

Undergraduate Research Journal

THE UNIVERSITY OF TEXAS AT AUSTIN
Senate of College Councils

2015

The University of Texas at Austin Undergraduate Research Journal

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Volume 14, Number 1 Fall 2015

ISSN 1538-9421

The *UT Austin Undergraduate Research Journal* is an agency of the Senate of College Councils. The Senate of College Councils is a registered student organization at The University of Texas at Austin. Its views do not necessarily reflect the views of the University.

Printed in the United States of America at
OneTouchPoint/Ginny's Printing in Austin, Texas

THE UNIVERSITY
OF TEXAS AT AUSTIN
Senate of College Councils

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Volume 14 Number 1 Fall 2015

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The editors of this journal wish to thank Dr. Juan Sanchez of the Office of the Vice President for Research, who has stepped down after a distinguished tenure of 16 years and has supported the Journal since its first issue. They sincerely wish him the best. They wish to thank Dr. Gage Paine of the Division of Student Affairs and the undergraduate research coordinators of each college for their generous support and guidance.

They also thank the University Co-op for their continued support.

They offer their appreciation as well to Ms. Veronica Cantu, Ms. Becky Carreon, Dr. Soncia Reagins-Lilly, Dr. Robert Reichle, the Office of Undergraduate Research, the Senate of College Councils, and the Office of the President for helping make The UT Austin Undergraduate Research Journal possible.

On behalf of the 2014-2015 Editorial Board, I am proud to present to you the 14th issue of The University of Texas at Austin *Undergraduate Research Journal*. This publication would not exist without the genius of our authors, the dedication of our editors, and the guidance of our mentors. The 2015 issue covers a range of disciplines within the sciences and humanities, from the development of nuclear weapons strategies to the proliferation of Captain America during the Second World War. One author prominently features a work housed within UT Austin's own art museum, the Blanton Museum of Art. The manuscripts featured in this issue represent some of the best and brightest minds of the Forty Acres, and we are proud to bring you their work.

Year after year, the *Journal* continues to grow, and this year has been no exception. Seeing the need for greater administrative structure, our editors assumed new responsibilities in finance, communications, campaigns, and archive teams. A new promotional video with former President Bill Powers, along with a website redesign, re-introduced our mission to the world in an engaging way. The *Journal* began accepting online gifts to fund its expenses for the first time. Our editors participated in the Forty Acres Fest and Research Week to increase our campus presence. To promote the importance of continued research across many fields, the *Journal* also hosted three events: our third-annual Business Research Panel (with panelists from Deloitte Consulting and UBS), our first-annual Sciences Research Panel, and our second-annual research writing workshop. Our office underwent substantial renovations for the first time in over a decade, establishing a modern and valuable facility for our future editors. The 2015 issue reached a new digital audience through the Apple iBooks platform for the first time. In short, the *Journal* is stronger than ever, and I am confident its success is secure for many years to come.

Thank you to everyone who made this issue possible. It has been a privilege to work with this great publication for the past four years. I hope you enjoy reading the research of our authors, and I encourage you to browse our archive online at texasurj.com/archive as well for further reading.

Best regards,

A handwritten signature in black ink, appearing to read "Evan Watts", with a long horizontal flourish extending to the right.

Evan Watts, Editor-in-Chief
Undergraduate Research Journal

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The Myth of Chechen Radical Islam

*The University
of Texas
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*Volume 14
Number 1
Fall 2015*

Jonathan Parker

Since he became president of the Russian Federation, Vladimir Putin has sought to portray Russia's war in Chechnya as part of the fight against global Islamic terrorism, and the Chechens as radical Islamists (specifically Wahhabists) with connections to Al-Qaeda, the Taliban, and Osama bin-Laden. This characterization is, in a word, false. Putin deliberately exaggerates the role of religion in Chechen separatism in order to simultaneously legitimise his own brutality against the Chechens while delegitimising the Chechen perspective. Religion, particularly radical Islam, plays merely a superficial role in Chechnya's struggle for independence.

The real roots of Chechen separatism lie in indigenous politics and culture, and ultimately in Chechen nationalism. Religion is a subordinate component of this separatism, and thus does not represent an act of *jihad*. Chechens use radical Islam as a means to an end, and not for its own sake.

