁶¹ Although the lay brethren would have received absolutely no wages for their labours, these figures are useful for contextualizing the amounts discussed. Using Miller and Hatcher's figures, Henry's claim of 300 silver marks reveals them to be equal to almost 33 years' worth of a craftsman's wages. Viewed in these terms, King Henry's figure escalates from a dramatic to an astronomical amount. However, this quantification does not instantaneously rule out the lay brothers' ability to acquire such large sums of money. While Gilbert informs us that Ogger was "taught the blacksmith's trade" and would, by his trade, be solidly within the "craftsman" category, it is important to note that both Ogger and Gerard had been "entrusted the care of all [the Gilbertine] houses."⁶² This position may have given them access to large quantities of the Order's resources for use in their case, as Gilbert claimed.

Before examining Gilbert's accusation of theft in depth, it is necessary to consider whether Ogger would have been capable of using his trade to procure the money necessary to travel to France and petition the Pope on at least two occasions,⁶³ if not also to bribe King Henry II. As previously stated, Ogger was a trained blacksmith. The mining, smelting, and smithing of ores were quite lucrative businesses for many monasteries, including several of the reformed Augustinian Orders. For example, the abbey of Rievaulx had an iron mine and forges in Barnsley, South Yorkshire which were operational by c.1150.⁶⁴ However, the Gilbertines appear not to have held any major iron-works.⁶⁵ Even if

⁵⁹ "The National Minimum Wage Rates," accessed January 19, 2012, http://www.direct.gov.uk/en/Employment/Employees/TheNationalMinimumWage/DG_10027201

⁶⁰ Edward Miller and John Hatcher, *Medieval England: Towns, Commerce, and Crafts, 1086-1348* (London: Longman, 1995) 90.

⁶¹ Golding, *Gilbert of Sempringham*, 416.

⁶² *Book of St. Gilbert*, 79.

⁶³ Becket letter 89 indicates that the lay brethren appealed to him in person at least two times. Duggan, *Correspondence of Becket*, 358-361.

⁶⁴ Miller and Hatcher, *Town Econ*, 61.

⁶⁵ Golding, *Gilbert of Sempringham*, 428.

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Ogger had access to forges, they could not have accounted for the monumental sum Henry claimed or the general expense of acquiring audience at the papal *curia*;⁶⁶ four forges in Knaresborough Forest, North Yorkshire, generated £35 17s. in 1296-97.⁶⁷ At this rate, the lay brothers would have had to control the entire income from at least twenty two forges to generate the income necessary to substantiate Henry's claims, much less pay for any other expenses incurred in pursuing their petition. In addition to the 300 marks allegedly used to bribe Henry II, the lay brothers would have also required additional funds to reach the papal *curia* in France and to enter an appeal before Pope Alexander III.

The twelfth century papacy was not only a vanguard of formalized judicial appeals, but also an extremely expensive system to operate and maintain. Rome's position⁶⁸ as the center of ecclesiastical justice transformed its chancery into a far more intricate and bureaucratic administrative unit than any other in Europe at the time.⁶⁹ As the complexity of Rome's bureaucracy increased so too did its employment of university trained clerks. These clerks were educated at Europe's newly founded universities in Paris, Bologna, and Oxford, as well a number of smaller, cathedral schools dotted throughout western Christendom, such as those at Lincoln and Laon where Gilbert himself may have studied.⁷⁰ As these new *magistri* filled the various offices within its administrative system, Rome's bureaucracy became increasingly complex. Lester Little describes the Roman *curia* as "a labyrinth in which every corner and curve was jealously guarded by a toll-keeper."⁷¹ These toll-keepers not only exacted payments for their services, but also acted as gate-keepers for the petition process. This image of convoluted bureaucracy gives credence to Knowles' statement that it was remarkable that "two or three unlettered and immoral *conversi* should have been able so completely to gain the ear of a very able pope."⁷² However, as Golding points out, the lay brothers' role as the administrators of Gilbert's priories previous to the inclusion of canons regular may go some distance in dispelling notions of their uneducated

⁶⁶ *Curia* is the Latin word for "Court" and is used to describe the administrative apparatus of the Roman Catholic Church.

⁶⁷ Miller and Hatcher, *Town Econ*, 61.

⁶⁸ The term "Rome" is here used to describe the actions and opinions of the Roman Catholic Church.

⁶⁹ Lester Little, *Religious Poverty and the Profit Economy in Medieval Europe* (Ithaca: Cornell University Press, 1978) 30.

⁷⁰ Golding, *Gilbert of Sempringham*, 12.

⁷¹ Little, *Religious Poverty*, 30.

⁷² Knowles, *Revolt*, 474.

nature.⁷³ Ultimately, as the *conversi* have left us no written trace, any such statements remain entirely in the realm of speculation. Luckily, Knowles provides a key to uncovering this apparent mystery when he mentions that Archbishop Becket “was a personal friend of Gilbert.”⁷⁴ What Knowles did not point out is that Becket was a companion of the Gilbertine lay brothers as well.

Thomas Becket, archbishop of Canterbury from 1162 until his assassination in 1170, appears to have begun his relationship with the Gilbertine Order ca.1163. As Golding points out, prior to this year there was no obvious connection between the archbishop and the *magister*.⁷⁵ However, in 1163 Becket began the argument that would ultimately lead to his death in 1170 – whether members of the church should be tried in an ecclesiastical or a secular court. This fierce debate began when Henry de Broi, a canon of Bedford, assaulted and killed a knight. Becket successfully argued that Henry should be tried in an ecclesiastical court. This resulted in a significantly more lenient sentence than would have been imposed had he entered his pleas with a secular court, which could have imposed a death sentence.⁷⁶ This event is significant for our purposes primarily because Henry de Broi was the priest of Hawnes, a church belonging to the Gilbertine priory of Chicksands.⁷⁷ This fact alone would not be enough evidence to link Becket with the Gilbertine lay brethren, especially considering that neither Gerard nor Ogger appear to have originated from Chicksands. However, Thomas’ involvement with the Gilbertines did not end with his defence of Henry of Broi. Following his rejection of the Constitutions of Clarendon and evasion of a civil suit pursued by Henry II in 1164, Thomas Becket was forced into exile.⁷⁸ It was during his flight to France that Becket’s relationship with the Gilbertine lay brotherhood comes to light.

Following his rebuke of Henry’s authority, Becket undertook a circuitous route toward France. He first travelled northwards from Northampton toward Lincoln before taking to sea. In order to evade detection, Becket took refuge in a Gilbertine priory. The author of Gilbert’s *Vita* claims that it was within this monastery that the “plans for

⁷³ Golding, *Gilbert of Sempringham*, 42.

⁷⁴ Knowles, *Revolt*, 470

⁷⁵ Golding, *Gilbert of Sempringham*, 39.

⁷⁶ Frank Barlow, *Thomas Becket* (Berkeley: University of California Press, 1986), 93.

⁷⁷ Golding, *Gilbert of Sempringham*, 39.

⁷⁸ For a more detailed historical narrative of the build-up to, and consequences of the meeting at Clarendon see Frank Barlow, *Thomas Becket*, 88-116.

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his journey and his hiding places were most carefully drawn up, companions and servants being received by Thomas from among Gilbert's brethren."⁷⁹ However, as Barlow's account indicates, Becket's flight was not quite as simple as Gilbert's anonymous hagiographer portrayed it as being. Two Gilbertine brothers accompanied Thomas, providing him with assistance. These brothers are identified as Robert de Cave and Scaiman in the anonymous *Life of St. Thomas*.⁸⁰

Golding and Knowles both identified Robert and Scaiman as lay brethren.⁸¹ This is most likely based upon three facts. First, the *Vita*'s use of the term "*fratribus*" to describe the servants Becket acquired,⁸² had they been Canons it is likely that the *Vita* would have identified them as such, preferring the terms *canones* or *clerici*.⁸³ The word "*fratribus*" is also used to describe Becket's companions in Edward Grim's *Life of St. Thomas*.⁸⁴ Second, Scaiman continued to stay with Becket for two years following his exile to France and served as his messenger until his capture in England in 1166. Upon his capture, Henry II is said to have severely tortured Scaiman for additional information.⁸⁵ Had Scaiman been a canon, it is unlikely that he would have suffered such a gruesome fate at the hands of Henry's men. Finally, and most convincingly, the anonymous author of the *Life of St. Thomas* states that Becket "*vocavit ad se vir Domini duos conversos religiosos quos in comitatu suo*

⁷⁹ *Book of St. Gilbert*, 72-73.

⁸⁰ Anonymous I, "Life of St. Thomas" in *Materials for the History of Thomas Becket* vol. iv (London, Longman & Co. Publishing 1879) 53.

⁸¹ Golding, *Gilbert of Sempringham*, 38-39 and Knowles, *Thomas Becket* (Stanford: Stanford University Press 1971) 99-100.

⁸² *Book of St. Gilbert*, 72-73.

⁸³ Cf. *Book of St. Gilbert*, 46-47, and 50-53 for instance of Canons being referred to in terms of *canones* and *clerici*; compare to 54-55, in which the Canons are referred to as *canones* while the lay brethren are listed simply as *fratribus*.

⁸⁴ Edward Grim, ed. James Robertson, "Life of St. Thomas" in *Materials for the History of Thomas Becket* vol. ii (London: Longman & Co. Publishing 1876), 399 – "*sumpsi secum duobus fratribus, quibus ante propositi sui secretum aperuerat*" trans (mine): "[Thomas] took with him two brothers, to whom he had unveiled the secret of his plan;" cf. with Herbert of Bosham's "Life of St. Thomas" in *Materials for the History of Thomas Becket* vol. iii, (London: Longman & Co. Publishing 1877) 323, which states that Becket fled "*fratrem unum de ordine de Simpligeham secum habens*," trans(mine): "[Thomas] had one brother from the Order of Sempringham with him."

⁸⁵ Cf. Golding, *Gilbert of Sempringham*, 39 and Barlow, *Thomas Becket*, 161.

habebat” (trans: “the man of God called to himself two religious lay brothers whom he had in his service”).⁸⁶

After these two Gilbertine *conversi* joined him, Becket travelled to Lincoln and stayed with a wool worker named James *ad Pontem*.⁸⁷ James was an acquaintance of at least one of the lay brothers, most likely both.⁸⁸ The relationship between the lay brothers and James provides evidence of the lay brethren’s extended social and political network. While Becket’s escape was most likely planned well in advance, as Golding suggests,⁸⁹ the lay brothers’ ability to negotiate and secure safe passage for the archbishop amongst their fellows indicates the degree to which they were capable of coordinating resources. Following their flight to Lincoln, Becket and his Gilbertine lay brethren companions sailed southward along the River Witham toward Boston. Once the three arrived on the outskirts of Boston they made their way to another Gilbertine Priory, the newly established Chicksands.⁹⁰ En route to Chicksands, Becket disguised himself as a Gilbertine lay brother⁹¹ (that the sources mention neither Scaiman nor Robert de Cave donning similar disguises serves as yet further evidence to indicate their status as *conversi*). There the three met up with yet another member of the Gilbertine order, this time a chaplain-canon named Gilbert. Finally, Becket, Scaiman, and Gilbert the Chaplain all fled to Sens, France.⁹²

⁸⁶ Anonymous, *Mats* v. iv, 53. Trans mine.

⁸⁷ *Ad Pontem* translates from Latin as “near the bridge,” perhaps relating to his family’s relationship with High Bridge in Lincoln. Golding suggests that the *ad Pontem* family is the source of the altar of Thomas Becket that was on High Bridge, although the evidence to support this is tenuous. The only information available indicates that the *ad Pontem* family acquired lands in an effort to build an altar to the martyred archbishop, but there is no indication that this altar is the one built on High Bridge. Cf. *ibid.* and Francis Hill, *Medieval Lincoln*, (Cambridge: Cambridge University Press 1948) 149.

⁸⁸ The relationship between the lay brothers and *ad Pontem* is unclear; Edward Grim’s *Life of St. Thomas*, 399 states that “*apud civem Jacobum nomine, notum fratribus, latitabant*,” trans(mine): “they [Thomas and his companions] hid with a citizen named Jacob, who was known to the brothers;” cf. Golding, *Gilbert of Sempringham*, 39 and Barlow, *Thomas Becket*, 115

⁸⁹ Golding, *Gilbert of Sempringham*, 39.

⁹⁰ The Gilbertine double-monastery of Chicksands was founded in ca.1151-3 following a land grant by the Countess Rohaise and her husband, Payne de Beauchamp; Golding, *Gilbert of Sempringham*, 117.

⁹¹ Cf. Herbert of Bosham, *Mats* v. iii, 325 and Edward Grim, *Mats* v. ii, 399.

⁹² Robert de Cave may have joined them, but there is no evidence indicating this. Golding, *Gilbert of Sempringham*, 39 and Barlow, *Thomas Becket*, 116.

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While Golding sees no evidence of a *quid pro quo* agreement between Gilbert and Becket regarding the archbishop's defence of Henry of Broi and the assistance that the Order provided him in his escape,⁹³ he does not consider whether there was any connection between the lay brothers' assistance in this episode and their ability to gain the ear of the archbishop through their petition, and by extension that of Pope Alexander III. Did the time that Becket spent with the Gilbertine lay brothers engender a special connection with them? Such a question is entirely speculative. However, regardless of any sense of indebtedness that Becket may or may not have felt toward the lay brethren, it is possible that the Gilbertine *conversi* may have had access to Thomas outside of the customary appellate system. It is quite likely that Scaiman, the Gilbertine lay brother, was still with Becket during Ogger and Gerard's initial trip to Sens. The lay brothers initiated their appeal to Alexander in late 1164 or early 1165, whilst Scaiman was still in Becket's service prior to his capture in 1166.⁹⁴ The presence of a trusted *conversus*⁹⁵ within Becket's inner circle during his exile could have given the petitioning lay brothers an alternate point of entry. As previously demonstrated in the example of James *ad Pontem*, the political and social networks of the Gilbertine *conversi* were potentially still in use during the 1160s. It is likely that such a network would have existed between the Gilbertine lay brothers themselves. If the Gilbertine lay brothers were capable of circumventing the usual and customary bribes and payments required to lodge an appeal before the papal *curia*, then the monetary resources required for their endeavour would, by extension, have been substantially lower. However, this does nothing to explain how the lay brothers paid for their trips to Sens nor does it shed light on the thorny question of Henry II's 300 silver marks.

Knowledge of James *ad Pontem* and his extended family will assist in piecing together a plausible theory regarding the lay brothers' route. It is possible that Ogger and Gerard took a route to France similar to Becket himself. The *ad Pontem* family was a well-to-do family of Lincoln, holding property just north-west of Lincoln Cathedral. Following Becket's assassination, the family began acquiring lands in an effort to build a shrine for Becket.⁹⁶ Members of the family eventually served as bailiffs and mayors. While Golding associates James *ad Pontem* directly with the *de Ponte* family outlined in Hill's *Medieval*

⁹³ Golding, *Gilbert of Sempringham*, 39 fn. 146.

⁹⁴ For the timeline concerning the appeal process, please see pages 4-6 above.

⁹⁵ *Conversus* is the singular of *conversi*.

⁹⁶ See Fn. 88.

Lincoln, it is important to recall that James *ad Pontem* was also a fuller.⁹⁷ Judging from fines collected in the early thirteenth century, Miller and Hatcher conclude that the wool industry was “solidly established,” with a weaving gild existing in the town as early as 1130; and that the cloth emanating from the city was “of quality production.”⁹⁸ However, this does not mean that James himself was well-to-do enough to be counted in the same social class as those who shared his name. The fullers within Lincoln were, at least by the end of the twelfth century, decidedly unfree.⁹⁹ It must also be remembered that, according to Gilbert, the Gilbertine lay brother Gerard was “endeavouring to make a living from his skill at weaving,” prior to his entry into the Order.¹⁰⁰ While this does nothing to prove the existence of a connection between Gerard and *ad Pontem*, it does provide a potential tie between the two; they were both lower class wool workers in Lincolnshire and James had some acquaintance with the Gilbertine *conversi*, of which Gerard and Ogger were members.

Although plausible explanations can be crafted regarding the lay brothers’ use of the resources at their disposal, ultimately the sources make claims of theft and bribery. However, it is what the sources are silent on that brings them into question. In Gilbert’s account of the lay brothers’ petition, he states that they “stirred up against [him] no less a person than Pope Alexander... as well as the Roman *curia*.”¹⁰¹ Nowhere does Gilbert allude to the role that Thomas Becket played in this affair, nor does the author of the *Life of St. Gilbert* make mention of the archbishop in his telling of the event. Furthermore, Thomas’ letters to Gilbert concerning the *conversi* are not included in the compilation at the end of the *Life of St. Gilbert*.¹⁰² That such a prominent player in the process would be so conspicuously absent serves as a stark reminder that the Gilbertines’ institutional memory of the lay brothers’ appeal is decidedly slanted in their own favour. Including Becket’s castigation of the order would highlight the potential validity of the lay brethren’s cause. This validity is something that the author of the *Life* takes great

⁹⁷ A fuller is the person responsible for cleaning and felting wool after it had been woven; for additional information see Miller and Hatcher, *Medieval England*, 95.

⁹⁸ *Ibid.*, 100.

⁹⁹ *Ibid.*, 104.

¹⁰⁰ *Book of St. Gilbert*, 78-79.

¹⁰¹ *Ibid.*

¹⁰² Cf. *Book of St. Gilbert*, 134-167 and 346-349. For a detailed textual analysis on the provenance of the various letters see Foreville, *Book of St. Gilbert*, lxiii-xc.

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pains to avoid, even when discussing Gilbert's eventual compromise with the *conversi* prior to his death.¹⁰³ With this in mind, the fact that Gilbert's and Henry's writings are the only such accounts that accuse the lay brothers of theft is extremely interesting; none of the letters within the dossier, including those of the papal judges-delegate, make mention of theft by the lay brethren, neither do they mention the "mockery and derision" Gilbert claims they received by "clergy and people."¹⁰⁴ Gilbert's recollection was recorded sometime after the events themselves, while Henry's account is clearly influenced by his desire to assert authority over ecclesiastical affairs within England.

Similar to the sources' silence regarding the lay brothers' theft, none of the other sources corroborate King Henry II's charge of bribery. As demonstrated above, the amount Henry alleges to have been offered is astronomical and, as Golding states, his figure was surely an exaggeration.¹⁰⁵ Nor is Henry's indictment of the lay brothers' mentioned anywhere in the *Life of St. Gilbert*, although his letter to Pope Alexander is explicitly referenced.¹⁰⁶

In addition to an analysis of how the lay brothers were able to pursue their claims, there has yet to be an extensive investigation into why the lay brothers took the particular course of action that they did, i.e., why did they choose to take their appeal directly to Pope Alexander III? All three established Gilbertine scholars agree that the pressures exerted on the *conversi* following the introduction of the canons are the most likely root of the petition. Golding astutely summarized the tensions between the lay brothers and the newly introduced canons over the Order's temporal affairs, claiming that "indeed [it was] this power struggle which lies behind the lay brothers' complaints."¹⁰⁷ Similarly, Knowles states that it was "the jealousy toward the more recently established canons," as well as the "audacity and success which distinguished their first movements of revolt" that spurred them on their course of action.¹⁰⁸ Foreville agrees with these assessments, arguing that "[the lay brothers] were subject to a rule which was harsher than those of the canons or the nuns; and these constraints had become unbearable at the point when the canons had taken over the effective administration of the houses of the Order, leaving the lay brethren the subordinate

¹⁰³ *Book of St. Gilbert*, 116-119.