Putin has tried hard since the late 1990s and the beginning of the Second Chechen War to portray the war in Chechnya as a theatre of the global war on terror, especially since the 9/11 attacks on the United States. As early as July of 2000, Putin described the formation of “a sort of fundamentalist international arc of instability” across regions experiencing so-called and actual Islamist insurgencies.¹ Later, in an interview with American journalist Barbara Walters, Putin specifically referred to the on-going separatist movement in Chechnya as a “terrorist attack”, and went on to claim that there are links between the Chechen fighters and Osama bin Laden.²

Further evidence of this desire to characterize Chechen separatism as an example of global Islamic terrorism comes from the official Russian response to ABC News’s controversial airing of an interview with Chechen fighter Shamil Basayev. In the official statement condemning the decision to air the interview, the Russian embassy referred to Basayev as an “internationally recognised terrorist” and “one of Al-Qaeda’s [sic] zealots”. Throughout the statement, in fact, the Russian embassy refers to Basayev as a terrorist, never as a separatist.³ While he can be considered both, this rhetoric clearly serves to emphasize the “Islamic terrorist” aspect of Basayev while deemphasizing his Chechen “separatist” (freedom fighter) aspect. At its conclusion, the Russian statement appeals to a “spirit of Russian-American partnership in [their] joint fight the global threat of terrorism”.⁴ Thus, Basayev is not merely a terrorist in the Russian story, but he is also a “global” terrorist, whom the United States should be helping Russia to fight. This characterization plays to the American, or even Western, idea of a ‘global war on terror’ and tries to place Basayev in that narrative. It is important to note that not all terrorists have a religious affiliation. However, there does exist a widespread perception that Islam and terrorism go hand in hand.⁵ Thus the key to understanding the strategy of Putin’s rhetoric is to consider how it influences the perception of foreign audiences, especially Western ones. Putin, and the Russian government more broadly, seek to persuade the West that Basayev and the Chechens are dangerous, radical Islamists who pose a threat to the West. However, to what extent is this characterization of the wider Chechen resistance true?

Historical background of the events prior to the 1990s provides a useful starting point in answering this question. Namely, history shows that Islam of any sort has been a part of Chechen culture for a relatively brief period of time, and has not been without turmoil. Archaeological evidence indicates that Chechens have lived in what is now Chechnya for up to 4000 years, while linguistic evidence suggests that their language originated in Upper Mesopotamia.⁶ Islam first arrived in the Caucasus region during the Arab-Khazar wars of the 8th through 11th centuries CE, and continued to influence the region through repeated

invasions in later centuries.⁷ The conversion of Chechens to Islam, however, did not begin in earnest until the late 18th century.⁸ The traditional Chechen system of *adat* continued to govern Chechen social norms even after the establishment of Islam.⁹ Thus, Islam was a late arrival to a mature society.

In addition to its late arrival, Islam also suffered a serious setback during the mid-20th century. During the Soviet period of rule in Chechnya, atheism became wide-spread especially among the young and middle-aged population at the expense of religious belief, particularly Islam (another important event for the Chechens under Soviet rule was the mass deportation of 1944, but more will be said on this later). By the mid-1980s, only 12% of residents in the Checheno-Ingush Autonomous Republic identified themselves as “believers” of any sort, including both Islam and Orthodox Christianity. With all this in mind, Valery Tishkov states the situation best: “[The] postfactual representation of Chechnya as an ‘Islamic Republic’ and of Chechens as ardent followers of Islam is a *romantic simplification*” (emphasis added).¹⁰ In contrast: “... while certain aspects of the ancient Chechen tradition have been vastly modified under Soviet rule, important elements of others still remain.”¹¹ Islam has shallow roots in Chechen culture, and roots which have been badly damaged during its short history among the Chechens. This was the state of Islam in Chechnya prior to the violent rise of Chechen separatism in the early 1990s with the First and Second Chechen Wars.