¹⁰⁴ *Ibid.*, 79.

¹⁰⁵ See pages 11-13 above and Golding, *Gilbert of Sempringham*, 42.

¹⁰⁶ *Book of St. Gilbert*, 83.

¹⁰⁷ Golding, *Gilbert of Sempringham*, 47.

¹⁰⁸ Knowles, *Revolt*, 467.

tasks.”¹⁰⁹ However germane these observations are, they fail to explain the significant lag time between the introduction of these “constraints” in the early 1150s and the lay brothers’ appeal to Pope Alexander III in 1164. In leaving unexamined the period between the introduction of the canons and the lay brothers’ petition, these scholars have also left unanswered a larger, more fundamental question – why did the lay brothers’ complaints arise a full ten years after the introductions of the canons?

The establishment of canons undoubtedly changed the power dynamic within the Gilbertine Order; however, the timing of their integration into the order demands an explanation. The canons were introduced to the Gilbertine order sometime after Gilbert’s unsuccessful attempt to join his order to the Cistercian houses in 1147.¹¹⁰ The exact timing of when the canons were brought into the Order is currently unknown, and perhaps unknowable; the earliest document attesting to the existence of canons is a confirmation charter issued to Watton dating from ca. 1151-1153. The Watton charter sets aside two knight’s fees for the upkeep of thirteen canons.¹¹¹ This indicates that the Order had incorporated canons into its overall structure by this date; however, it does nothing to illuminate the extent of their integration or the potential changes this introduction would have had on the lay brothers themselves.

Prior to the addition of canons, the Gilbertine *conversi* were “in charge of the nuns’ external and more arduous tasks.”¹¹² These external labors included, as Gilbert claims of Ogger and Gerard, “the care of all [Gilbertine] houses.”¹¹³ In fact, Gilbert claims to have introduced the lay element, both sisters and brothers, into his order specifically to act as a buffer between the nuns cloistered in Sempringham and the outside world.¹¹⁴ In the absence of canons, the *conversi* were the sole conduit for the Gilbertine houses to interact with the world at large. The level of authority wielded by the lay brethren would have been impossible in a Cistercian context, where the canons had absolute authority over the monastery’s affairs and, by extension, its lay brethren.¹¹⁵ Therefore, the rule under which Gilbert initially inducted the lay brothers into the order

¹⁰⁹ Foreville, *Book of St. Gilbert*, lviii.

¹¹⁰ See pages 3-4 above and *Ibid.*, xl-xlii, 41-47.

¹¹¹ Golding, *Gilbert of Sempringham*, 32.

¹¹² *Book of St. Gilbert*, 36-37.

¹¹³ *Ibid.*, 78-79.

¹¹⁴ *Ibid.*, 34-36.

¹¹⁵ Golding, *Gilbert of Sempringham*, 113.

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could not have resembled the Cistercian ordinances in any appreciable manner.

This elevated position of the lay brothers quickly changed with the adoption of a Cistercian-like rule and the introduction of canons. Although Gilbert denied that the lay brothers had taken oaths “following the custom of the Cistercian Order,”¹¹⁶ an analysis of the Gilbertine lay brothers’ oaths reveals what Golding calls “strong parallels between the two.”¹¹⁷ Furthermore, Golding’s expert textual analysis of the Gilbertine and Cistercian rules indicates that the former was modeled after the latter. This change occurred not later than 1157 and a date of 1153 is more likely.¹¹⁸ Given the role of lay brethren in Cistercian orders, the adoption of their rule indicates a degradation of the Gilbertine lay brothers’ authority. They were no longer in charge of the Order’s affairs; rather, they were relegated solely to the Order’s manual labor needs. This frustration and the shifting uncertainty of the lay brothers’ role prompted their initial complaints. However this change in the lay brothers’ status occurred a full ten years before their journey to Sens and the filing of their appeal ca. 1164. Golding believes that this period may be explained through Pope Alexander’s command, via the Norwich and York inquests, that Gilbert “receive brother Ogger and others in his house.”¹¹⁹ He argues that this command to reconcile with the lay brothers, along with statements that certain brothers had already received letters of absolution and dismissal from the Order, indicates that the “dispute had continued for some time” prior to reaching Alexander and Becket in 1164.¹²⁰ However, the evidence to indicate that this expulsion from the Order or the transference of lay brothers to other orders took place prior to their appeal to Alexander III is sparse. William of Norwich writes that the *conversi* complained that Gilbert “had excommunicated those who refused to take” an oath contrary to their first profession. The remainder of his letter reads as if the excommunication in question occurred after the brothers’ returned from Sens. He states that Ogger was excluded from Gilbert’s general excommunication out of reverence for the pope’s letter, which would date the incident after 1164.¹²¹ Furthermore, Becket’s initial letter to Gilbert, ca. 1164-1165, makes no mention of excommunication in

¹¹⁶ *Book of St. Gilbert*, 134-135, letter 1.

¹¹⁷ Golding, *Gilbert of Sempringham*, 113.

¹¹⁸ *Ibid.*, 114-116.

¹¹⁹ *Book of St. Gilbert*, 136-137, letter 1.

¹²⁰ Golding, *Gilbert of Sempringham*, 47.

¹²¹ *Book of St. Gilbert*, 136-137, letter 1.

relation to the *conversi*.¹²² It is not until his second letter of 1166 that Becket alludes to a potential excommunication.¹²³ Once again, this letter post-dates Ogger's attempted delivery of Pope Alexander's letter. It appears, therefore, that the excommunication edict in question occurred sometime in 1165 and not, as Golding suggests, during the ten years between the introduction of the canons and the lay brothers' appeal.

In spite of this evidence, it is possible that the ten years between the Gilbertines' adoption of the Cistercian rule and its canons and the lay brothers' appeal to the pope may have been due to some form of investigation internal to the Order itself. In his recollection of the *conversi* petition, Gilbert states that he "wished to call [the lay brothers] back from error to the way of truth" following what he states was a period in which they turned away from "their profession and the religious life" prior to their journey to Sens.¹²⁴ In doing so, Gilbert claims that the lay brothers "rebuked [his] reproaches and those of [his] followers."¹²⁵ These statements may indicate that the Order had some method of settling disputes internally and that the lay brethren had attempted to use this mechanism. Furthermore, Golding states that Bishop William's claim that certain Gilbertine lay brothers had joined other monastic orders "suggests... that the case had reached the pope after the dispute had continued for some time."¹²⁶ However, according to Gilbert, these reproaches arose from his initiative and not the *conversi* themselves. Therefore, they do not necessarily represent an organized system for dealing with grievances within the Order; rather, they are an ad-hoc attempt to impose order within the ranks of the lay brotherhood. In addition, while William of Norwich's letter indicates that some of the *conversi* transferred to other monastic orders, the timing of this move is not clear and it could very well have taken place following the lay brothers' initial complaint to the pope. Nor, it should be added, do these statements give sufficient explanation for the ten year gap between the introduction of the canons and the lay brethren's complaints before the pope; it is inconceivable that such a process of review would constitute ten years. The coincidental timing between Henry II's issuance of the Constitutions of Clarendon, Archbishop Becket's flight to France via Gilbertine monasteries, and the lay brothers presenting their complaints

¹²² *Correspondence of Becket*, 181-183, letter 44.

¹²³ *Ibid.*, 358-361, letter 89.

¹²⁴ *Book of St. Gilbert*, 78-79.

¹²⁵ *Ibid.* 80-81.

¹²⁶ Golding, *Gilbert of Sempringham*, 47.

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before the Pope presents a much more cohesive and well-rounded explanation.

Before a sufficient explanation can be posited for the decade of lag-time between the initial degradation of the lay brothers' position within the Order and the execution of their petition, it is necessary to examine the changing nature of justice in the eleventh and twelfth centuries. The European system of judicial review during this period has been categorized as tremendously fragmented, hopelessly tangled, and ultimately ineffective.¹²⁷ The execution of parallel, and frequently contradictory, jurisdictions characterized the law courts. The Anarchy, a civil war between King Stephen and Empress Matilda lasting between 1135 and 1153, exacerbated this fragmentation within England. For example, during a dispute over jurisdiction between the abbey of Bury St. Edmunds and the shire in 1149, an aged knight testified that "in the stress of war, justice has fled and laws are silenced."¹²⁸ While this knight's intent to bolster the claims of Bury St. Edmunds clearly influenced and dramatized his speech, it illustrates the fractious nature of the English judicial system in the mid-twelfth century.

The ecclesiastic system of jurisprudence centered in Rome grew in prominence and centralization in response to the confusion caused by the Anarchy and the twelfth century saw Rome transform into the center of a pan-European judicial system. The second Lateran council of 1139 epitomizes this shift; the ecumenical council made the claim that kings and princes had the right to dispense justice, but their authority to do so was contingent upon their "consultation with the archbishop and bishops."¹²⁹ The concept that the church was the source of all law, including cases unrelated to spiritual matters, received a boost with the publication of Gratian's *Decretum* circa 1140.¹³⁰ The *Decretum*, a compilation of canonical law, went much farther than the second Lateran council, by stating that cases were "called to the Roman church from everyone, especially from the oppressed."¹³¹ Gratian's work, building

¹²⁷ Marc Bloch, *Feudal Society*, trans. L.A. Manyon (Chicago: The university of Chicago Press, 1961), 359.

¹²⁸ As quoted in Austin Poole, *From Domesday Book to Magna Carta: 1087-1216* (Oxford: Clarendon Press, 1958), 156.

¹²⁹ Canon 20 in "The Canons of the Second Lateran Council, 1139," Fordham Medieval Sourcebook, <http://www.fordham.edu/halsall/basis/lateran2.asp>

¹³⁰ I.S. Robinson, *The Papacy 1073-1198: Continuity and Innovation* (Cambridge: Cambridge University Press, 1990), 179.

¹³¹ *Decretum C. 2 qu. 6 c. 8* as quoted in Jane Sayers, *Papal Judges-Delegate in the Province of Canterbury, 1198-1254: a study in ecclesiastical jurisdiction and administration*, (London: Oxford University Press, 1971), 6. – "Ad

upon the foundation of the second Lateran council and previous legalistic interpretations, emphasized that the Roman court was to be seen not only as the source of religious but also secular judgment.

The concept of Rome as a legal center escalated throughout the twelfth century until “appeals to the pope became a normal part of the procedure in English Church suits.”¹³² Even Bishop William of Norwich’s letter pertaining to the Gilbertine lay brothers echoes this sentiment when he states that “no one doubts that laws flow from [the pope.]”¹³³ Soon, however, the Roman court began eclipsing its own hierarchy of appeal; instead of progressing from bishop to archbishop and finally to the pope, most cases heard by the papal court during this period had received no prior hearing.¹³⁴

Rome’s position as a first-instance court was even more pronounced for monastic orders. Starting in the eleventh century, the papacy began issuing privileges to monastic orders that placed them directly under the authority of the Roman court. This trend continued throughout the twelfth century and became even more evident under the pontificate of Alexander III.¹³⁵ It is difficult to determine if the Gilbertine Order had obtained papal privileges exempting them from diocesan oversight by the time of the lay brothers’ inquest, as no extant privileges predate this event. However, the *Life of St. Gilbert* and a letter by Gregory, prior of the Augustinian priory of Bridlington, make explicit mention to “solemn privileges” issued by Pope Eugenius III and Pope Adrian IV.¹³⁶ Had this privilege mirrored the privileges granted to other reformed monastic orders of the twelfth century, it would likely have established Rome as the Gilbertines’ court of first-instance. Even if the Gilbertines did not possess papal privileges explicitly establishing Rome as their court of first-instance, the precedent for treating it as such was already well established by the time the lay brothers launched their petition.

The rise in ecclesiastical justice, and the reliance upon the pontificate as a first-instance court, lay at the root of the controversy between Thomas Becket and Henry II. As noted above, Becket’s flight

Romanam ecclesiam ab omnibus, maxime tamen ab oppressis appellandum est.”

Translation mine.

¹³² Sayers, *Papal Judges-Delegate*, 4. Cf. Knowles, *Thomas Becket*, 19 and Robinson, *Papacy*, 185.

¹³³ *Book of St. Gilbert*, 140-141, letter 2.

¹³⁴ Cf. Sayers, *Papal Judges-Delegate*, 5 and Robinson, *Papacy*, 186.

¹³⁵ Ibid.

¹³⁶ Cf. *Book of St. Gilbert*, 50-51 and 154-155.

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from England came upon the heels of his refusal to agree to the Constitutions of Clarendon in 1164. The clauses three and eight most vexed the Archbishop; the former attempted to bring criminous clerks under royal jurisdiction, while the latter designated the king as the ultimate adjudicator within ecclesiastical appeals. Provision eight explicitly attempted to contravene the papacy's claim of being the court of final appeal throughout Western Europe. This provision proved to be the most serious impediment to negotiations between Pope Alexander III, King Henry II, and Archbishop Becket, following the archbishop's flight to France.¹³⁷ Neither pope nor king was willing to concede the right to ultimate appeal. It is within this context of tension that the lay brothers chose to assert their right to appeal directly to the pope.

The language surrounding the investigation of the lay brothers' claims and its aftermath indicates that their decision to appeal to the pope may not have been timed solely upon the exhaustion of alternative methods and the acquisition of sufficient funds. Throughout the letters sent to Pope Alexander III in 1166 in support of Gilbert, two words are frequently used to describe the lay brothers – insolent and rebellious.¹³⁸ While these terms appear similar, their tone, intent, and the context in which they appear serve to differentiate them and provide a window into the lay brothers' intentions.

Both words, insolent and rebellious, appear in letters sent to the pope as part of the campaign on behalf of Gilbert prior to the establishment of papal judges-delegate and the official inquest.¹³⁹ This letter writing campaign included several prominent bishops, an Augustinian prior of Bridlington, a papal-legate, and no less than King Henry II himself. These letters all stressed Gilbert's sanctity, in addition to maligning the lay brothers and, in Henry's letter, all but commanding the pope to dismiss their claims. As Golding argues, this "marshaling of [Gilberts] supporters" may be conceived of "as part of the anti-Becket policy of the crown."¹⁴⁰ While this is likely, the language difference between these letters reveals a dramatic difference in their intentions.

For example, in the letters written by Henry, bishop of Winchester, and Gregory, prior of Bridlington, the actions of the

¹³⁷ Barlow, *Thomas Becket*, 121-122.

¹³⁸ For the use of *insolentia* see *Book of St. Gilbert*, 146-147, letter 4 and 156-157, letter 8. For the use of *rebellibus* see 142-143, letter 3 and 160-161, letter 11.

¹³⁹ See Foreville, *Book of St. Gilbert*, lxxxiv-xc and 343-344; Cf. Golding, *Gilbert of Sempringham*, 44 and 458-462.

¹⁴⁰ *Ibid.*

conversi are referred to as *insolentiam*.¹⁴¹ The bishop and prior claim that the lay brothers' actions constitute insolence because they "are refusing to acquiesce in the profession of the holy religious life,"¹⁴² and because they are "men of lower nature, men who love only themselves."¹⁴³ For these two members of the ecclesiastical community, the problem with the lay brothers' petition lay in their breaking of the monastic commitment toward "humility, obedience, and patience and the like."¹⁴⁴ While Prior Gregory's and Bishop Henry's opposition to the lay brothers' appeal is based in part upon social distinctions and notions of propriety – for example, Prior Gregory claims that the *conversi* are "men dedicated only to flesh and blood"¹⁴⁵ – the prime motivation behind their censure of the lay brothers actions appears to be one grounded in notions of monastic submission.

Rather than using the term *insolentia* as the churchmen's letters employed, Henry II opts to refer to the lay brothers as *rebelles*.¹⁴⁶ The differences between Henry's accusations against the lay brothers and those of Bishop Henry and Prior Gregory do not end there, however. In describing the lay brothers' "rebellion," Henry asserts that they would have "caused to be killed, the master of the Order... if they had not been afraid of us and of the other founders of houses."¹⁴⁷ No other sources claim that the *conversi* were violent or had violent intentions. The closest any of the other letters come to this assertion is Alexander III's statement that bishops are to excommunicate anyone who violently attacks "any canon or professed religious of this Order."¹⁴⁸ Alexander does not state that there was any violence against the Gilbertines and his command to censure and anathematize any aggressors against the Order seems to be generally applicable. The remaining sources, including the *Vita* and Gilbert's own statements, do not make even the slightest mention of any attacks. The accusation of violent *conversi* appears to be completely unique to Henry's letter. In fact, this imagery of violence is quite telling in its novelty and two conclusions can be made about it – the first historiographic and the second historic.

¹⁴¹ *Book of St. Gilbert*, 146-147, letter 4 and 156-157, letter 8.

¹⁴² *Ibid.* 146-147, letter 4.

¹⁴³ *Ibid.* 156-157, letter 8.

¹⁴⁴ *Ibid.* 38-39.

¹⁴⁵ *Ibid.* 156-157, letter 8.

¹⁴⁶ *Ibid.* 142-145, letter 3.

¹⁴⁷ *Ibid.*

¹⁴⁸ *Ibid.* 158-159, letter 10.

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On the historiographic side – a good deal of scholarship surrounding the Gilbertine lay brothers has portrayed their actions as an act of violence. The view among modern scholars that the lay brothers' petition was an inherently violent affair appears to have begun with Rose Graham's statement in 1901 that the lay brothers had "utterly failed to move Gilbert by violence."¹⁴⁹ Foreville goes farther than Graham in her assessment, claiming that the lay brothers "engaged in brigandage and murder."¹⁵⁰ As recently as 1990, Jane Sayers continued to perpetuate this belief by stating that "the severity of the rule incited the lay brothers to violence."¹⁵¹ While Golding does not make similar statements regarding the supposedly violent actions of the lay brothers, he does nothing to correct the statements of previous historians. The existing historical record does not attest to violence among the Gilbertine *conversi* and there is no reason to suspect that the lay brothers furthered their petition through violent means.