For Chechens, the cause of their own nationhood is superior to that of radical Islam. The historical experiences of the Chechen people cause them to feel a national identity more strongly than a religious one. Foremost among these experiences is the deportation of the entire population of Chechnya to Kazakhstan in 1944. During the Second World War, as the German armies retreated west out of the Soviet Union and the North Caucasus, Soviet leader Josef Stalin ordered the deportation of 500,000 Chechens and Ingush to Central Asia.¹² They were not allowed to return to Checheno-Ingushetia until 1957.¹³ It was this experience which created a sense of national identity among the Chechens. Carlotta Gall and Thomas de Waal point to the “closeness of Chechens in deportation” as a major factor in this creation, as Chechens were forced to meet other Chechens from other villages. They also draw a parallel between Chechnya and Israel and Armenia, as places where a national identity became founded on collective memory of an attempted genocide. Indeed, this memory would serve as a source of collective anger against Soviet and Russian rule as the 1980s came to a close.¹⁴ Notably, this anger came to a head just a few years before the disintegration of the Soviet Union and the official beginning of Chechen separatism.

There is another important factor, however, to do with the deportations which Gall and de Waal do not discuss: The Chechens were exiled *not* because they were nominally *Muslim*, but because they were *Chechen*. This distinction is important for understanding the psychology of Chechens’ relationship to religion and nationality. When the Chechens asked themselves “why is this happening?” the answer would always be “because I am Chechen” or even “because we are Chechen”. Thus, by persecuting the Chechens for being

Chechen, the Soviet regime made them more *conscious* of the fact that they are Chechen, and strengthened this aspect of their identity. This explains the phenomenon which Gall and de Waal mentioned, that attempted genocide causes the creation of a stronger ethnic identity. This identity forms the basis for national movements in the future.

Snippets of more recent Chechen culture reveal that this ethnic identity has taken root since the Soviet deportations. A Chechen proverb which epitomizes this development runs as follows: “Mohammed was an Arab, but Allah is Chechen”.¹⁵ This proverb demonstrates several things. Firstly, that Chechens recognise Islam as a religion that is ultimately foreign to their lands and which was brought to them by Arabs. Secondly, that Chechens still insist on an “ethno-national particularity” in which national identity overrides religion.¹⁶ This idea would be analogous to Americans claiming that “God is an American”. That Allah is said to be Chechen, even if jokingly, shows that Chechens feel that their religion is a deep part of their national identity, but at the same time is a subordinate component to that identity. By claiming Allah as a Chechen, this proverb claims Him and Islam as a member of the Chechen community, but neither as the only member nor as the only characteristic of that community.

The unofficial Chechen national anthem from the 1990s also shows that Chechens feel their ethnic identity very strongly, and underscores the subordinate role of religion in Chechen identity. This song, *Freedom or Death*, was the most famous national fighting song of the 1990s. Here are the first two verses:

*We were born at night when the she-wolf whelped,
In the morning to the roar of lions we were given our names.
In eagles' nests our mothers nursed us.
To tame wild bulls our fathers taught us.*

There is no God but Allah.

*Our Mothers pledged us to our people and our homeland.
And if they need us – we know how to fight hard.
With the eagles of the mountains we grew up free together.
With dignity we have overcome every obstacle in our way.*

*There is no God but Allah.*¹⁷

The main verses of the song clearly refer back to the land of Chechnya itself. The song references the animals with which the singers wish to associate themselves, especially the eagle. The singers tie themselves to their “people and [their] homeland”, emphasising and appealing to this connection. Religion makes almost no appearance, except for the choral lines between each verse. Furthermore, these lines seem more like an after-thought in the song and the way they are interspersed among the stirring, nationalist lyrics seems incongruous. Perhaps they were added as an acknowledgement of Islam’s connection to recent

Chechen culture. Regardless, they appear merely as references, not appeals as the main lines are. Clearly then, this song is first and foremost a *nationalist* song, while religion is a superfluous addition. This reflects the general relationship between religion and nationalism among Chechens: religion, particularly Islam, is seen as a subordinate component of a national identity with much stronger roots in ethnicity. In the words of infamous Chechen fighter and terrorist Shamil Basayev: “Freedom is primary ... Shari’a [sic] comes second.”¹⁸ It seems likely, given certain aspects of Chechen society, that freedom would continue to remain primary in relation to religion even after a hypothetical Chechen statehood.

Chechens’ main enthusiasm for radical Islam, particularly Wahhabism, comes from *merely practical needs*. Paramount among these are economic aid (cash) and organization (both social and military). Tishkov records a number of interviews with Chechens which reveal such motives. One man said, in reference to the Arabs who came to Chechnya to spread Wahhabism, “I liked what they said. I found it all convenient, because I am a busy man. And time is money, as they say on television.” He goes on in the interview to explain that these same Arabs gave him money as a gift for his acceptance of their faith, and then paid him an additional \$10,000 for bringing two of his relatives, who were also paid \$1,000 each.¹⁹ These are not the words of a religious fanatic. Rather, religion here served as a means to acquire much needed aid from any source. As Tony Wood argues, radical Islam among Chechens represents “opportunism ... born of necessity, and nourished by a global indifference to the loss of thousands of Chechen lives.”²⁰

Since Chechens had no other sources of economic aid to fund their struggle and their economy, they were forced to turn to extremists, since they were the only ones with ready cash. As another Chechen noted: The Arab Wahhabis “went to the market and paid with dollars... There was no power here; disorder was everywhere, and their influence was very strong.”²¹ The Wahhabis’ influence here is clearly directly tied to their ability to pay with ready money. This gave them tremendous economic power in a society where money was scarce. Rather than rejecting these wealthy militant missionaries, it made sense to embrace and accept their religion if only for the money, despite that “Wahhabist Arabization, ... is totally alien to [Chechen] culture.”²² Thus, acceptance of Wahhabism was necessary for simple personal survival.

Islam, and religion in general, also served as an important stabilising force for ordinary Chechens, as Tishkov has noted. Elina Salazhieva, citizen of Grozny, observed that: “... faith was the only thing that supported people. What was happening surpassed the limits of logic. So they turned to God.”²³ In other words, ordinary Chechens were simply overwhelmed by the scale of destruction caused by the First Chechen War. They turned to belief in an other-worldly divine force in order to cope with their all-too earthly hell. Radical religion served as a coping mechanism. Chechens turned to a new faith in order to survive psychologically, rather than for its own sake. As Anatol Lieven pithily states: “We all pray under fire.”²⁴

Radical Islam has also served as a force to control and mobilise armed resistance to Russian power. Chechens have sometimes been called a nation of anarchists. Lieven refers to the Chechen style of society as “ordered anarchy”.²⁵ This has made it difficult for any central authority to govern the actions of individual militant groups.²⁶ Islam, with its strict moral code, could provide a focusing ideology to control the Chechen combatants. In addition, radical Islam in the form of Wahhabism helped to mobilise Chechen fighters by giving them symbols to rally around, a greater sense of solidarity because of those symbols, and a new justification for their personal sacrifice. Notably, Wahhabist proselytizing was most effective among young combatants in the war.²⁷

Indeed, the plight of young men in Chechnya is a good example of the needs which Chechen society as a whole has for radical Islam. Matthew Evangelista records an interview with the Moscow-appointed administrator of Chechnya’s third largest city, who states that “[t]he poor Chechen people were already suffering so much and young guys couldn’t think... They were ready to accept any ideas.” A lack of economic opportunity and an astronomical unemployment rate did not help matters.²⁸

Radical Islam is a *means* to survival not only on the individual level, but on the national level as well. When Chechnya declared independence from Russia in 1991, Islam did not play a big role.²⁹ This is evident even in the rhetoric that then Chechen leader General Dudayev used in the build up to and during the First Chechen War. At first, Dudayev “explicitly ruled out the creation of an ‘Islamic Republic’”.³⁰ He told reporters that religious leaders “do not play an essential role here [in Chechnya]. Religious and public figures, representatives of peoples and confessions place their trust in the legally elected president and the government.”³¹ Lieven reports that the rhetoric of political Islam became more “insistent” as Chechnya and Russia came closer to war.³² This trend would continue. Indeed, in 1994, just prior to the beginning of the war, Dudayev would attempt to use an “Islamic threat” against Russia, stating that if Russia attacked then his government would institute the *Shariat*, or Islamic law. Here, the official imposition of Islamic culture served as a deterrent. As Lieven points out, this was a blatant attempt to use Islam for political and national ends, and not as an end in itself.³³ Further evidence of this trend in the Chechen national government in the 1990s is abundant. Suffice it to say that radical Islam, such as the *Shariat*, was used to serve the nation rather than vice versa.