Although both Henry and Alexander mention violence against Gilbertines, the different context each presents illuminates their positions and ultimately gives greater depth to the lay brothers' own intentions. As stated above, while Henry makes the accusation that the *conversi* had violent, albeit frustrated, intentions, Alexander asserts no such claims; rather, the pope reminds his bishops of their duty to anathematize anyone, lay or otherwise, who attacks a member of a Religious Order. He makes absolutely no reference to violence on the part of the Gilbertine lay brothers. Furthermore, in his letter to Henry, Alexander goes on to state that before the bishops deliver this sentence of excommunication, they are to establish the truth through a process of arguments and appeals.¹⁵² This contrasts sharply from Henry's letter pre-dating the papal inquisition demanding that the pope order his bishops to "compel" the lay brothers to "obey their vow and profession."¹⁵³ Henry's demands upon the pope make no mention of inquests, arguments, or appeals on the part of the lay brothers; the right to gather evidence and petition¹⁵⁴ is reserved to Gilbert alone. Although these letters are ostensibly about Gilbert and the lay brothers, a stronger

¹⁴⁹ Graham, *St. Gilbert of Sempringham*, 22.

¹⁵⁰ Foreville, *Book of St. Gilbert*, lvii.

¹⁵¹ Jane Sayers, "Violence in the Medieval Cloister" in *The Journal of Ecclesiastical History*, vol. 41, no. 4 (Cambridge: Cambridge University Press, 1990), 539-540.

¹⁵² *Book of St. Gilbert*, 158-159, letter 10.

¹⁵³ *Ibid.*, 142-145, letter 3.

¹⁵⁴ Henry uses the word "*petitionem*" to refer to Gilbert's defence.

subtext infuses them. Each letter reads as if its author is attempting to justify his positions *vis-à-vis* the dispute surrounding the papacy's right to act as a court of first-instance and its ability to render appropriate punishments, both of which were disputed items under the Constitutions of Clarendon.

Given the context of the Constitutions of Clarendon, Henry's statement that the lay brothers would have acted violently "if they had not been afraid of [him]"¹⁵⁵ appears to make the claim that ecclesiastical authorities were incapable of effectively dealing on their own with violence. Clause three of the Constitutions states that clerks convicted of crimes, even in an ecclesiastical court, were to be punished by secular authorities, rather than receive their punishments through the church.¹⁵⁶ While the lay brothers were not clerks, and thus not subject to clause three, this struggle over ecclesiastical jurisdiction was central to the Constitutions.¹⁵⁷ As Barlow states in his survey of the English church, "A principle which runs through the Constitutions... [was] that whenever there was a conflict of laws the king or his justices should decide whether the case should go to the ecclesiastical court."¹⁵⁸ It must be remembered that it was Philip of Broi's light sentence in an ecclesiastical court that sparked the initial controversy between Henry II and Thomas Becket. Therefore, it is understandable that the subtext of tension between secular and ecclesiastical enforcement would run throughout Henry's letter. His letters to Pope Alexander are a continuation of the claims he pressed within the Constitutions of Clarendon.

Henry also uses his letter to remind the papacy of the role that his secular power plays in his claim to supremacy of jurisdiction. The king argues that he and his fellow lay magnates would be within their rights to withdraw previously drafted charters for Gilbertine houses were the pope unwilling to support Gilbert in the case. He is quick to remind Pope Alexander that if Henry receives what he wishes then these charters will be supported "to the height of [his] powers," "as far as [his] secular justice is concerned."¹⁵⁹ Although he freely acknowledges Rome's claims to jurisdiction over the vows and professions of monastic members, Henry's not-so-subtle reminders that ecclesiastical institutions

¹⁵⁵ Ibid.

¹⁵⁶ "The Constitutions of Clarendon, 1164," The Medieval Sourcebook, accessed February 1, 2012, <http://www.fordham.edu/halsall/source/cclarendon.asp>

¹⁵⁷ Cf. Frank Barlow, *The English Church: 1066-1154*, (New York: Longman Inc, 1979), 154-157.

¹⁵⁸ Ibid. 157.

¹⁵⁹ *Book of St. Gilbert*, 162-163, letter 12.

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rely upon the secular powers of he and his fellow lay magnates serve to reinforce his claims to implementing and controlling justice within England.

Alexander's actions surrounding the affair, as well as his letter to Henry immediately following the inquest, argue for a much more nuanced balance of power between the two potentates. Alexander's words to Henry serve as an attempt to reaffirm Rome's position as the head of ecclesiastical justice and the font from which secular justice receives its justification. Perhaps the most important expression of papal supremacy by Alexander III is his implementation of papal inquests ca. 1166-1167. Although letters authorizing these legislative bodies do not survive, their outcomes are recorded in great length in the letters of Roger, archbishop of York, and Bishop William of Norwich.¹⁶⁰ These epistles explicitly reference Alexander's command to oversee the Gilbertine dispute, as Archbishop Roger claims, "we have proceeded in the dispute... according to the instructions which your highness gave in writing."¹⁶¹ These delegations post-date the concerted letter writing campaign of 1166 detailed above.

In setting up the inquests of Norwich and York, Alexander was making a very clear statement to Henry II that the church's judicial system was a robust system that was capable of reviewing and correcting disputes. In his letter, Henry had all but demanded that the pope order the "rebellious lay brethren... to observe without deviation their profession,"¹⁶² threatening that failure to do so would lead him and his barons to revoke the grants they had previously issued to the Gilbertines.¹⁶³ Interestingly, this threat to rescind temporal grants to the Gilbertine houses is echoed in Bishop Henry's letter to the pope when he states that "many nobles of our kingdom... have charitably assisted [the Gilbertines'] purpose with gifts and have increased his flock with the means for their conversion."¹⁶⁴ Rather than bow directly to this pressure, Alexander established two inquests and charged them with investigating the full extent of the lay brothers' claims.

Perhaps the most telling feature of the papal inquests was their composition – they were populated by the bishops and archbishops who initially voiced their support of Gilbert. As Golding points out, "all but

¹⁶⁰ Letters 7 and 1, respectively.

¹⁶¹ Ibid. 150-151, letter 7.

¹⁶² Ibid. 142-143, letter 3.

¹⁶³ Ibid. 162-163, letter 12; this section of letter 12 was originally appended to the end of letter 3, see fn. 37 above.

¹⁶⁴ Ibid. 146-147, letter 4.

the bishop of Durham had already shown themselves to be supporters of Gilbert.”¹⁶⁵ For example, letter one outlines the inquest established in the diocese of Norwich. This letter is the most complete and thorough of all of the letters written by the papal judges-delegate, spanning a full three pages and giving detailed findings on the committee’s investigation of each of the lay brothers’ complaints. As Bishop William claims, the inquest most certainly “made a very diligent and careful inquiry.”¹⁶⁶ However, it should be of no surprise that the inquest ultimately found in favor of Gilbert himself; Bishop William had previously sent a letter to Pope Alexander making the explicit claim that “Gilbert does not presume to alter [the lay brothers’ profession.]”¹⁶⁷ Alexander was fully aware of William’s opinion on the matter before establishing him as a judge-delegate commissioned with overseeing the Norwich inquest. Had it been Alexander’s intent to have the lay brethren’s dispute objectively investigated, such a choice for the inquest might be questionable. Rather, it appears that Alexander’s intentions were to proceed with the inquest to demonstrate its efficacy and to reinforce his claims to authorize such proceedings.

This is not to say that the inquests were necessarily kangaroo courts. The proceedings from both Norwich and York attest to a thorough investigation that presented the lay brothers with opportunities to substantiate their allegations. For example, during the York inquest, the lay brethren were “insufficiently prepared to prove” that Gilbert had claimed that the pope’s letter was a forgery and they requested, and received, an adjournment to prepare additional supporting evidence.¹⁶⁸ While the *conversi* were unable to gather the necessary evidence to prove their allegations during their second hearing, the fact that they were provided with an opportunity to muster and present evidence demonstrates the degree to which the papal inquest was committed to investigating the lay brothers’ claims. In addition, this instance also indicates the active role that the lay brethren played in the proceedings. Rather than demonstrating that the inquests were established explicitly to support Gilbert in his opposition to the lay brothers’ goals, as Henry had demanded of Alexander, the findings of Roger and William show that the *conversi* were provided with ample opportunity for their voices to be heard before the delegated judges. The *conversi*’s failure to prove their

¹⁶⁵ Golding, *Gilbert of Sempringham*, 45.

¹⁶⁶ *Book of St. Gilbert*, 136-137, letter 1.

¹⁶⁷ *Ibid.* 140-141, letter 2; for the disagreement surrounding the timing of this letter see fn. 37 above and Golding, *Gilbert of Sempringham*, 458-462.

¹⁶⁸ *Ibid.* 152-153, letter 7.

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case merely reveals that they were uninformed about and ultimately ill-equipped to deal with the procedures of ecclesiastical courts.

This failure on the lay brothers' part is demonstrated in the legalistic logic that Gilbert employs to repudiate their claims. According to William of Norwich's letter, Ogger asserted that Gilbert "had judged to be forged a letter sent by [the pope]" and that he had excommunicated Ogger.¹⁶⁹ Archbishop Roger's report states that Pope Alexander's letter had been "sent to the whole of that Order" and that the lay brethren had claimed that Gilbert had "aspersed [it] as being forged."¹⁷⁰ In addition, Roger writes that Gilbert "has excommunicated no one" from Watton.¹⁷¹ Conversely, Bishop William found that Gilbert "asserted that he had not rashly excommunicated anyone" but had "embraced in a general excommunication those who overturned his order."¹⁷²

Perhaps the most telling finding of the inquests relates to the lay brothers' charges that Gilbert had excommunicated the lay brethren who sought Pope Alexander's assistance. Upon investigating this claim, Bishop William concluded that Gilbert had excluded Ogger "by name" from the general excommunication and that he had done so "out of reverence for [the pope's] letter."¹⁷³ Such an exemption would require that Gilbert be made aware of the letter and acknowledge its authenticity. However, Gilbert consistently asserts that "he had not seen this letter, nor had it ever been delivered to him"¹⁷⁴ and "denied either receiving or seeing it."¹⁷⁵ Ogger was ultimately unable to publicly prove his allegations and was forced to "admit" that Gilbert's statements were true. This ultimately leads to the question – if Gilbert had never seen nor received the letter, why would he have excluded its bearer by name?

Bishop William's initial letter to Gilbert may provide insight into this question, if not provide an answer. In this letter, William informs Gilbert that "letters from the pope will be coming" to him and urges him to not "provoke those who bear them with any roughness of speech or fierce looks."¹⁷⁶ This letter almost certainly predates Ogger's initial delivery of Alexander's letter, thus making Foreville's date of 1166

¹⁶⁹ Ibid. 136-137, letter 1.

¹⁷⁰ Ibid. 152-153, letter 7.

¹⁷¹ Ibid. 150-151, letter 7.

¹⁷² Ibid. 136-137, letter 1.

¹⁷³ Ibid.

¹⁷⁴ Ibid.

¹⁷⁵ Ibid. 152-153, letter 7.

¹⁷⁶ Ibid., 146-149, letter 5.

several years too late.¹⁷⁷ If this is correct, as is probable, the only explanation for Gilbert neither seeing nor receiving these letters can only be his staunch refusal to do so in spite of his knowledge of their attested authenticity. His intentions for doing so are quite obvious, as he was able to claim to have never seen them and, thus, not enact their commands, while still maintaining enough plausible deniability that he would be legally shielded if necessary. The lay brothers, clearly not as knowledgeable of the legal system's workings, took his refusal as indication that he did not believe their claims of the letter's authenticity. This episode of legalistic legerdemain demonstrates the dramatic differences in the two sides' understanding of the law. As a *magister*, Gilbert was quite familiar with the workings of ecclesiastical justice and knew precisely what he would and would not be required to prove within court. The lay brothers, although knowledgeable in their own right, were unfamiliar with ecclesiastical proceedings and, thus, were not capable of winning their case. This episode bears witness to Paul Hyams' statement that "rhetoric and grammar must have been quite as essential to lawyers as logic."¹⁷⁸ However, the lay brothers' lack of knowledge regarding the internal workings of the ecclesiastical judicial system does not indicate that they were unfamiliar with the larger, contemporary quarrels concerning the execution of justice within England. In fact, the timing of their petition points toward a sophisticated understanding of these issues.

The lay brothers' role as the temporal administrators within the Gilbertine Order and the uniquely integrated political system of medieval England support the notion that the execution of their petition may have been carefully timed. The *conversi* would certainly have been familiar with the political firestorm surrounding the Constitutions of Clarendon. As Scott Waugh persuasively argues, every stratum of English society was infused with politics and "events at one level of the realm reverberated through the others."¹⁷⁹ The effects of pan-European political and religious struggles reached down into local communities. Becket's flight through the Gilbertine monasteries was both symptomatic of this awareness and a cause for it. The lay brothers' knowledge of the

¹⁷⁷ Cf. Ibid. 148-149 and 343 with Golding, *Gilbert of Sempringham*, 43.

¹⁷⁸ Paul Hyams, "The Legal Revolution and the Discourse of Dispute in the Twelfth Century" in *The Cambridge Companion to Medieval English Culture*, ed. Andrew Galloway (Cambridge: Cambridge University Press, 2011), 43.

¹⁷⁹ Scott Waugh, "From Court to Nation" in *The Cambridge Companion to Medieval English Culture*, ed. Andrew Galloway (Cambridge: Cambridge University Press, 2011), 18.

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struggle between the crown and church undoubtedly influenced their decision to present their case to Pope Alexander III.

Furthermore, the language and intentions behind Henry and Alexander's actions and letters demonstrate that this tension was at the core of the entire affair. Could the lay brothers have been calculating enough to foresee this conflict? Perhaps; their role as temporal administrators within the Gilbertine Order would surely have given the *conversi* a certain acumen and guile in worldly affairs. Although this strategizing and forethought was ultimately undermined by their unfamiliarity with the ecclesiastical judicial system, Alexander's need to assert Rome's dominance in trying ecclesiastical cases ensured that he would support the lay brothers' right to petition the Roman *curia*.

Contrary to previous theories on the character and intentions of the Gilbertine lay brotherhood, they were part of an integrated and well-connected network. Their ability and desire to press their complaints all the way to the papal seat demonstrates that rather than attempting to "turn their back and depart"¹⁸⁰ from the religious life and its hierarchy, the *conversi* were acting in what they perceived to be the appropriate, if untested, chain of command. The rise in first-instance cases reaching the papal court, especially among the various monastic orders, would have given them the template through which to seek a resolution for their grievances. Furthermore, their role as temporal administrators for the first twenty or so years of the Order's existence and the integrated nature of their social networks, as demonstrated during the flight of Thomas Becket, provided them with the tools necessary to lodge their petition. With this wealth of resources and connections available to them, it is quite telling that the lay brothers chose to pursue the course of action that they did.

The lay brothers' journey to Sens makes very little sense had flight from the religious life or a desire to threaten the very existence of the Order been the lay brothers' intentions.¹⁸¹ Their desire to maintain their social status includes with it a belief that they were entitled to a voice not only within the Order but also within the ecclesiastical hierarchy as a whole. In the end, the lay brothers' actions were not a "rebellion," as traditional scholarship has seen it. Their choice to petition the papacy directly was in no manner novel; the only difference between their appeal and previous ones was their social position. As

¹⁸⁰ *Book of St. Gilbert*, 146-147, letter 4.

¹⁸¹ Paraphrased from Golding, *Gilbert of Sempringham*, 50; it should be noted that Golding does not ascribe this intention to the lay brothers, he is only claiming that it was a potential outcome to their actions.

“serfs” and men who “before entering the religious life were tied to the soil”¹⁸² the lay brothers were thought unfit and unworthy of having a substantial place within the power structures of the period; that they did not share this view should come as no surprise.

It is perhaps ironic that an essay dedicated to reconstructing the worldviews and intentions of the Gilbertine lay brotherhood should focus so heavily on the goings on of the upper echelon of the late twelfth century. However, this does not necessarily invalidate or further marginalize the *conversi*. They were quite clearly operating within and attempting to integrate themselves into this larger pan-European social, cultural, and religious milieu. The interrelated nature of the church, state, regional, and local powers within the twelfth century, especially in England, means that any discussion of one must, by necessity, consider the others. In utilizing their connections to Thomas Becket and exploiting the struggle between King Henry II and Alexander III, the lay brothers demonstrated this point quite clearly. Although the *conversi* may have been “serfs” and men of the soil and plow, it is evident that they were not segregated from the world that they lived in, nor did they attempt to overturn this world. Although the Gilbertine lay brothers do not represent the existential threat to the church’s hierarchy and monastic power structures that Cassidy-Welch sees, it would be well to heed her advice that *conversi* are only *perversi* in the eyes of those who are opposed to them. In their own eyes, the lay brothers were not rebellious or perverse; they were simply *conversi* seeking to uphold their rights as they had customarily understood them.

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¹⁸² *Book of St. Gilbert*, 162-163, letter 12; I have rendered *rusticorum* as serfs here.

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Different Perspectives of Higher Education: A Journey through Education in Tahiti

Stephanie Peña

Abstract

Do cultural norms and expectations affect the purpose and value of an educational system? For my research, I traveled to Tahiti and observed the educational system at the University of French Polynesia. Employing ethnographic research methods, I conducted informal interviews with professors and students of different educational levels about their views on higher education, and the importance of their culture in their educational experience. As a comparison, I interviewed those who did not attend higher education. For the latter half of the multisided research project, I conducted similar interviews in the United States at the University of Washington, and compared my findings. I found that in French Polynesia many Tahitians believe that higher education is not the only way to attain their dreams, while Americans typically agree that higher education is the best way to become successful. A few key factors in these opposing views are best seen through the difference of cultures, the effect of colonization, and the meaning of education. My research determines that it is essential to recognize that culture and education are closely linked to one another, in order to better understand education on an international level.

Introduction

I strongly believe that we, as individuals, are our greatest teachers and that the world is our classroom. Traveling does not only open one's eyes to problems and experiences that they were once blind to, but it also opens the door to release our minds from our one-track mentality. I was fortunate enough to be able to spend three months emerging myself into a different region, culture, and way of life that has allowed me to see that we are a lot more similar than we tend to believe. Along with the similarities come differences; differences in history, culture, beliefs, understandings and appreciation. It is through studying our differences that we ensure the probability of bettering ourselves as well as the community, country and world.

Education is a social phenomenon that is relative to needs and structures of particular societies.¹ Education is one of the institutions that

¹ Durkheim, E. (1961). *Moral education: A study in the theory and application of the sociology of education*. New York: Free Press of Glencoe.

unites us as a world, therefore it is important to understand the differences that lie within the educational systems so that we can better understand and learn from one another. I was able to participate in an Independent Study Abroad Program at the University of Washington to conduct my own research on education in the beautiful island of Tahiti for the length of one quarter. The lessons I learned and the people I came in contact with insured me that the importance of education is in the eye of the beholder. As an outsider looking in, we will never fully understand the Tahitian people and lifestyle, just as you will never fully understand my experience, but I invite you to take a look at my journey as well as challenge you to open your mind to appreciate the differences that lie within the Tahitian and the American educational systems.