With all this in mind then, why has Putin tried to emphasize the image of Chechnya as a radical Islamic state, like another Afghanistan? Simply put, he has done this in an attempt to make his own position more secure. Internationally, Putin has been heavily criticised, especially by European countries, for the on-going war in Chechnya.³⁴ Once Putin began framing the war in Chechnya as part of the global war on terrorism, however, this criticism subsided.³⁵ Thus, Putin made his position stronger internationally by silencing a persistent source of criticism. The claim that the wars in Chechnya and the on-going insurgency there are part of a broader global Islamic *jihad* is thus, evidently, false, and a deliberate

misunderstanding. Putin has promoted this image for his own political reasons, and as a result has inflamed the situation beyond any chance of easy conciliation. The truth of the matter is that Chechens have fought, and continue to fight, for ethnic reasons, not religious ones. Chechnya declared its independence purely for nationalist reasons. The majority of Chechens, many with memories of oppression, deportation, and exile, wanted their own nation-state in order to create a space in which it would be safe to be Chechen. Extremist religion became a useful tool with which to further this goal. Chechens converted to Wahhabism in order to receive economic aid from abroad, and to maintain some kind of societal structure. Religion always served as a means to an end, and never as an end in itself.

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35. Wood, *Chechnya*, 123.

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Genre and the Perception of Massacre: The Contrast of Medium through Bartolomé de las Casas and Cildo Meireles

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*Volume 14
Number 1
Fall 2015*

Lauren Ferguson

INTRODUCTION

When an artist relays a message or theme, the medium of the idea often determines its effectiveness as a piece of art. Such is true for Cildo Meireles' *Missão/Missões [Mission/Missions] (How to Build Cathedrals)* (Figure 1), an installation art piece, and Bartolomé de las Casas' published description, *A Short Account of the Destruction of the Indies*. Each work uses its respective genre, a category of artistic composition and communication, in order to communicate similar critiques of violence. For example, Meireles' piece rebukes 17th century Jesuit missions, while Las Casas' writing depicts the destructive nature of the

16th century Spanish slave trade. The two works, although stemming from different periods of time, show similarity in their critical analysis of the violent relationship between the explorer and the natives. However, while their underlying messages are the same, they are communicated differently through varying methods of interaction with their viewers. For instance, Meireles utilizes the interactive medium of his piece to incite discussion, while Las Casas uses violence to excite and persuade his readers. As a result, Cildo Meireles and Bartolomé de las Casas are both able to communicate effective critiques of explorer and native relations by employing the characteristics of their own unique media.

Cildo Meireles' (*How to Build Cathedrals*) and Transmission of Meaning through Genre

Beginning the discussion with Meireles, his art installation *Missão/Missões* [*Mission/Missions*] (*How to Build Cathedrals*) is noted for its representation of the avaricious actions performed by the Jesuits during their time in 17th century Brazil (Blanton 85). The Society of Jesus, more commonly known as the Jesuits, are a Roman Catholic religious order founded in the 16th century for the purpose of finding salvation for the world's souls. However, during the time of their encounters with the Brazilian natives, the Jesuits were a violent and problematic order primarily known for enslaving the people they encountered in order to construct cathedrals (Thompson 36). Ironically enough, the founder of the Jesuits, Ignatius of Loyola, believed the Society of Jesus was "absolutely necessary for the eradication of those abuses with which the church is affiliated," but the Jesuits perpetrated abuse to those they were trying to convert (Thompson 36).

Although the Jesuits' preached peace and salvation, the communities of the Brazilian natives were under their strict control, and the mission villages benefited only the Papacy and the Jesuits themselves. The colonists killed over two million natives during their two hundred year history in Brazil, and it wasn't until 1757 that a royal decree allowed the Brazilian populace to be freed ("Jesuit"). In an 1894 anti-Jesuit document written by R.W. Thompson, ex-secretary of the Navy, he notes that the slave-built cathedrals "were the product of unrewarded labor, and did not contain a stone or marble block not stained by the tears and sweat and blood of numberless humiliated victims" as the natives died in building their own 'salvation'" (Thompson 342). Unsurprisingly, animosity was built up against the Jesuits and the religious order was expelled from the country in 1782. Thompson notes that the relationship became so strained that the natives' simplified views of the explorers were of a people who "adored gold, had a devil in their bodies, and were the enemies of the Indians" (Thompson 186). The Jesuit's cruel behavior in the name of salvation resulted in massive genocide of the Brazilians, epitomizing the often times problematic nature of explorer and Indian relations.