History of Tahiti

In order to understand my journey, you must first understand the history and culture of the Tahitian people. Tahiti, often referred to as the Queen of the Pacific, is located in the Pacific Ocean between Hawaii and New Zealand. Tahiti is the largest of 118 islands that make up what is known as French Polynesia, which covers over two million square miles of the South Pacific Ocean. In the 1600s, Captain Wallis from England as well as Captain Louis-Antonie de Bougainville from France, both stumbled across Tahiti during their voyages through the Pacific. It wasn't until the 1800s that the two countries would rival to control the island of Tahiti. After a gruesome war between the French and Tahitians, French settlers annexed Tahiti in 1880 upon the death of Queen Pomare. Tahiti became an overseas territory of France and Tahitians were granted French citizenship. More recently, in 1998 French Polynesia became an independent territory but is still very much protected and influenced by the French government.² Figure 1 shows where French Polynesia, specifically Tahiti, is located.

The number of people living in Tahiti is estimated to be just over 220,000 in the year 2010. About 75% are Polynesian; 15% European and about 10% Chinese.³ Due to the colonization of the French, it is commonly said that there are no full blooded Tahitians left. Both French and Tahitian are the official languages of Tahiti, although English is also well known amongst the islands.

² Dodd, E. (1983). *The rape of Tahiti: A typical Nineteenth-Century colonial venture wherein several European powers with their iron, pox, creed, commerce, and cannon violate the innocence of a cluster of lovely Polynesian Islands in the South Pacific Ocean*. New York: Dodd, Mead & Co.

³ Image found on Google Images, website <http://across.co.nz/Tahiti.html>.

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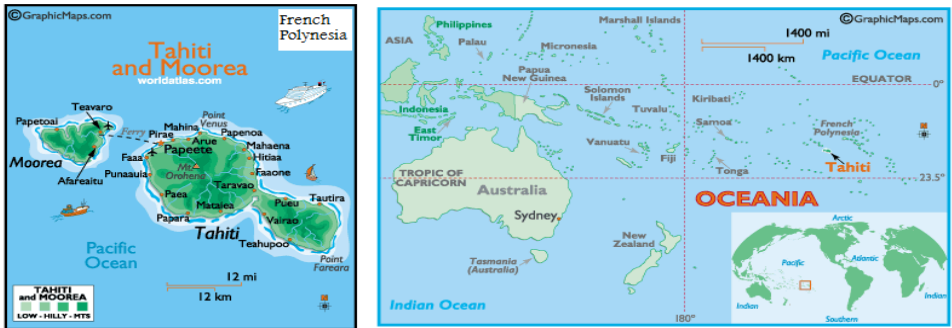


Figure 1. Map of Tahiti.

Effects of Colonialism

The Tahitian culture was drastically affected by the colonization of the French. It was as though the “culture had to rapidly transform to survive.”⁴ When the settlers and missionaries came to the island, they saw the people as savages that needed to be saved. Religion plays a vital role in colonization; Tahitians were told that the gods they worshiped were false, and that their land was not sacred. The white man came in hopes of saving these people from their lifestyles, simply because Tahitian culture and customs did not match with what they believed to be correct. Smith describes it best when writing about the Maori⁵ people saying, “We did not need, ask, or want to be ‘discovered’ by Europe.”⁶ Tahitians, like the Maori, were not in need of being saved. While there are a plethora of areas of the culture that have been forever changed due to the colonization of Tahiti, for the purpose of this paper I will focus on: (1) dance, (2) tattooing, and (3) education. I chose to focus on these specific areas because throughout my journey I was able to experience each of these categories on a personal level.

- (1) Dance: Historically, Tahitian culture comprised an oral tradition that included mythology of various gods and beliefs as well as ancient traditions such as dance. In ancient times, dances were directly linked with all aspects of life (Newbury, 32). One would dance for joy, to welcome a visitor, to pray to a god, to challenge an enemy, and to seduce a mate. Both men and women Tahitian

⁴ Hokowhitu. 2008, 120.

⁵ Maori: Tribal people of New Zealand.

⁶ Smith, 1999, 24

dancers were clothed in only “more”⁷ (pronounced mo-rae), with nothing covering their chest.



Figure 2. Tahitian dance (a) A local Tahitian dance group performing in Tahiti for a small group of students from the University of Washington in 2009. (b) A local Tahitian dance group after a performance at a hotel in Punaauia, Tahiti in 2012.

Dance was a way in which the people celebrated the power and beauty of women, but settlers and missionaries told the Tahitian people that this form of dance was indecent and sinful. Original Tahitian dance was banned from the island for over 100 years because Tahitians began to believe that they were inferior to the settlers (Smith, 47). Today, the Tahitian people have no recollection of the original style of dance, because it was forced to transform throughout history. The annual Heiva Festival in July is a celebration of traditional culture, dance, music and sports including a long distance race between the islands of French

⁷ More: a grass skirt made from bark; a traditional Tahitian dance costume. Made from plant fibers (from the bark of "puru" tree), the skirt is embellished with accessories and ornaments from the natural Polynesian environment (pearl, feathers, shells, etc.).

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Polynesia, in modern outrigger canoes (va'a).⁸ I had the opportunity to experience the Heiva the first time I traveled to the island of Tahiti in the summer of 2009.



Figure 3. Heiva Festival (a) A brochure from the Heiva 2009 in which I attended (b)Jeremie Kalsbeek performing in the Heiva Festival 2011 (c) Heiva 2009 professional dance competition (d) Canoe races of the Heiva 2009.

- (2) Tattoo: In pacific cultures tattooing has a deep historic significance that was banned from the island as well, due to the religious belief that the body is the temple, and to mark it is to destroy one's temple. In 1819 the Pomare code (proclaimed by the first king to embrace Catholicism) forbid the art tattooing throughout the Islands. The skin baring aspect and sexual connotations made tattoos completely unacceptable in the eyes of the missionaries who inspired Pomare's proclamation.⁹ The word 'tattoo' is said to has two major derivations- from

⁸ Heiva-Image 1 and Image 2 were photos taken by Stephanie Pena to show the beauty of Tahitian dance and the richness in culture at the Heiva Festival.

⁹ Blackburn,1999

the Polynesian word ‘ta’ which means striking something and the Tahitian word ‘tatau’ which means ‘to mark something’. The history of tattoo began over 5000 years ago and is as diverse as the people who wear them.¹⁰ Polynesian tattoos are more than just lines and designs; each individual mark in a tattoo tells a story. Tattooing was a form of strength and pride. Women had tattoos around their hands, waists, and legs to accentuate their beauty, while the tattoos on men were seen as symbols of power often worn by warriors and chiefs (Blackburn, 62). In the ancient times, the pigment was made from soot of burned candle nut ti’ a’iri, and thinned out with water. The mixture would turn blue once it entered the skin. This operation was done with a tattooing comb “ta”, a utensil with sharp teeth on one end carved in fish teeth and bird bones (Blackburn, 64). A mallet was used to strike the utensil and make the pigment penetrate the skin. It was an honor to have Polynesian tattoos, and was a public display of the Tahitian culture.



Figure 4. An ancient tattooing ritual being demonstrated for tourist in French Polynesia.

In pacific cultures tattooing has a deep historic significance. Polynesian tattooing is considered the most intricate and skillful tattooing of the ancient world. Polynesians believe that everyone has mana¹¹ which is displayed through their tattoo. Tattoos were at once a decoration, a language, a symbol of power and a mark of glory. It was through tattoos that Polynesians could differentiate themselves, show their social importance, rank, geographic origin, family lineage, courage

¹⁰ Cole, 2003

¹¹ Mana- a spiritual power or life force which resides in all living beings.

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and power (Blackburn, 64). It was as though their tattoos were a unique form of identification that could never be duplicated. The tattooing ceremony (pictured above) was a sacred ritual played out to the beat of drums, the melody of flutes and conch horns. To have tattooing taken away was not just stripping the Tahitians of their culture and pride; it also took away their sense of belonging and their identity as people. It wasn't until the 1980's that tattooing returned to French Polynesia with the inspiration of the Samoans during the Heiva.

- (3) Education: Education was also an area in the Tahitian culture that was drastically shifted. Through my interactions and interviews with Tahitians from all ages, they all mention how much education has changed through time, and still continues to change. Before the settlers, formal education never existed; they did not need it. The education they had was deeper than any book or lecture, they were taught to survive. They learned how to use natural resources of the island to maintain survival. They learned how to use rocks to sharpen each other to make weapons, to prepare for war. They learned about their history, their culture, and their ancestors. They learned of chiefs and warriors before them who paved the way for their existence. They learned about the gods and how to worship and respect the land. Most importantly they learned how to be proud of their Tahitian culture, which remains evident in Tahiti today. The type of formal education that they now have is geared toward the Westernized way of thinking and was never the intention of the Tahitian people until colonization, which is a key factor in my research.

My Journey

I taught English to four fifth grade classes at a local school in Punaauia, Tahiti where I was able to interact with students, teacher and faculty to experience the educational system at the middle school level. Before teaching, I sat in the classrooms to observe the ways in which the students interacted with the teacher as well as the other students. Because French is the dominant language, and I do not speak or understand French, I had to pay close attention to other forms of communication such as body language, tone of voice, actions and reactions.

I noticed rather quickly that respect was a very important feature of education. The students would come into the classroom, and quietly stand behind their desks until the teacher told them to sit down. Students did not speak while the teacher was talking, but instead engaged in the lessons being taught. The teachers spoke with an authoritative tone, which commanded the respect and attention of the students. The faculty worked together as a team for the betterment of the students.

Another obvious observation was the fact that the teachers incorporated their culture into the classroom. They were taught the history of their culture, mythical stories on how their city got named, and competed against one another to be given the opportunity to represent their school in an oratory contest against other cities and islands based on their culture and history.

One area I appreciated personally, as a teacher myself, is the fact that teaching in Tahiti holds such importance. I would strongly argue that teachers in Tahiti are more important to their society than teachers here in America. I believe teaching is a rewarding occupation which allows teachers to touch the lives of our future generations. The impact that teachers have on the lives of their students can shape their ideas of themselves as well as education for the rest of their lives. In Tahiti a teacher's salary exceeds the salary of a nurse, showing the importance placed upon the teachers.

Methodology

The purpose of my research was to compare the perspectives of higher education with those who live in Tahiti and those who live in America. The process of my research was split into two major sections: the research I conducted in Tahiti, and the research I conducted in America. For the purpose of my study I created two additional groups: those who are, or have been, in higher education (students) and those who did not pursue higher education (non-students). I conducted ethnological research by interviewing 20 students and 20 non-students in Tahiti and in America.

I asked a series of questions that centered on the idea(s) of: the importance of education, whether education is linked to success, what they like/dislike about their educational system, their views or beliefs about education around the world. It is important to note that French is the main language in Tahiti, therefore I did use a translator for each interview in Tahiti regardless of the level of English proficiency. The students of Tahiti and America were all from the ages of 18-25 and were either current or recently attended the university. The sites at which I

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conducted the interviews were at the University of French Polynesia and the University of Washington.

Before each interview my translator, Tamatoa Dööm, would explain the purpose of my interview and research. I split the interview into two sections. The first was the structured interview with a list of questions. The questions I asked were as follows:

1. What are you studying at the university?
2. What do you want to do with your degree after the university?
3. Is it possible to do that (job) without a degree?
4. Do you think education is important? Why? Why not?
5. In the (Tahitian/American) culture, are there other forms of education outside of schooling?
6. How does the (Tahitian/American) culture shape education?
7. If you were not at the University, what would you be doing now?
8. Where there influential people who helped guide you into higher education? Who?
9. What do you like/ dislike about the university?
10. Why do you need your education?
11. What do you know about education in other areas around the world? Similarities/differences?



Figure 5. Interview at University of French Polynesia. Stephanie Peña conducting an interview with a local Tahitian student at the University of French Polynesia with the help of her translator (Tamatoa Dööm).

I also conducted interviews with non-students, those who have for many reasons not pursued higher education. Many of the Tahitians that I interviewed and came in contact with had different levels of education: some got their high school diplomas, some dropped out of school and some never having attended primary schooling. These interviews were very informative, and challenged my westernized way of thinking. I am a strong advocate for higher education, but it was through these interviews that I was forced to open my mind to better understand ways of life and beliefs that are not necessarily my own. The ages of those being interviewed ranged from 18-48 years old. The questions I asked non-students were as follows:

1. What is the highest level of education you received?
2. Why did you not pursue higher education?
3. What is your job/main source of income?
4. Are you content with the fact that you didn't go to a university?
5. What is your main reasoning for not attending higher education?
6. Do you think education is important? Why or why not?
7. Do you think (Tahitian/American) culture affects education?
8. Do you think having a higher education would make you happier or lead to a better life? More successful?
9. What do you know about higher education in general?

The second part of each interview was a conversation in which I asked them to share anything they thought could add to my research; I often received more information through this portion than the original questions; they would share with me their personal experiences within education and reasons as to why they feel a particular way about higher education.

After returning to America, I began analyzing my interviews and linking common themes together. I then continued with the second portion of my research: the interviews of 20 university students, and 20 non-students. I asked the same questions to the American group as I did with the Tahitians. For the purpose of my research, the group in which I focused on at the University of Washington were those who have historically been oppressed in America. I chose to focus on minorities because I feel that the struggles shared between the two groups are similar. I conducted the interviews in a similar manner as the interviews in Tahiti, but because there was no language barrier I was able to converse in more depth with the American group.

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Results

Tahitian Students

Tahitian students have many differences, from what they choose to study, to why they are achieving higher education, but one aspect they typically have in common is their view of higher education as a whole. I was surprised to see the amount of similar opinions and frustrations this group shared. Every student agreed that education is important, for many different reasons. One interviewer, Hiro, went in depth mentioning that the level of education one obtains is related to what they want to do with their life. In Tahiti, you do not need a degree to be successful or even happy for that matter.¹² Happiness comes from within. Tahitians are happy people because "...we can see the beauty in life that most tourists that come here are searching for."¹³ While they all agreed that they personally believed education was important, not everyone on the islands believed this to be true.

When asked how Tahitian culture affects higher education a lot of interviewers were not able to fully explain what they meant, but Mahi described it best by saying, "...our culture has changed over time with the influence of the French. Education is important now because it is important to France, not Tahiti." Even today there have and continue to be after effects of colonialism on Tahitians, specifically in the institution of higher education.

Students did not have much appreciation for their home university (University of French Polynesia); in fact there were many aspects that they wished could be different. The educational system is unorganized. Students do not have consistent class schedules; instead they have to check their schedules every Sunday to see when their professors are available to conduct class. The majority of professors at the university are full-time professionals; therefore, the class schedules are created for a time that is convenient to them, not the students. This places unnecessary stress on the students, which affects their views of higher education as well. They all admitted that they do not need education, but it helps their future. "[Higher] education is simply a bonus. We are lucky to graduate high school."¹⁴

When I explained how a university in America is typically functioned, they were stunned. The students said that they would like to learn and understand how other countries view higher education. They could not understand why anyone would pay such a large amount of

¹² Interviewer: Hiro. March 7, 2012.

¹³ Interviewer: Aroaurii. March 11, 2012.

¹⁴ Interviewer : Mahia, February 27, 2012.

money for higher education. The cost of higher education in Tahiti is around \$300 a year, which makes the \$12,000+ at universities in America seem absurd. Many Tahitian students mentioned that they knew someone who has left the island to pursue higher education in different parts of the world, such as France. There were mixed feelings on the subject. "Why they have to leave the island, I will never understand."¹⁵ Another mentioned, "I think [she] isn't happy. They (French) treat her like an outsider. Our French is different than their French, so they think we are not educated."¹⁶

Identity plays a vital role in the way Tahitian students see themselves in education. Colonialism has affected the way in which Tahitians see formal education. Over 80% of the students interviewed mentioned that if they were to take higher education seriously, they would not be in Tahiti. In fact, they would go to France, (where they are also citizens) or New Zealand where they could get a better education. A lot of students admitted different reasons as to why they were in higher education, and while some knew what they wanted to pursue, many confessed that they were at the University of French Polynesia because they did not know what else they would be doing, or because they did not want to start working after high school.

Tahitian Non-Students

This group taught me the most about the culture and historical importance of Tahitians. They shared with me that there are many ways to be successful in Tahiti; education was not necessarily one of them. The level of education that was completed by this group varied drastically. The majority of students had graduated high school. Many of the interviewers had dropped out of high school, for different reasons. A smaller portion, which were typically the older aged Tahitians, had either never been in an educational system or did not surpass elementary school. For personal reasons, a few did not care to disclose their maximum level of education.

¹⁵ Interviewer : Timia, March 15, 2012.

¹⁶ Interviewer: Leialoha, March 15, 2012.

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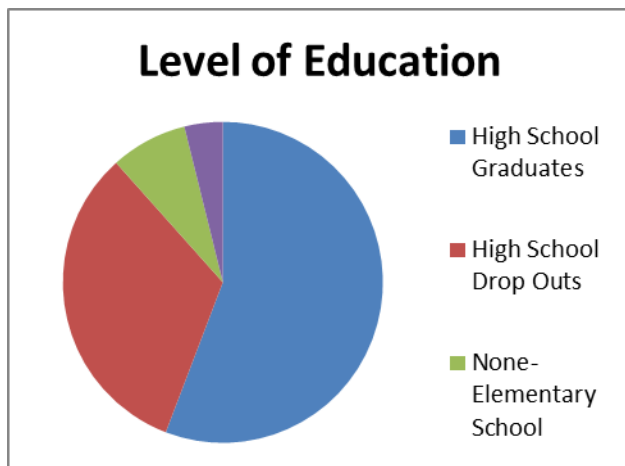


Figure 6. Tahitian Non-Students level of education.

Reasons as to why these Tahitians did not pursue higher education were similar. Many of them had no interest in higher education. “What is the point? It is a waste of time and money.”¹⁷ High school is a big accomplishment on the islands, and many do not even make it that far. Obtaining a high school degree is valued greatly in Tahiti. These high school graduates simply did not enjoy education, so when they finished high school they had no interest in continuing their education. For high school drop outs, a key factor was the lack of guidance in high school. Mihimana Tang described his experience saying that he was very good at school, he actually enjoyed it. In high school, he thought he wanted to pursue one area, in which they prepare you for the work force, but he later found out he could not qualify for that specific area. “I wasted a lot of time, that when I realized I was not going to be able to do what I wanted, I was upset and hurt. It happens a lot in Tahiti.” As for those who did not attend formal schooling, they did not see a problem with not attending school. They needed to help their families, which was much more important to them. They entered the work force, helping their fathers and learning how to prepare for their families.

When asked if they regret not pursuing higher education, the majority answered saying no. “Education does not make you happy. I am happier than many people with a college degree.”¹⁸ In French Polynesia, you typically do not need a degree to get a job that will allow you to support yourself or your family. There were a few younger interviewers

¹⁷ Interviewer: Lolani, February 13, 2012.

¹⁸ Interviewer: Mihimana, March 7, 2012.

who said they do wish to return to higher education because they think they would get more opportunities. Yet they would not want to go to the University of French Polynesia, which again reiterates the lack of appreciation of the local university, similar to the Tahitian students. These few non-student interviewers were the exception to the typical theme of being content with the decision to not pursue higher education.

The area where there were a lot of different views was in result to the question on whether or not education was important. I found that the level of competence in education was related to their view on higher education. The more education one had obtained, the more likely they were to believe that higher education is important. Those who did not spend much time in education did not see any value in higher education. They saw it as a waste of time, and believe that society has shifted drastically from the way it once was, when education meant more than what you read in a book. "You can give a man a book, but does he know how to work the land? Does he know how to supply for his family? Money cannot give you everything...Tahitian [society] is starting to believe that [formal] education is more important than educating our children the way our ancestors were educated."¹⁹

American Students

As an American student, I was able to relate the most with this group of interviewers. Like previously mentioned, I chose to focus on minorities within the University of Washington because I believe their experiences to be more similar to that of the Tahitians experience because they are both victims of being socially oppressed. The students at the University of Washington that I interviewed experienced similar struggles, beliefs and experiences in higher education. Although they came from drastically different fields of education, their overall ideas of higher education were consistent with one another.

For the professions that the students in this group want to one day pursue, higher education is essential. Future doctors, lawyers, professors, have to continue education even after their undergraduate. "A bachelor's degree holds no weight in our society these days."²⁰ Higher education is very important to each individual that was interviewed, and as a minority they feel that their presence in higher education is even more important. As a minority, we have historically had struggles that

¹⁹ Interviewer: Lilihina, March 17, 2012.

²⁰ Interviewer: C. Sanchez, April 9, 2012.

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have limited our attendance to higher education, therefore our education is not just important to us, but to our people as a whole.²¹

When asked if they believed the American culture has affected higher education, I received mixed responses. Some did not believe America has a culture; instead we are a mix of many cultures. "America is a melting pot and no definite culture is assumed. There are American traditions that other cultures will partake in but in my opinion it is not an indication of an "overall" American culture."²² Other said that they believed the American culture has placed a significantly level of important on education, especially higher education. As a country, our educational system has to be top of the line in order for us to maintain our position as a global leader. Higher education teaches you more than what is in a book; it teaches you the way our society is ran. Higher education allows you to grow as a leader, challenges your mind, and enables you to see struggles that are not your own. I believe we can learn a lot about our world through higher education, which is why it is important to not only our society as Americans, but to the world.

Unlike the Tahitian students, the American students fully appreciate their university. The University of Washington is one of the leading universities in the world, and the opportunities that lie within the university are limitless. The area in which the American students wish their university were different is in the attendance of minorities. They wish that they could walk around campus and see more faces like themselves; they wish that they could look at faculty and see more people of color; they wish that they could see a part of themselves within the curriculum. Minorities have a lot to offer every field of education, while some fields accept and appreciate that, there are still some areas of higher education that are geared towards the white, middle class male.

American Non-Students

This group, unlike the Tahitian Non-Students shared a lot of similar idea on higher education. I found this group to be the most consistent with the ideas of higher education as a whole. The age group within the interviewers was from 18-45 years old. Although these are two different generations, their ideas of education seemed to match one another. Reasons as to why they did not pursue higher education were one of two: they either (1) did not have the finances to do so, or (2) they did not take their education as seriously as they should have in high school which hindered them from attending a university.

²¹ Interviewer: K. Cuevas, April 15, 2012.

²² Interviewer: T. Rosario, May 9, 2012.

When asked if they regret not attending higher education, they all in one way or another wish that they could have. Higher education opens doors that a high school degree cannot. While some are successful men and women, who are able to support their families, they believe that if they would have attended a university, their life would be better off today. They would be making more money in their jobs, and the journey to get where they are today would not have been so difficult. A lot of the interviewers mentioned that it still is not too late. The beauty of American education is that we have courses that allow one to work full time and still pursue higher education. Unlike Tahiti, our educational system is organized to be able to cater to all students.

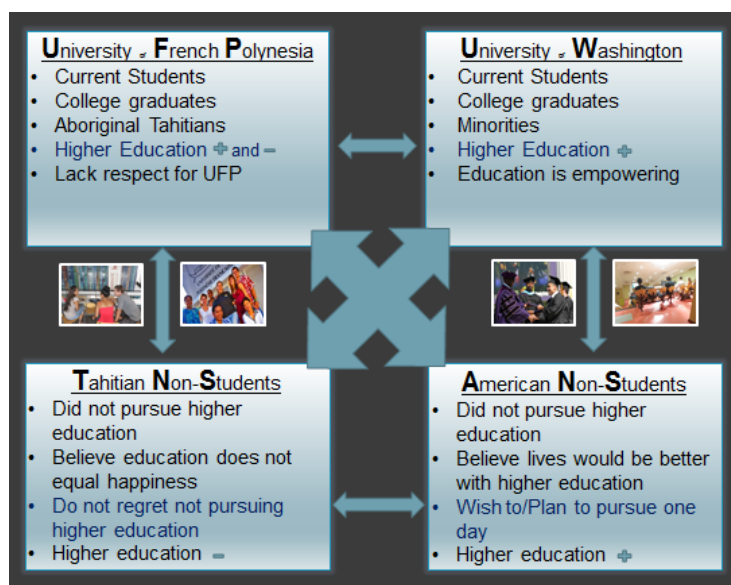


Figure 7. Diagram that links the University of French Polynesia (Tahitian) students, University of Washington (American) students, Tahitian Non-Students and the American Non-Students.

Everyone agreed that education is very important. In fact, it seems as though the importance of higher education is increasing over time. When many of the older interviewers were in high school, a Master's degree was unheard of but today it is becoming more common within society. If we expect our country to continue advancing, our expectations of our educational systems and our level of education that we obtain must continue to grow as well. Education is considered very important to both American students and non-students. This shows that even though the groups have different views, in many aspects they have

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similar ideas regardless of their educational level and their cultural background. Figure 7 demonstrates the overall ideas of each group and the ways in which they link to one another.

Conclusion

I believe it is important to study the differences in perception of higher education because it allows us to understand other mentalities as well as the reasons for them. Education is often described as being the key to success, but how accurate is that statement? Success can only be defined by each individual. Higher education may not be everyone's idea of becoming successful, and we need to be able to accept that. In my study I found that Tahitians do not necessarily have the same views of higher education as Americans for multiple reasons. The University of French Polynesia is still young, whereas the University of Washington just celebrated its 150 years as an institution. In America education has gradually grown into what it is today, but Tahiti is still behind. They may eventually become similar to what our educational system is today, but it is important that we do not try to force it upon them. Different regions across the world have diverse levels of education as well as perceptions of it. It is essential that we learn from one another so we can better ourselves and the world.

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I will be attending University of California, Los Angeles for my M.A. in International Education and eventually my Ph.D. as well. I am interested in studying International Comparative Education and Development, specifically in Latin America and the Caribbean.

The Natural Dangers of Poverty: A Hazard Analysis of Poverty Regions in the United States

Harrison Togia

Abstract

Since the end of the American civil rights movement, understanding and lessening social equality gaps has been the focus of the federal government and social scientists alike. Some of the traditional equality debates include equal employment opportunities, education equality, and housing segregation. One measure of equality which has been overlooked is that of the differences in geological hazard between opposing socio-economic populations. That is, are poverty populations in the United States disproportionately susceptible to natural hazards? Here I show that in a majority of cases, poverty neighborhoods with a poverty rating of category II or higher in Seattle, Los Angeles, and Hawaii have natural hazard ratings statistically equal to or greater than those of local non-poverty areas. These conclusions were formed by analyzing the intersections between hazard maps, provided by the USGS and various local resources, and spatial financial divisions, provided by the 2010 United States Census, in ArcMap 10. My results suggest that populations living in category II and higher poverty neighborhoods are equally or more likely to be both physically and financially affected by natural dangers. In the United States where safety of both property and life are protected under the Bill of Rights, this newly found gap in social equality refreshes earlier debates such as housing segregation and governmental responsibility. I anticipate this project being used as a stepping stone for the revival of social equality debates through the integration of natural sciences.

Introduction

Along with the mechanisms of geological evolution, one of the major interests of the earth sciences is the potential risk of natural hazards affecting the public. In response to this interest many geological institutions produce hazard maps for a range of natural factors, over a range of geographical regions. In the United States it is often the task of the state, county, or city geological service to produce public hazard maps for their areas of jurisdiction. Currently, the geological community utilizes geographic information systems, such as ArcMap, to calculate and display the effect and extent of hazards. Very often these maps incorporate a series of regional and population factors such as population density, area of effect, and infrastructure into determining the relative

hazard rating of a defined area. While hazard maps provide essential public information on the risks each person incurs by residing at their geospatial location, they do not account for the distribution of hazard between socio-economic classes. This is often because it is public opinion that environmental hazards affect everyone equally.

In the 1970's and 80's, as the effects of the civil rights movement were pulsating through all levels of social and governmental institutions, the United States became very interested in understanding the spatial relationship of equality. In response to this interest a list of social theories were produced, including the spatial mismatch theory (Kain, 1968; Kasarda, 1985), the declining significance of race thesis (Wilson, 1978), and the residential segregation thesis (Douglas S. Massey, 1993). As Liam Downey interpreted them in his report *Spatial Measurement, Geography, and Urban Racial Inequality*, "all made predictions about the geographical distribution of social groups and social goods within the urban landscape (Downey, 2003)." Simply, the social analyses of the time were focused on understanding the spatial relationships between social classes and the resources available to them. These reports concluded that along with the centralization of racial groups into geographical zones, in many cases these zones were not located near the resources available to that group of individuals. Similar modern analyses, conducted by the United States Census Bureau, concentrated on the effects of social zoning on poverty population, instead of racial groups. Much like the conclusions from the racial analyses of the past, current geospatial analyses concluded that "people living in poverty tend to be clustered in certain neighborhoods rather than being evenly distributed across geographic areas..." also "living in areas with many other poor people places burdens on low-income families beyond what the families' own individual circumstances would dictate. (Bishaw, Areas With Concentrated Poverty: 2006-2010, 2011)"

This analysis attempts to introduce the factor of geological hazard as a measure of equality between differing socio-economic groups, using the geographic information systems (GIS) of modern hazard maps. Location analysis tools inside the GIS software allow for fast and accurate geospatial comparisons between natural hazard maps and socio-economic population data. The goal of this analysis is to determine whether or not centralized poverty communities in the United States are disproportionately at risk from natural hazards using GIS. This analysis will compare the hazard ratings of both poverty and non-poverty analyses of similar factors are commonly referred to as environmental equality assessments. One significant difference between traditional environmental equality assessments and my own is that previous

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analyses using GIS have focused specifically on the relationship between “manmade” environmental hazards and affected racial groups (Downey, 2003) rather than natural hazards.

Background

With its roots in the early 90’s, the concept of Environmental Equality argues that “, among other things, that the poor, the working class, and the people of color are disproportionately burdened by environmental hazards (Paul Mohai, 1992). (Downey, 2003)” Additional studies of the environmental equality debate focused primarily on the importance of race and income in predicting who lives near environmental hazards (Downey, 2003). The utilization of GIS into the process of analyzing environmental equality did not come until 2003 when Liam Downey produced his report *Spatial Measurement and Racial Inequality*. Downey’s report was focused on proving that GIS could be used as an effective and necessary test bed for the spatial equality theses of Massey, Kain, and Wilson.

In the article *Spatial Measurement and Racial Inequality* Liam Downey attempted to illustrate the importance of taking spatial measurement and geography seriously by investigating the distribution of blacks and whites around pollution manufacturing facilities in the Detroit metropolitan area (Downey, 2003). Downey set out to answer three questions using GIS to prove its importance. “First, are blacks more likely than whites to live near potentially hazardous manufacturing facilities? Second, do black and white households with similar incomes share the same spatial relationship to polluting manufacturing facilities? Third, has the spatial relationship between blacks, whites, and polluting manufacturing facilities changed over time?” (Downey, 2003) Because of limitations in GIS data for Detroit in 2003, Downey began his analysis by generating raster maps of manufacturing facilities and the exposure of adjacent regions. Downey’s method of scaling exposure on distance from the manufacturing facilities is very similar to the way natural hazard maps scale danger or effect by distance from source. Downey’s next step in the analysis was to intersect the exposure maps with racial distribution maps from the U.S. Census. Once the two layers were intersected, location selection tools built into the GIS software allowed Downey to automatically calculate the total number of facilities surrounding a specific population, the average exposure of black or white neighborhoods, and the average minimum distance of a facility and a specific community. Downey found that while the number of facilities in 1990 was significantly negatively correlated with income it was not correlated with percent black. However, Downey did discover that in

1990 the average exposure and minimum distance were both correlated with percent black, in the expected directions (Downey, 2003). Building off of Downey's research, this project attempts to expand on both the negative correlation found between income and locality to hazard, as well as the GIS based analysis methodology.

Just as integral to infrastructure of this project are the geographical analyses of *Areas With Concentrated Poverty* (Bishaw, *Areas With Concentrated Poverty: 2006-2010*, 2011). While not officially published until 2011, geospatial poverty analyses have been conducted in the United States since 2006. These analyses are focused on answering dynamic questions of what defines poverty, what are the varying degrees of poverty in American neighborhoods, and what is the geospatial distribution of these categories across states and cities in the United States (Bishaw, *Poverty: 2009 and 2010*, 2011) (Bishaw, *Areas With Concentrated Poverty: 2006-2010*, 2011). For the purposes of this project, Bishaw's reports and data provide poverty classifications and spatial zones necessary for the differentiation between poverty and non-poverty areas within the analysis.

In the article *Areas With Concentrated Poverty* Bishaw compiled nearly four years of American census survey data looking at the distribution of poverty across the United States (Bishaw, *Areas With Concentrated Poverty: 2006-2010*, 2011). In order to interpret this data accurately Bishaw borrowed the area poverty categories from earlier census reports. Poverty in each state, city, tract, and block would fall into one of the four poverty categories (Bishaw, *Poverty: 2009 and 2010*, 2011). Areas with 13.8% of all households under the poverty line fell into category 1, areas with 13.8% to 19.9% were deemed category 2, areas with 20.0% to 39.9% were classified category 3, and any area with 40% of the households or greater below the national poverty line were considered category 4 poverty areas (Bishaw, *Areas With Concentrated Poverty: 2006-2010*, 2011). From this data Bishaw calculated the appropriate poverty category for each of the four cardinal quadrants of the U.S, each state, and large cities. In large cities such as Washington D.C., each census block was determined to fit into a predetermined poverty category, from the average of the blocks a tract classification was determined, and from the average of census tracts the poverty classifications for districts, counties, and states could be calculated. Bishaw's poverty area categories as well as the American census survey data served as the base for determining poverty distributions across the three study areas for this analysis.

Downey and Bishaw agree that households in areas with concentrated poverty are burdened beyond what their individual financial

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status would induce. Downey's research determined that one of the inadvertent burdens on these communities is that of manmade environmental hazards. If the analyses of Bishaw and Downey are evident of larger trends then I hypothesize that there will be a negative correlation between poverty areas within American cities and hazard from natural dangers.

Data

In order to conduct a socio-economic analysis of environmental equality, spatial and physical data are necessary. Data utilized throughout this research has been divided into three sub categories: spatial background data, hazard data, and census poverty data. Background spatial data serve as the base maps, while both poverty and hazard data are intersected and analyzed for congruencies.

Spatial Background Data

Spatial background data for Hawaii, Seattle, and Los Angeles have been acquired from the United States Census Bureau, 2011 Census TIGER Database. All three maps are oriented to the GCS_North_American_1983_HARN geographic coordinate system along the Lambert_Conformal_Conic projection. Each map title follows the U.S. Census spatial organization system and runs left to right beginning with an identification label "tl" for the TIGER database, followed by the year which the map data represent, then the regional number assigned to the geographical location, and finally the label "bg" identifying the map as a block group map. The TIGER map containing Seattle and the greater King County area is titled "tl_2011_53_bg" and is set to the NAD_1983_HARN_StatePlane_Washington_North_FIPS_4601_Feet projected coordinate system Figure (1). Similarly the TIGER map representing all of the Hawaiian Islands is titled "tl_2011_15_bg" and is projected with the NAD_1983_UTM_Zone_4N coordinate system Figure (2). The last map titled "tl_2011_06_bg," represents the entire state of California and utilizes the NAD_1983_StatePlane_California_V_FIPS_0405_Feet projected coordinate system Figure (3). Each map consists of vector digital representations of geographic and cartographic information from the Census Bureau's MAF/TIGER database, which stands for "Master Address File/Topologically Integrated Geographic Encoding and Referencing." Census tracts, census blocks, street divisions, coast lines, and district boundaries are represented on the maps dividing the total area into individually accessible "blocks."

Washington State Census TIGER Map

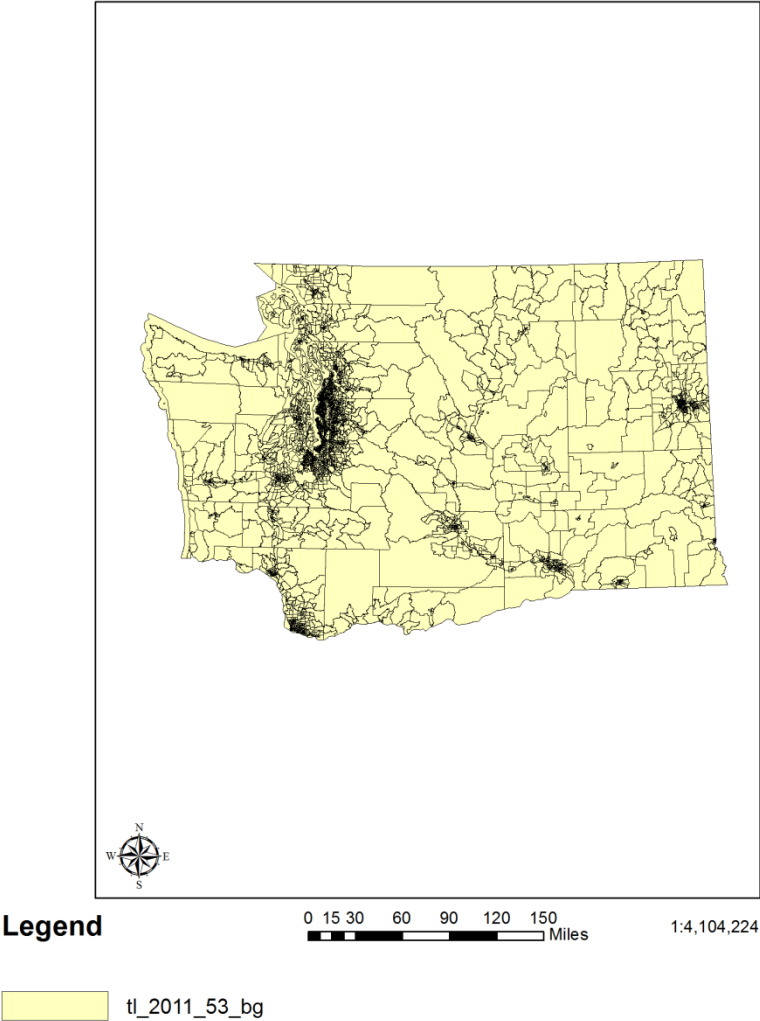


Figure 21. 2011 United States Census Bureau Topologically Integrated Geographic Encoding and Referencing Map for Washington State.