A critique of the Jesuit's morbid behavior is found in Cildo Meireles' *How to Build Cathedrals*, most notably for emphasizing the ironic nature of the cathedrals themselves.

Although the Brazilian cathedrals were built for the goodwill of the natives, it was the natives themselves that were enslaved to build them. Despite this paradox, the structures remain some of the finest pieces of the Latin American baroque period (“Missão”). In the installation, Meireles creates his own cathedral, but unlike the original Brazilian structures, his work is visibly constructed with materials of deceit and manipulation. Meireles uses American pennies, cattle bones, and communion wafers to censure the Jesuit’s desire for wealth (pennies) that was played out in agricultural exploitation (dead cattle bones) under the guise of religion (communion wafers). Meireles teaches the viewer how to build the Jesuit’s type of cathedral in *How to Build Cathedrals* with the three materials, demonstrating how the entirety of the structure is created with greed and destruction. In Lisa Christine DeLosso’s study *A Phenomenon of Thought: Liminal Theory in the Museum*, DeLosso suggests that the oppressive cathedral metaphor goes deeper, as the work demonstrates “the church has paved over [the natives] with cement blocks and money” on which the viewer stands (DeLosso 55). The piece critiques the exploitative and violent nature of the Jesuits through this creation of a new cathedral, one that is obvious about its deception.

However, understanding Meireles’ criticism begins with comprehending the work itself. *Missão/Missões [Mission/Missions] (How to Build Cathedrals)* was created in 1987 and obtained by its permanent home, the Blanton Museum of Art, in 1998 (Scarborough 57). The installation itself is an interactive piece constructed of 600,000 coins, 800 communion wafers, 2,000 cattle bones, 80 paving stones surrounding the pool of the coins, and a black netting that frames the entire work. Unlike a typical untouchable piece of art, *How to Build Cathedrals* is unique in that the viewer is allowed to enter the work by walking along the stepping-stones and physically handling the coins. Because of its uncommon nature, the installation functions in ways different from a standard piece of art. The medium is unorthodox and breaks down the usual barrier between art and observer. Additionally, the color of the work is a particularly salient aspect. The only light shining in the room in which the work is housed comes from diffused light through the cattle bones, which reflects off of the pennies, creating a warm glowing atmosphere. There are no other lights near the piece, and the only window in the room is permanently covered so as to disallow any spillage of outside light. The effect results in the alluring radiance of the pennies. Color and light work together to create a piece that hypnotically draws in the viewer, inviting them to explore the space.

Furthermore, Meireles instructs that, depending on where the work is, the coins of the installation must match whatever the lowest denomination of money is for that country. Thus, the work can also radiate colors of silver or gold depending on its location, but the effect of the work entrancing the viewer remains the same. Additionally, the space of the work is conducive to a physical exploration of the piece. Unlike art works limited to a visual plane, the space can literally be inhabited by its viewer, which allows varying visual perspectives of *How to Build Cathedrals*. The space’s enormity further supplements this effect. Viewers may walk full circle around the piece, enter through the curtains, or crouch low in order to

handle the pennies. All the elements interact together in order to form a work that is easily appealing to its audience.

The piece's significant attractiveness is fortunate because it lacks a straightforward image to convey its purpose. Meireles' goal in having such an indirect theme is to encourage viewers to discuss its potential message. The piece does not feature direct representations of violence, thus making its possible meaning ambiguous. Furthermore, in a case study entitled *How Family Groups Experience the Blanton Museum of Art* researched by Jessica Piepgrass, it seems that not only did many families consider this piece their favorite in the Blanton, but also it was the one that they spent the most time viewing. Two families spent "approximately 15 minutes together sitting and playing with the artwork", a large amount of time compared to the glances other works in the museum receive (Piepgrass 61). In fact, the study found that "all the families observed at *How to Build Cathedrals* stayed for a significant period of time, when compared with other works they viewed" (Piepgrass 93). Furthermore, Piepgrass noted that "the children enjoyed handling the pennies and the mothers discussed the artwork with each other," demonstrating the effectiveness of the work's inviting essence (Piepgrass 61). The study argues that the work was effective because it could be interacted with regardless of education, as "parents did not need any background knowledge regarding the artist or the intended meaning of the piece in order to discuss how it looks, what it is made of, what you can do with the pennies" (Piepgrass 61). Therefore, in creating an uncomplicated piece, Meireles made it readily accessible to any viewer.