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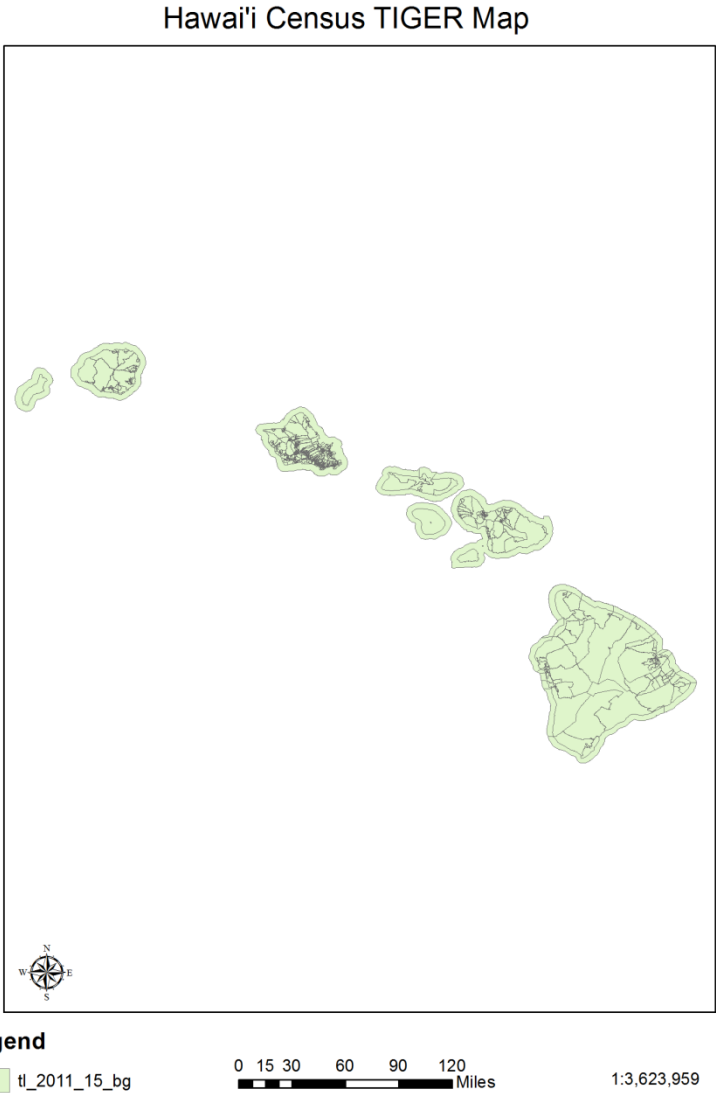
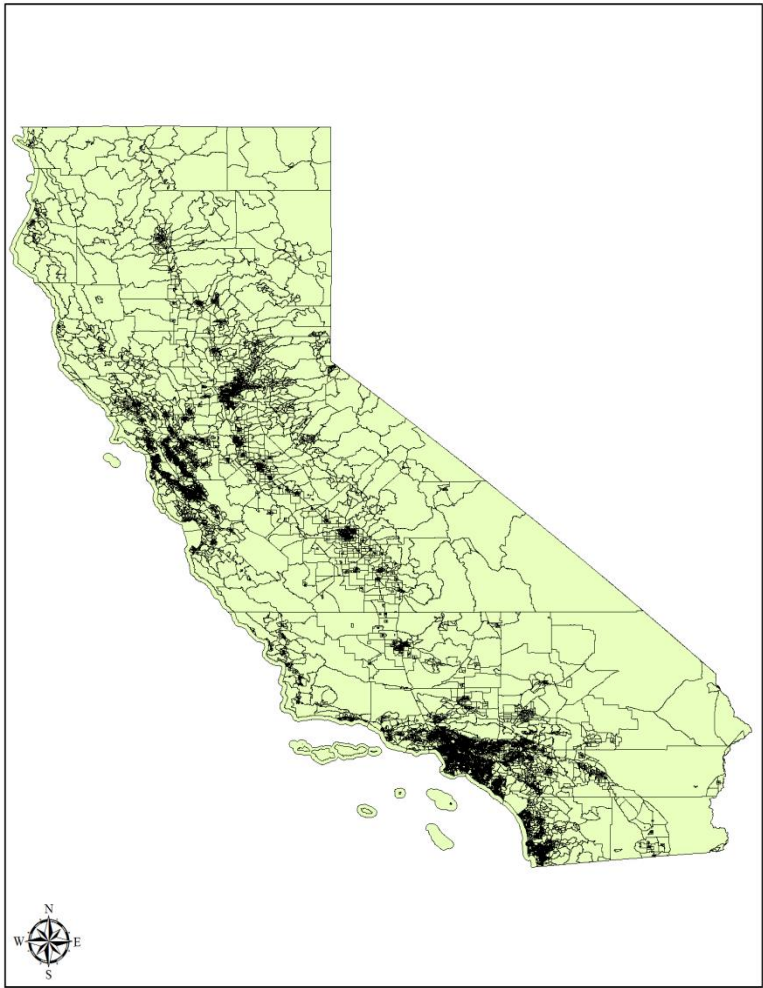


Figure 22. 2011 United States Census Bureau Topologically Integrated Geographic Encoding and Referencing Map for the State of Hawaii.

California Census TIGER Map



Legend



Figure 23. 2011 United States Census Bureau Topologically Integrated Geographic Encoding and Referencing Map for the State of California.

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Hazard Data

Unlike the standardized TIGER maps, hazard data incorporate large amounts of geospatial and geophysical data, which are tailored to the local regions. Because these maps require both social and physical studies they are not produced annually and often have a time dependent variable, allowing the hazard rating to be applied over the time till the next production.

In the Seattle region, vector data were acquired representing liquefaction and seismic motion hazard. The liquefaction data set, titled "Liquefaction zones Within Seattle City Limits," was taken from the Central Geographic Database produced by the City of Seattle Figure (4). This layer represents areas within the city limits of Seattle which have a probability of liquefaction greater than 80% during a magnitude 5.0 earthquake. Because the liquefaction data were produced primarily for internal use, it was generated without a default orientation or projection. Unlike the liquefaction data, the seismic motion map for the Seattle area, titled "sea10percentg" is oriented to the GCS_North_American_1983 geographic coordinate system on the D_North_American_1983 datum Figure (5). The Seattle seismic motion hazard map was acquired from an open file report database produced by the United States Geological Survey. This seismic hazard vector layer displays the 1Hz spectral acceleration of the Seattle region with a 10% probability of exceedance over a 50 year time frame (Arthur D. Frankel, 2007). Accounting for directional distance from recently active faults, population density, sedimentary base composition, and nonlinear local ground responses, this seismic hazard map assigns a scaled grading to each five meter square by a predicted vertical acceleration measured in percent gravity (Arthur D. Frankel, 2007).

In the Hawai'i study area hazard data were gathered from the State of Hawaii GIS Database outlining the danger of flood and lava inundation. The flood hazard data, titled "Digital Flood Insurance Rate Map," are projected to the Transverse_Mercator with the NAD_1983_UTM_Zone_4N coordinate system Figure (6). Each block area is rated by the probability of flood inundation based on local flood history as well as regional topography. Across the Hawai'i study area flood hazard is rated as "X500" meaning flood damage is predicted outside of 500 years, "X" meaning flood damage is predicted within a 100 year margin, or "A" meaning that flood damage up to 2 feet can be expected within a 10 year period. Similarly, the lava hazard layer, titled "Lava Flow Hazard Zones," is also projected to the Transverse_Mercator with the NAD_1983_UTM_Zone_4N coordinate system Figure (7). Lava hazard has been scaled from 1 to 9, with 1 being the most hazardous and

9 being the least, by comparing historic and current volcanic activity with topographic directionality.

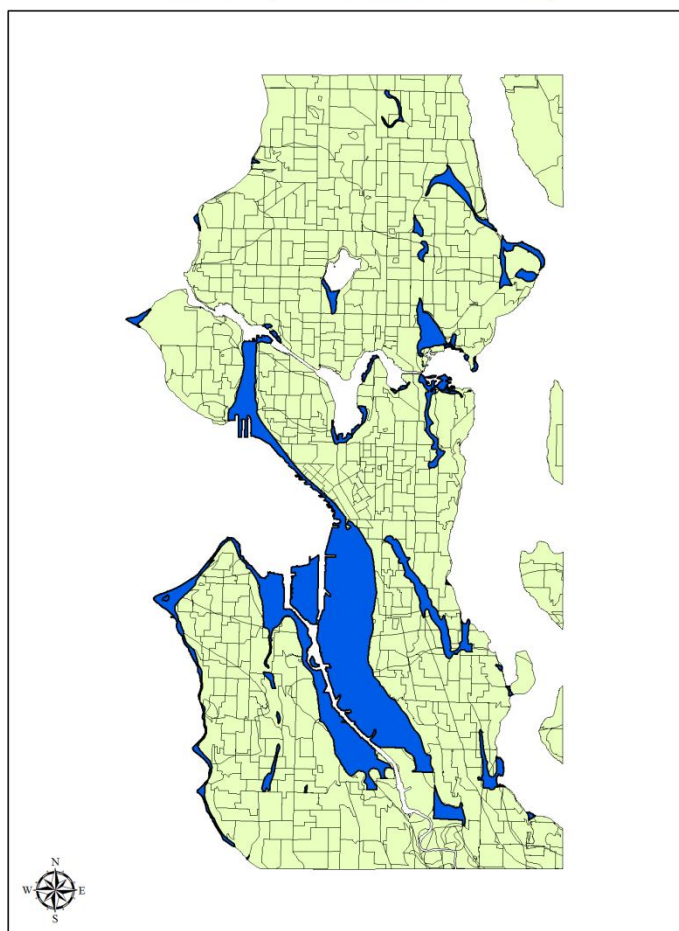
For the Los Angeles region, data were acquired for both fire and seismic hazards. Fire hazard vector layers, titled “fhszs06_3” and “c19fhszl06_1,” were established for Los Angeles County and have been taken from the FRAP GIS Database created by the California Department of Forestry and Fire Protection Figure (8). Both fire hazard layers are on the Albers projection with the NAD_1983_Albers coordinate system. Fire hazard is represented over the base map as vector data where in each block hazard has been rated from “very high” to “non-wildland/non-urban,” based on human development as well as natural fire hazards. Seismic hazard data, titled “Seismic Hazard Map for the United States,” has been taken from the National Atlas Database created by the National Atlas of the United States Figure (9). Seismic hazard in the Los Angeles area is represented as vector data over five meter square cells, allowing the hazard ratings to divide individual blocks. Unlike the other hazard data sets, which have been tailored to their respective areas of study, this geographic information data set contains the seismic hazard rating for the entire United States, and as such is projected along the D_North_American_1983 datum with the DD_NAD83 geographic coordinate system. Much like the seismic hazard data in the Seattle region, danger is measured in percent gravity and is determined by regional factors such as geology and locality to active faulting.

Unlike the spatial and hazard data collections, census poverty data are compiled with numerous other surveys into ASCII (American Standard Code for Information Interchange) attribute summary files, rather than standard GIS feature layers. Titled “Washington_Tracts_Blocks_Groups_Only”, “California_Tracts_Blocks_Groups_Only”, and “Hawaii_Tracts_Blocks_Groups_Only” each compressed file contains ASCII text for geographies, estimates, and margins of error for the numerous surveys taken by the American Community Survey (ACS). These summary data sets, taken from the American Community Survey file transfer protocol server, contain estimates for roughly 300 communal population surveys ranging from “Sex By Age” to “Ratio Of Income to Poverty Level of Families in the Past 12 Months.” Because of the enormity, diversity, and coding of the ACS data, the services of PolicyMap, a web based geographic information system tailored for American population statistics, have been enlisted to quicken the data integration process. The use of PolicyMap is necessary because the poverty information, which this project is

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interested in, is divided among a small set of surveys which are buried in the vast number of surveys provided in the state block summary files.

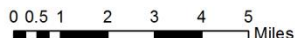
Seattle Liquefaction Hazard Map



Legend



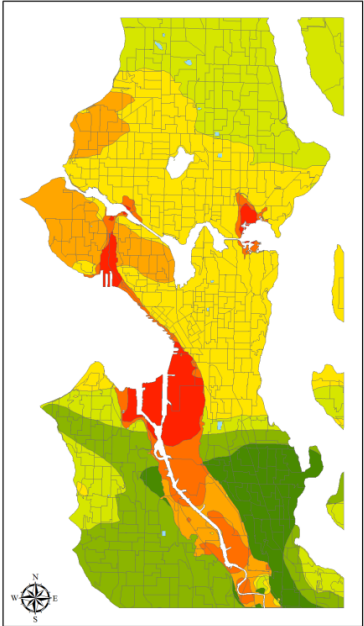
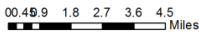
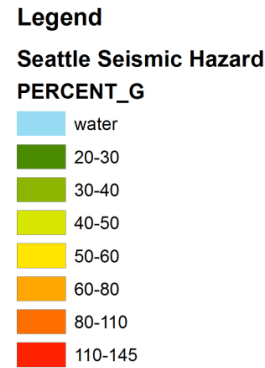
Liquefaction Hazard Area



1:137,113

Figure 24. Map of Liquefaction Hazard in the Seattle Area.

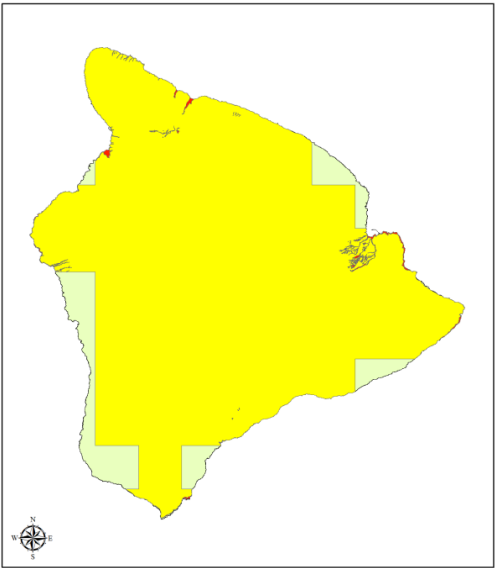
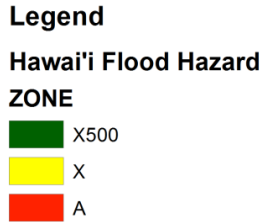
Seattle Seismic Hazard Map



1:137,113

Figure 25. Seismic Motion and Hazard for the Seattle Area, Rated for Lateral Ground Motion in Percent of the Acceleration of Gravity.

Hawai'i Flood Hazard Map



1:952,497

Figure 26. Flood Hazard for the Island of Hawai'i.

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Hawai'i Lava Flow Hazard Map

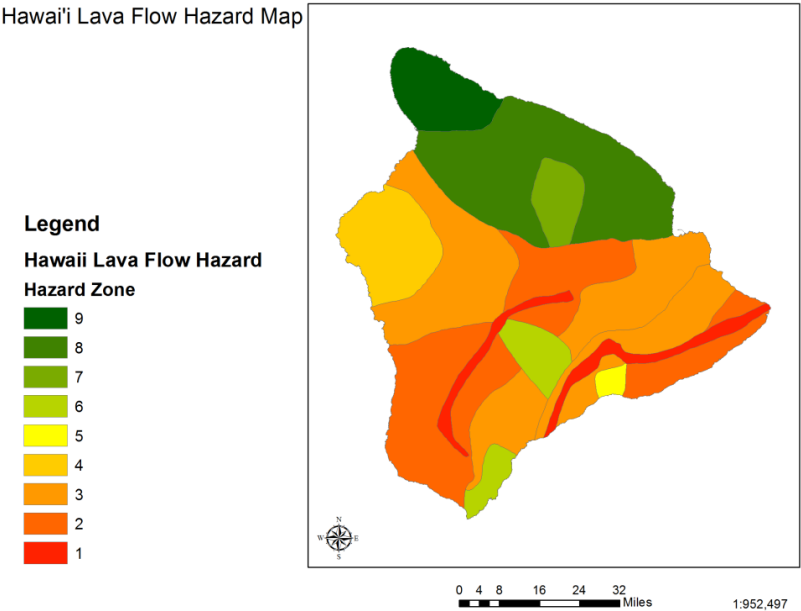


Figure 27. Lava Flow Hazard for the Island of Hawaii, Rated from 9 to 1 with a Rating of 1 being the Most Hazardous.

Los Angeles
Fire Hazard Map

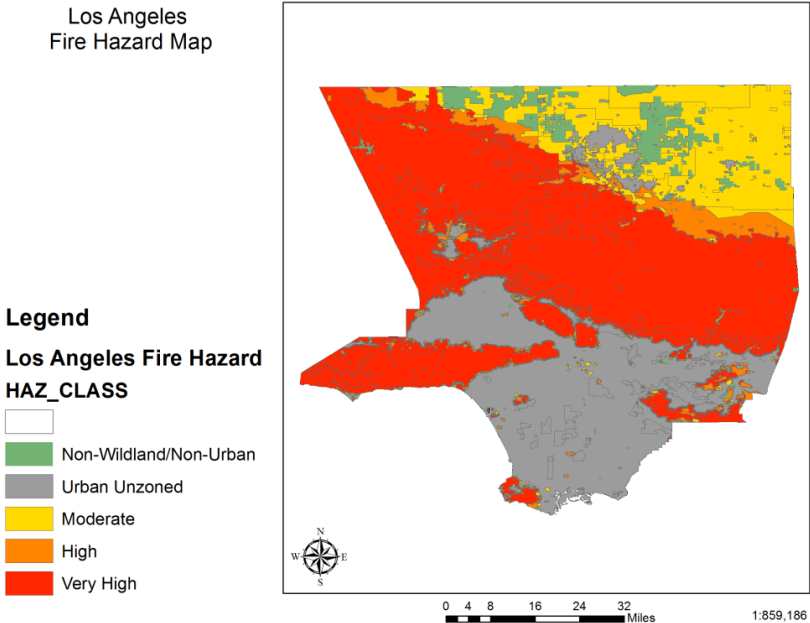


Figure 28. Fire Hazard for the Los Angeles Study Area.

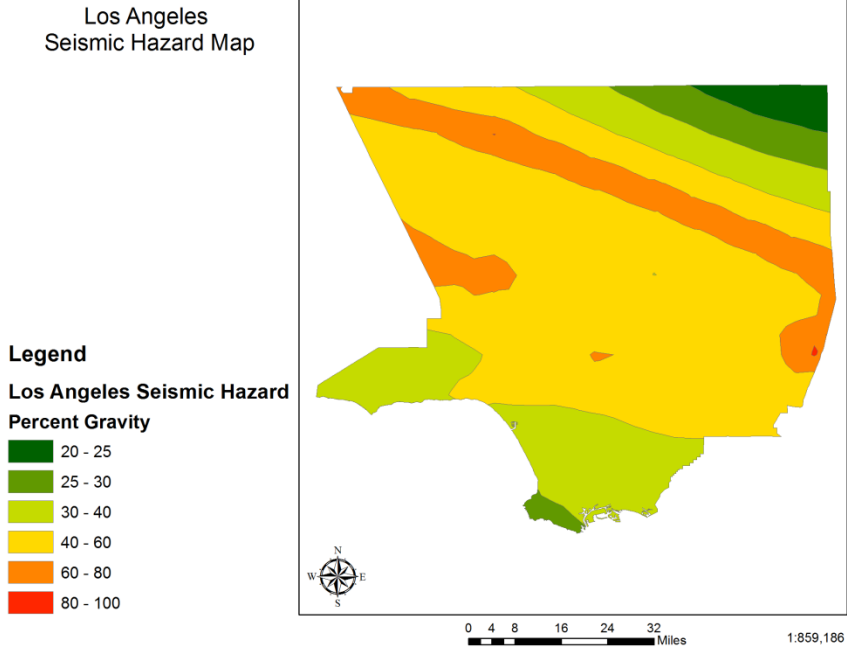


Figure 29. Seismic Motion and Hazard Map for the Los Angeles Study Area.

Census Poverty Data

While used primarily as a data sorting service, PolicyMap is also able to geographically represent the desired poverty data in the form of web based maps. However, because the PolicyMap GIS representations do not adhere to any standard file formatting or projected coordinate system they are unable to be integrated into ArcMap 10 as feature layers. Despite the inability to transfer the poverty maps from the PolicyMap website, they do simplify the process of interpreting and applying the desired ACS poverty data to the census base maps.

Methodology

The process of investigating whether or not poverty populations in the United States are disproportionately affected by natural hazards began by identifying three study locations in the United States. After a brief scrutinizing process, focused on availability of GIS data, propensity of natural dangers, and familiarity with the region, Seattle, Hawai'i, and Los Angeles were chosen as the study regions. Once the areas of study had been chosen, a five step process was created which could be applied to each study area to determine the spatial relationship between the local poverty blocks and natural hazards. The five step analysis utilized in this

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project for determining the relationship between poverty populations and natural hazards, is an adaptation of the process which Liam Downey developed in his article *Spatial Measurement and Racial Inequality* to determine the spatial relationships between racially segregated housing and local environmental hazards in the Detroit metropolitan area.

I. Establish a base vector map, consisting of block level spatial information in ArcMap 10.

Starting with the large scale census TIGER maps, a base map for each study is generate by first importing the TIGER map into ArcMap 10. Next, using the select by attributes tool, the study area is selected based on the desired spatial attribute. For the Seattle region the attribute was identified as “City of Seattle,” for Los Angeles the attribute was “Los Angeles County,” while for Hawai’i the desired spatial attribute was titled “Hawai’i.” Once the desired area has been selected a new layer is formed from the selection using the “create new layer from selection” tool in the selection options. The newly generated layer will serve as the base map for the remainder of the project.

II. Identify and collect GIS data for local natural hazards using federal, state, and city geological services

Using resources such as United States Geological Survey, the California Geological Survey, the Washington State GIS Database, and the State of Hawaii GIS database identify locally documented geophysical hazards for each research area. Once the hazards have been identified, narrow the field to such hazards which are wide spreading such as earthquakes or wild fires.

III. Outline Category II – IV poverty areas over the base map ArcMap 10, using the spatial data representations of the American Community Survey data generated by the PolicyMap service.

Begin the process of outlining the poverty regions by opening the intended base map in ArcMap 10. Once open, referencing the images provided by PolicyMap, select all of the poverty blocks using the selection tool built into ArcMap 10. When all the appropriate blocks have been selected right click the selected objects slide, under the “list by selection” tab of the table of contents. Create a new feature layer by

selecting the “create layer from selected features” slide from the drop down menu. Under the properties of the new layer, alter the title so that it is distinguishable for later use.

IV. Collect and adjust regional natural hazard maps gathered from both the United States Geological Service and local geological services.

Utilizing the same resources as those in step II, locate GIS data sets representing varying degrees of impact and affective range for each of the identified hazards. Once the data has been acquired import the appropriate hazard layers into their respective research area environments in ArcMap 10. Next, using the conversions tools of the ArcToolbox, convert varying hazard maps or layer types to match the vector layer format of the base spatial maps. This will ensure that later analysis between the hazard, poverty, and spatial layers share the necessary layer properties.

V. Intersect the hazard features with the poverty and base map layers in ArcMap 10. Using the new intersected features compare the spatial distribution of hazard using simple statistical percent distribution equations in Microsoft Excel

The final step requires intersecting the hazard layers with both the base spatial layer as well as the poverty layer. Intersection between two desired layers is accomplished using the “Intersect” tool in the “overlay” tab of the ArcToolbox. Once the tool is opened, select the desired layers, designate the output folder, and click ok. The new layer generated from the intersection contains only the information with could be associated with both of the intersected layers. Any data which extended beyond the spatial range of the smaller layer was removed leaving only the hazard and spatial data relevant to the two layers. In each case, one of two types of layers will be generated. First is a spatial intersection between the hazard layers and the base spatial map. This layer will serve as the control layer for the comparisons between the distribution of hazard of poverty and non-poverty zones. The second is a vector layer representing the hazard distribution in the poverty zones of the research areas. A statistical analysis between the poverty and non-poverty zones begins by separating and exporting the desired hazard distribution information from ArcMap 10 as simplified charts. This is achieved by first opening the attribute table of the desired layer, next right click the hazard attribute

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and select the “summarize” option from the drop down menu, then select the “sum” calculation of the “shape_area” tab, finally designate the output folder and select “ok”. Once the information from the table is copied into excel, determine the percent distribution of each level and type of hazard between the poverty and non-poverty areas using equation [1], the area percent comparison equation.

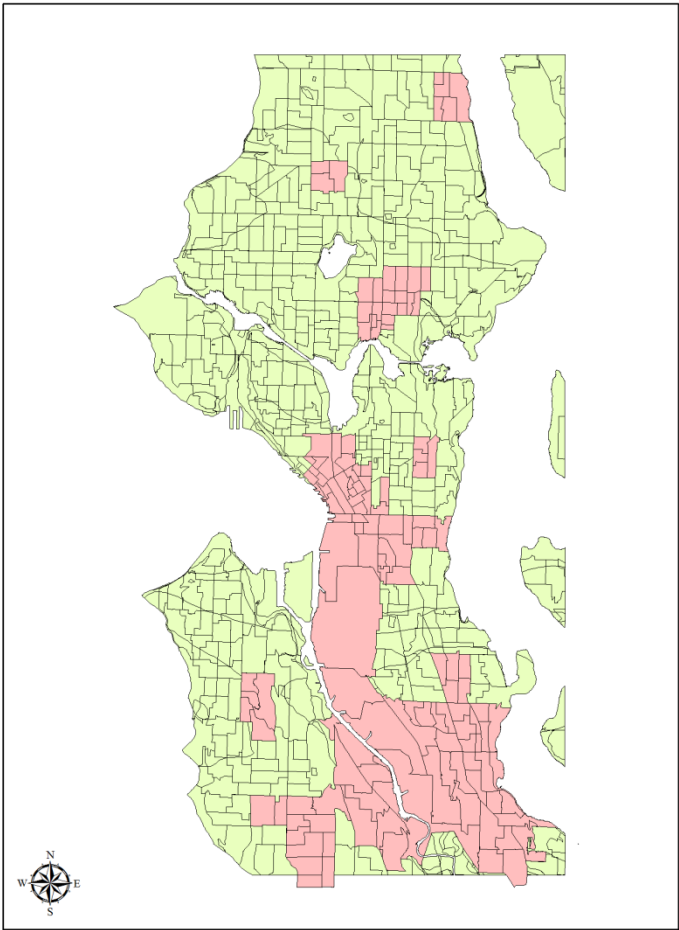
Eq. [1]
$$\left(\frac{\text{"Area of Desired Hazard Level"}}{\text{"Total Area Affected by Hazard"}} \right) * 100$$

Results

Seattle

Beginning with the U.S. Census TIGER base map and the American Community Survey poverty data, the Seattle study region covers an area of approximately 150 square miles with 17.83% of which is categorized as a poverty zone Figure (10). Hazard equality analyses of the Seattle region compared both seismic and liquefaction hazard distribution between the poverty and non-poverty areas. Comparison of the seismic hazard distribution across the Seattle region, as outlined in Table (1), shows that a greater percentage of Seattle poverty areas are affected by the highest 60 – 145 percent gravity seismic motion regime than those not in poverty Figure (11). With an approximate area of only 26 square miles, 30.1% of poverty zones in the Seattle area are determined to be in the highest 3/7 of seismic motion compared to only 23.1% of non-poverty areas. Liquefaction hazard distribution, outlined in Table (2), also shows that hazard is disproportionately distributed between poverty and non-poverty regions Figure (12). With an affect area of 12.56 square miles, 54.1% of liquefaction hazard area is classified as poverty zones. This translates to roughly 26% of the all poverty areas are at risk of liquefaction, compared to only 4.8% of the non-poverty areas. Hazard distribution analyses of the Seattle study region show that in both liquefaction and seismic hazards poverty populations are disproportionately at risk.

Seattle Poverty Areas



Legend

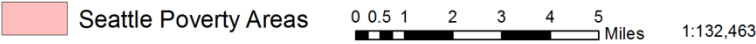


Figure 30. This map outlines the poverty areas (pink) and non-poverty areas (green) for the Seattle research area on the “Census Block” scale.

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Table 7. This table displays the distribution of Seismic hazard between the Poverty and Non-poverty areas of the Seattle research region. Area is quantified in square miles while distribution is quantified as a percent fraction of 100.

Seattle Seismic Hazard		
% Gravity	Non-Poverty Area:	% Distribution
20-30:	9.16	7.30
30-40:	17.60	14.02
40-50:	33.49	26.68
50-60:	36.20	28.84
60-80:	14.43	11.50
80-110:	11.94	9.51
110-145:	2.69	2.14
Total:	125.51	100.00
% Gravity	Poverty Area:	% Distribution
20-30:	4.90	18.95
30-40:	5.22	20.17
40-50:	1.66	6.40
50-60:	6.31	24.39
60-80:	2.35	9.08
80-110:	3.01	11.63
110-145:	2.43	9.38
Total:	25.87	100.00

Seattle Poverty and Seismic Hazard
Intersection Map

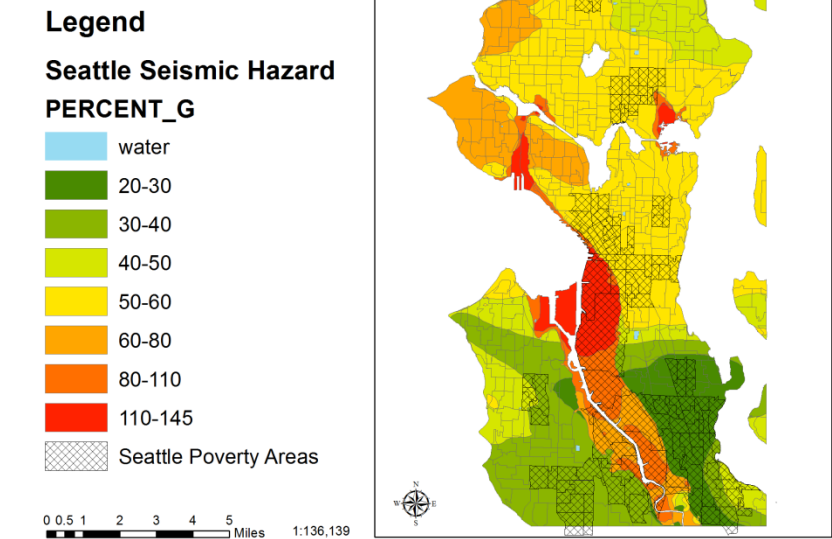


Figure 31. This map displays the intersection of the Seismic Hazard areas (green-red scale) with the Poverty (hashed) and Non-Poverty (solid) areas in Seattle study region.

Table 8. This table displays the distribution of Liquefaction hazard between the Poverty and Non-poverty areas of the Seattle research region. Area is quantified in square miles while distribution is quantified as a percent fraction of 100.

Seattle Liquefaction Hazard	
Total Area Affected:	12.56
Area of Affected Zones not in Poverty :	5.77
Area of Affected Zones in Poverty :	6.79
% Affected Area in Poverty:	54.09
%Poverty Area Affected:	25.95
%Non-Poverty Area Affected:	4.78

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Seattle Poverty and Liquefaction Hazard Intersection Map

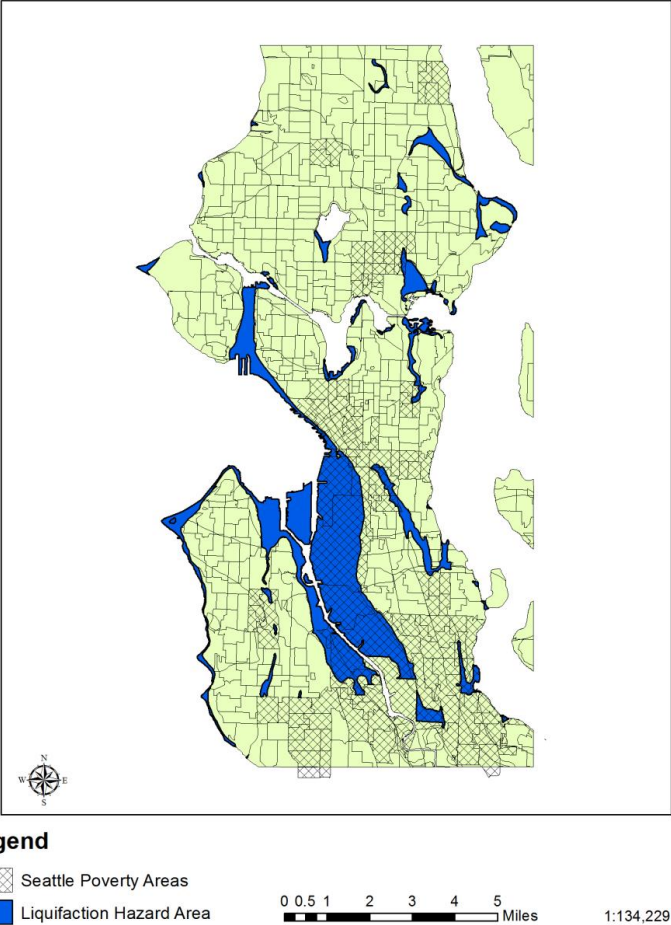


Figure 32. This map displays the intersection of the Liquefaction Hazard areas (blue) with the Poverty (hashed-green) and Non-Poverty (solid-green) areas in Seattle study region.

Hawaii

With a total area of roughly 4038 square miles, nearly 36% of the Hawai'i study area is classified as in poverty Figure (13). Unlike the results from the Seattle study region, hazard equality analyses of flood and lava danger across the Hawai'i study region are mixed. Analysis of the distribution of lava flow hazard across the Hawai'i study region, as outlined in Table (3), shows that a significantly greater percentage of poverty areas are affected by the highest levels of hazard Figure (14). While only 43.2% of the non-poverty area is within the top 1/3 of hazard

ratings, nearly 84.3% of the poverty area is attributed with the same hazard. In contrast, the results of the distribution analysis of flood hazard across the Hawai'i study area, as outlined in Table (4), reveals that there is little to no statistical difference in hazard between poverty and non-poverty areas Figure (15). Of the Hawai'i poverty and non-poverty areas roughly 99.6% of both are characterized with a one hundred year flood hazard margin, while roughly 0.4% of both are within the 10 year flood margin. Unlike the results of the Seattle analyses, hazard studies of the Hawai'i region show that only in lava flow hazard are poverty populations at a disproportionate risk, while in flood hazard both poverty and non-poverty populations are equally at jeopardy.

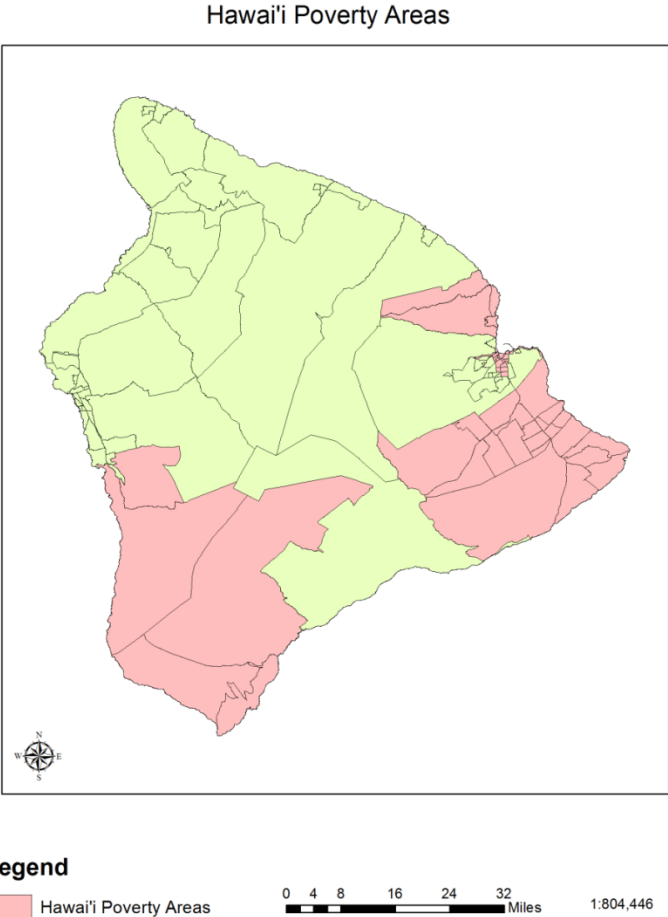


Figure 33. This map outlines the poverty areas (pink) and non-poverty areas (green) for the Hawai'i research area on the "Census Block" scale.

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Table 9. This table displays the distribution of Lava flow hazard between the Poverty and Non-poverty areas of the Hawai'i research region. Area is quantified in square miles while distribution is quantified as a percent fraction of 100.