Moreover, when interacting with *How to Build Cathedrals*, Piepgrass noted that viewers began to discuss the meaning of the work, which could possibly lead to them learning of, and ultimately critiquing, the Jesuit missions as Meireles does. The work is effective in drawing viewers in, which in turn allows them to interact with and potentially discuss the meaning of the work. Thus, *How to Build Cathedrals* is effective in engaging viewers, for interaction with the piece may lead to discuss of its purpose. In fact, the efficiency and discussion of the piece stem directly from its interactive nature.

The Success and Effectiveness of Bartolomé de las Casas'

Short Account

A similarly captivating piece of critique against the connection of explorer-missionary relations is Bartolomé de las Casas' description, *A Short Account of the Destruction of the Indies*. Las Casas, a 16th century Dominican priest, is notable for being one of the first to call for the abolition of slavery in the New World, primarily through *A Short Account*. He was originally a willing participant in the takeover of the New World, leaving for Granada as a soldier in 1497, but after viewing the atrocities in the Spanish conquest of Cuba, Las Casas became one of the most significant activists for the native populace. He announced in a 1514 sermon that he was returning his Indian serfs to the governor, and shortly thereafter returned to Spain in order to negotiate the treatment of the natives (Dussel). Then, in 1542, he wrote

A Short Account, which advocated for the fair treatment of the natives and led to the New Laws of 1542 that outlawed slavery in the colonies. The account, intended for King Charles I of Spain, was one of the first to demand better treatment for the natives and reprimand the Spanish for their violent and selfish actions in the New World.

The work itself is a piece fraught with gore and greed, aided by Las Casas' commentary on the Spaniards' actions as they destroyed the Indies in search for gold. Las Casas engages the reader by describing in detail the horrific behavior of the explorers. *A Short Account* describes the "ultimate end and scope" of the explorers was "gold only; that thereby growing opulent in a short time, they might arrive at once at such Degrees and Dignities" (Casas 4). Las Casas' depiction casts the explorers as covetous and cruel, establishing the men as somewhat barbaric. The Spanish, whom Las Casas snidely notes, "style themselves as Christians," came to the new land to "rob, kill, and slay," and as he further suggests, "pretend they undertook this voyage for the people of the country" (Casas 14). Las Casas proposes that not only do the explorers destroy the New World, but they do so by deceiving the people of Spain by lying about their motives. While the explorers claimed they came to the New World to bring glory to Spain, they actually pillaged the land viciously in search of gold. Las Casas suggests that the explorers do not serve the people of Spain, but rather serve only their own selfish desire for wealth.

From Las Casas' description of the horrors the Spanish committed, it is clear that the explorers had little compassion for the native people. If the natives escaped the Spaniard's first attempt of murder, the explorers "immediately cut off [their] legs," crippling or murdering the inhabitants (Casas 7). Las Casas implies the Spanish are not only interested in obtaining gold but also vengefully destroying any opponents. In fact, the natives who escape their "butcheries" are "committed to servitude during life," demonstrating an extensive need to demean their enemy in order to feel successful (Casas 7). The conquistadors' characterization as barbarians, as well as the description of their horrific actions, serves to make *A Short Account of the Destruction of the Indies* an influential and effective piece of literature in establishing native's rights.

The prosperity of Las Casas' work was seen almost immediately in Spain, particularly in the New Laws of 1542, which eradicated slavery in the colonies. The laws were directly inspired by Las Casas' writings on the violence in the New World, which were published in 1552, shortly before the creation of the New Laws (Castro 144). However, unlike the Meireles piece, the book does not force interaction, and because it was written specifically to persuade Charles I, the work is not necessarily as accessible to mass readers. This raises some questions as to how the work was able to gain such popularity and success.

It can be argued that the narrative's significant depiction of injustice is entertaining because of its ruthless portrayal of such atrocities. For example, in a consultation on whether to burn a Peruvian Indian alive or not, the native asks the Spaniard "why do you burn me? Did you not promise to set me free for a Sum of Gold? And did I not give you a far larger

quantity than I promised?” signifying that the Spanish were not killing only for wealth, but for their own pleasure as well (Casas 32). This notion is inhumane and horrifying, but also entertaining. Human nature is inclined to enjoy the fanciful and violent, and Las Casas utilizes this fact, as violence makes *A Short Account* persuasive, particularly to its intended audience of Charles I.