Hawaii Lava Flow Hazard		
Hazard Level	Non-Poverty Area:	% Distribution
1.00	76.57	2.96
2.00	327.83	12.69
3.00	709.42	27.47
4.00	313.56	12.14
5.00	29.90	1.16
6.00	51.76	2.00
7.00	126.95	4.92
8.00	715.52	27.70
9.00	231.39	8.96
Total:	2582.90	100.00
Hazard Level	Poverty Area:	% Distribution
1.00	104.43	7.18
2.00	624.11	42.90
3.00	496.15	34.10
4.00	0.00	0.00
5.00	0.03	0.00
6.00	132.53	9.11
7.00	0.00	0.00
8.00	97.53	6.70
9.00	0.00	0.00
Total:	1454.77	100.00

Hawai'i Poverty
and Lava Flow Hazard
Intersection Map

Legend

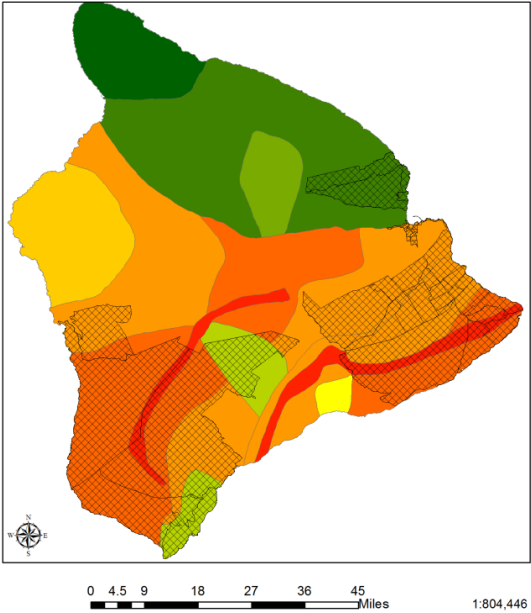
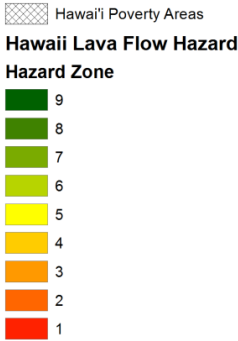


Figure 34. This map displays the intersection of the Lava Flow Hazard areas (green-red scale) with the Poverty (hashed) and Non-Poverty (solid) areas in Hawai'i study region.

Table 10. This table displays the distribution of Flood hazard between the Poverty and Non-poverty areas of the Hawai'i research region. Area is quantified in square miles while distribution is quantified as a percent fraction of 100.

Hawaii Flood Hazard		
Hazard Level	Non-Poverty Area:	% Distribution
X500	0.65	0.03
X	2464.47	99.55
A	10.38	0.42
Total:	2475.50	100.00
Hazard Level	Poverty Area:	% Distribution
X500	0.06	0.00
X	1224.69	99.63
A	4.54	0.37
Total:	1229.29	100.00

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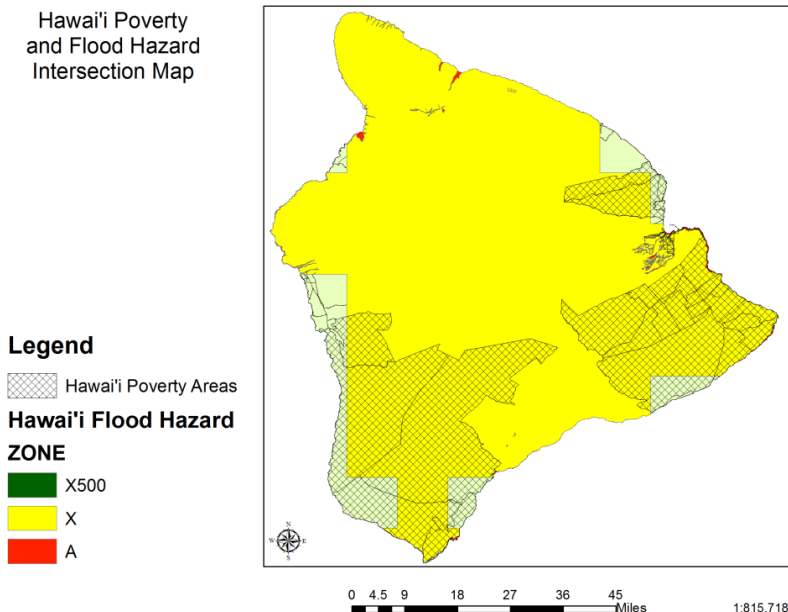
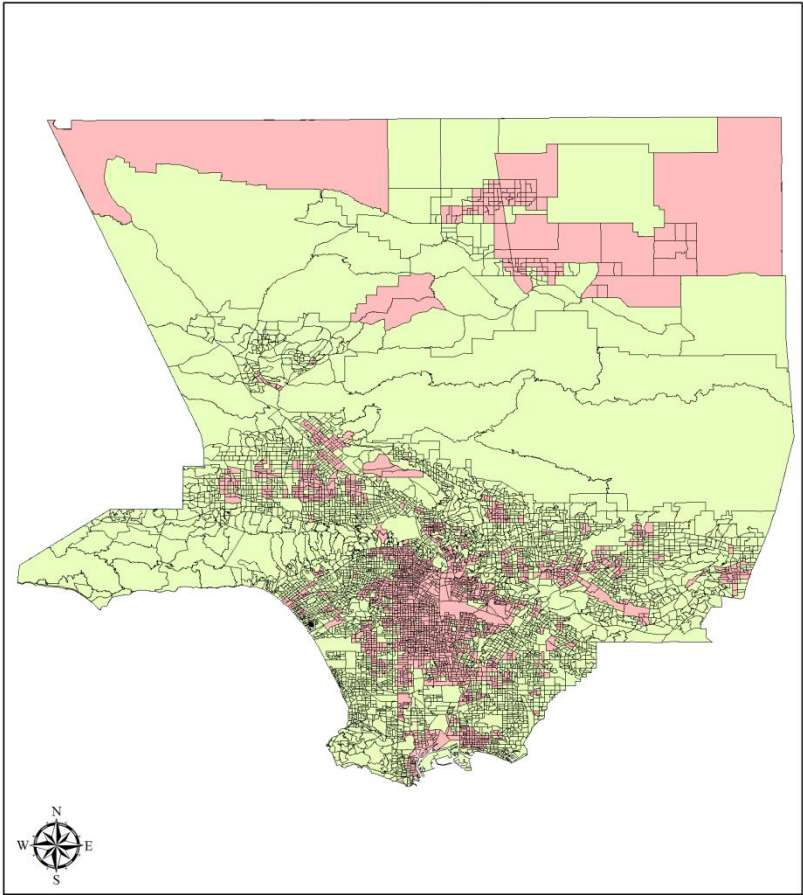


Figure 35. This map displays the intersection of the Flood Hazard areas (green-red scale) with the Poverty (hashed) and Non-Poverty (solid) areas in Hawai'i study region.

Los Angeles

Largest of the three areas the Los Angeles study region is comprised of roughly 3952 square miles, 23.2% of which is classified as poverty areas Figure (16). Unlike the conclusions from either the Seattle or the Hawai'i study regions, results from the fire and seismic hazard distribution analyses of the Los Angeles study area suggest that there is little to no difference between the levels of danger associated with local poverty and non-poverty areas. As outlined in Table (5), the results of a hazard analysis of fire across the Los Angeles area reveals that nearly 50% of both poverty and non-poverty zones have a risk level of moderate or greater, with the remainders as either urban or unclassified woodlands Figure (17). Similarly, the results of seismic hazard analysis outlined in Table (6), show that roughly 15% of non-poverty areas and 12% of poverty areas are subject to a predicted seismic motion regime of 60 to 100 percent gravity Figure (18). Hazard distribution analyses of the Los Angeles study region suggest, in contrary to the general trend of conclusions, that there is little to no difference between incurred hazards for poverty and non-poverty populations.

Los Angeles Poverty Areas



Legend



Figure 36. This map outlines the poverty areas (pink) and non-poverty areas (green) for the Los Angeles research area on the “Census Block” scale

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Table 11. This table displays the distribution of Fire hazard between the Poverty and Non-poverty areas of the Los Angeles research region. Area is quantified in square miles while distribution is quantified as a percent fraction of 100.

Los Angeles Fire Hazard		
Hazard Level	Non-Poverty Area:	% Distribution
Non-Wildland/ Non-Urban:	95.12	3.00
Urban Unzoned:	674.15	21.28
Moderate:	315.85	9.97
High:	175.49	5.54
Very High:	1907.74	60.21
Total:	3168.35	100.00
Hazard Level	Poverty Area:	% Distribution
Non-Wildland/ Non-Urban:	83.83	9.16
Urban Unzoned:	313.77	34.27
Moderate:	332.64	36.33
High:	48.13	5.26
Very High:	137.16	14.98
Total:	915.53	100.00

Los Angeles Poverty and
Fire Hazard Intersection Map

Legend

Los Angeles Fire Hazard HAZ_CLASS

- Non-Wildland/Non-Urban
- Urban Unzoned
- Moderate
- High
- Very High
- Los Angeles Poverty Areas

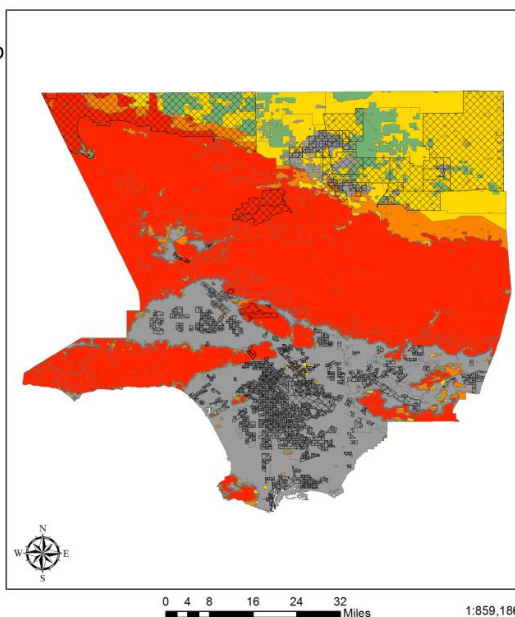


Figure 37. This map displays the intersection of the Fire Hazard areas (green-red scale) with the Poverty (hashed) and Non-Poverty (solid) areas in Los Angeles study region.

Table 12. This table displays the distribution of Seismic hazard between the Poverty and Non-poverty areas of the Los Angeles research region. Area is quantified in square miles while distribution is quantified as a percent fraction of 100.

Los Angeles Seismic Hazard		
% Gravity	Non-Poverty Area:	% Distribution
20-25	40.79	1.34
25-30	112.90	3.72
30-40	559.77	18.44
40-60	1872.09	61.68
60-80	448.90	14.79
80-100	0.96	0.03
Total:	3035.40	100.00
% Gravity	Poverty Area:	% Distribution
20-25	52.46	5.73
25-30	82.02	8.96
30-40	247.54	27.03
40-60	427.11	46.64
60-80	106.60	11.64
80-100	0.00	0.00
Total:	915.74	100.00

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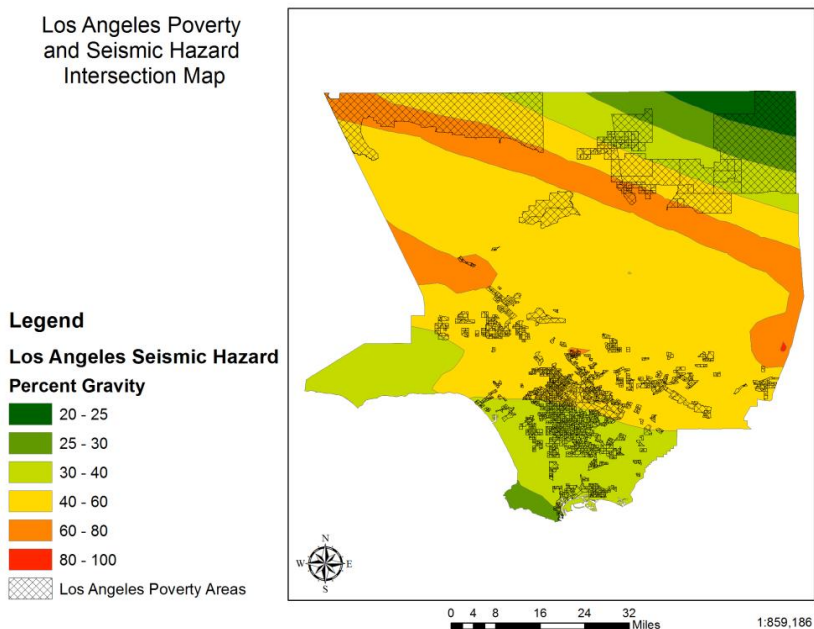


Figure 38. This map displays the intersection of the Seismic Hazard areas (green-red scale) with the Poverty (hashed) and Non-Poverty (solid) areas in Los Angeles study region.

Discussion

Results suggest that in Seattle, Los Angeles, and Hawai'i the distribution of hazard between poverty and non-poverty areas is either equally distributed or disproportionately favoring poverty populations. These results agree with my original hypotheses that, poverty populations are displaced to areas which are potentially more prone to hazard. Despite the concurrence with my original theory, the lack of similar work prevents a proper comparison and diagnostic of my analysis. Similarly, small issues in both the poverty and the hazard datasets prevent obvious conclusions. Some of these data issues include minor area incongruences between hazard and spatial layers and areas of exclusion from the original hazard analyses. Still, these results imply problems such as socioeconomic inequality, population segregation, and even governmental responsibility. To address these issues in future research I would construct individual hazard maps for both poverty and non-poverty populations in each city, based on both the probability of hazard and the local conditions of structures and people. Also I would standardize each base map to a pre-defined coordinate and measurement system to remove area exclusion in layer intersection. From the results of

this study it can be concluded that poverty populations reside in areas which are as susceptible, if not more susceptible to natural hazards, than those of populations which are not in poverty.

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My continued research interests, beyond continuing this project, are looking at the complex solid earth reactions to the current climate changes. I intend to pursue this research interest with a Masters and Ph.D. program at the University of Hawai'i with Professor Clint Conrad.

p120 catenin-RhoA GTPase Interactions during Early Vertebrate Gastrulation

Martha A. Zepeda Rivera*, Maya Sangesland

Gastrulation is the developmental process during which cells migrate in order to differentiate the blastula into three germ layers: endoderm, mesoderm and ectoderm, which then each give rise to specific tissues and organs. This process requires a balance of cell migration and cell-cell adhesion mediated by cadherin-catenin interactions at adherens junctions (Fang et al., 2004; Reynolds et al., 1994; Shibamoto et al., 1995). Cadherins are transmembrane cell-cell receptors that extracellularly homodimerize on adjacent cells. This interaction is in turn stabilized by the intracellular binding of the N-terminus of p120 catenin to the juxtamembrane domain of cadherins. When membrane-associated p120 catenin activates Cdc42 and Rac1 GTPases through a common Rho-family GTPase GEF (guanine nucleotide exchange factor) Vav2 (Hall 1998; Noren et al., 2000). Cdc42 and Rac1 lead to filopodia and lamellipodia formation, respectively. These actin protrusions push the cell at the leading edge to aid in signal-directed cell migration. In order to decrease cell-cell adhesion and further promote cell migration, cytosolic p120 catenin binds to GDP-bound RhoA GTPase and prevents RhoA from interacting with its GEF to become GTP-bound and thus activated. Activated RhoA is known to increase cell-cell adhesion by activating RhoA kinase, which in turn phosphorylates and activates myosin light chains, inducing cross links to stabilize actin filaments. When cells have migrated to their proper location in order to enhance cell-cell adhesion, p120 catenin brings RhoA-GDP to the membrane, where RhoA then interacts with its membrane-bound GEF to become GTP-bound and activated. The regulation of this mechanism is thought to occur via tyrosine phosphorylation in the N-terminus regulatory domain of p120 catenin that consequently affects the p120 catenin-RhoA binding interaction.

Through its interaction with cadherins and regulation of Rho-family GTPases, p120 catenin is crucial not only in early gastrulation of vertebrates, but additionally in processes such as wound healing (Baek et al., 2010), axonal growth (Gross et al., 2007, Linseman et al., 2008), neuroplasticity (Auer et al., 2011), neurodegenerative disease (Antoine-Bertrand et al., 2009, Huesa et al., 2010), and abnormal cell migration during cancer metastasis (Liu et al., 2009, Yanagisawa et al., 2008). As such, by assessing the interaction between p120 catenin and RhoA, as well as the regulation of that interaction within the context of early

gastrulation, potential relationships in other processes can be extrapolated.

Our research focuses on p120 catenin-dependent cell migration in the context of early gastrulation using a zebrafish embryo model. We hypothesize that RhoA lies downstream of p120 catenin and furthermore that GDP-bound RhoA is able to rescue development in splice morpholino (Sp-MO) p120 catenin-depleted embryos by allowing the low concentration of maternally derived p120 catenin to be sufficient to activate Cdc42 and Rac1 to stimulate cell migration. By microinjecting mRNAs of constitutively GDP-bound (dominant negative) RhoA, constitutively GTP-bound (constitutively active) RhoA, and wild-type RhoA alone, as well as co-injecting these with p120 catenin Sp-MO, we were able to show that wild-type and constitutively active RhoA mRNAs are unable to rescue p120 catenin-depleted embryos while 1pg and 2pg dominant-negative RhoA mRNAs were able to partially rescue p120 catenin-depleted embryos. During development the head and tailbud of the embryo come together on the ventral side of the egg as the anterior-posterior axis elongates, therefore ventral-head-to-tailbud distance was used to quantify axis elongation in embryos up to the 10-somite stage (14 hours post fertilization). p120 catenin-depleted embryos had decreased axis elongation compared to uninjected controls. Wild-type and constitutively active RhoA mRNAs were unable to rescue this defect in p120 catenin-depleted embryos, however, dominant negative RhoA mRNA resulted in significantly shorter ventral-head-to-tailbud distances indicating greater axis elongation. For embryos at later developmental stages (up to 20 hours post-fertilization) defects were qualitatively described and the percent of normally developed embryos as compared to uninjected controls showed that dominant negative RhoA, but not wild-type or constitutively active RhoA, was able to partially rescue p120- catenin depleted embryos. (Manuscript under review, *Developmental Dynamics*)

From our observations we can conclude that RhoA lies downstream of p120 catenin and is inhibited by p120 catenin. In p120 catenin-depleted embryos, constitutively GDP-bound RhoA down regulates cell-cell adhesion and allows low concentrations of maternally derived p120 catenin to sufficiently activate Rac1 and Cdc42 to stimulate cell migration. Future research will be focused on tyrosine phosphorylation of p120 catenin and its impact on the p120 catenin-RhoA binding interaction that has been implicated in vitro (Castaño et al., 2007). Using site-directed mutagenesis, tyrosine to phenylalanine mutations at three implicated sites, Y112, Y217, and Y228, have been or will be made. These mutations will mimic inability to phosphorylate

p120 catenin-RhoA GTPase Interactions during Early Vertebrate Gastrulation

these sites, and as such we will be able to isolate and test the importance of phosphorylation at each individual site and assess relative RhoA activation, which is dependent on p120 catenin-RhoA binding.

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p120 catenin-RhoA GTPase Interactions during Early Vertebrate
Gastrulation

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I am interested in how protein structure relates to its function, and how structure is and can be modified to regulate function. I will begin my PhD in the Department of Cellular and Molecular Biology at Harvard University in September 2012.