A possible explanation as to what makes the gore and violence of *A Short Account* so entertaining can be found in the 2014 study entitled *Making Sense of Violence: Perceived Meaningfulness as a Predictor of Audience Interest in Violent Media Content*, performed by Anne Bartsch at the University of Augsburg in Germany and Louise Mares of the University of Wisconsin-Madison. The study suggests “depictions of violence...can foster empathy with victims, admiration for acts of courage and moral beauty in the face of violence” (Bartsch). Thus, human nature may not intrinsically enjoy the violence, but rather it is engaging because it fosters empathy for the victims. This particular interpretation of violence is pertinent to the discussion of Las Casas because it validates the author’s goal of cultivating compassion for the natives, signifying that the portrayal of violence is necessary to liberate an oppressed group.

While the possibility of justice may be the cause of its enjoyment, another perspective that clarifies Las Casas’ success comes from Neil L. Whitehead’s essay, “On the Poetics of Violence.” Whitehead argues that art and literature regarding war and violence is consumed because of its ritualistic nature, and it is a pattern that humans intrinsically believe they must follow. Whitehead defines war as “a ritual performance as much as it is an artifact of social structures and their symbolization,” meaning that war gives society context in understanding their identity (Whitehead 71). Whitehead’s interpretation is relevant because the need for identity in a changing world was present in the 16th century, thus explaining a need for social structure. The violence in *A Short Account* may have become exceptionally successful because it solidifies European dominance by establishing the Spanish as the stronger race, especially through the genocide of the native population. *A Short Account* may have been popularly consumed because the violence allowed readers a way to negotiate the new relationship between themselves and the natives without fear of debasement.

The Limitations of Genre in Discussing Genocide

Due to the complex nature of humanity, it is difficult to describe exactly why the violence of the work can be interpreted as enjoyable, but, through its popularity, it is clear that the violence was certainly satisfying as it allowed the 16th century readers a way of negotiating their place in society and make meaning for themselves. Thus, the work proves to be successful in engaging an audience. In fact, Michael Zobelein’s *Bartolomé De Las Casas: Liberation for the Oppressed* cited the account as “one of the most widely circulated documents of its time” as it was translated into a dozen languages shortly after its initial publication, allowing all of Europe to read the narrative (Zobelein 3). Unfortunately for the author, and perhaps proving the idea of the ruthlessness of the invaders, Las Casas was brought to court by his

fellow explorers for possibly hyperbolizing the accounts. The point was valid, for as noted by *Liberation for the Oppressed*, “Las Casas never ceased in his efforts to impress... the profound disregard for the lives and well-being on the Indians,” potentially causing Las Casas to embellish his work in order to persuade Charles I (Zoebelein 15). The thought of Las Casas’ exaggerated accounts is not out of question due to his passion to validate the Indians, and as Henry Wagner and Helen Parish state in *The Life and Writings of Bartolome De Las Casas*, “the multiplicity of objectives and the need for a response helps us understand the nature of *A Short Account*,” meaning the potentially biased features of the work is comprehensible when its goals to persuade are realized (Wagner, Parish 108).

While Las Casas’ desire to liberate the natives possibly influenced the biased writing in *A Short Account*, it should be noted that the claim was never proven. For example, an early twentieth-century Argentine historian, Romulo D. Carbia, spent his time until his death denouncing Las Casas by claiming that he forged documents and lied to promote his agenda (Hanke 148). However, Carbia never offered any proof for his claim, dying without presenting any information. There is no concrete evidence confirming his deceit or lack thereof, and due to the hundreds of years between his work and the present, it is almost impossible to discern his writing’s truthfulness. Ultimately, the work fails the reader because due to its genre of a persuasive document, it does not present a completely accurate rendering of genocide.

Similarly to Las Casas, Meireles’ work is also unsuccessful in telling a historically accurate story. Although it is effective in engaging viewers, it does not portray a complete account. Unlike Las Casas, the piece does not allow for a possibly untrue account due to its symbolic rather than literal representation. However, its simplified medium of art functions only as a visual piece and not as a directly historical one. Although the piece invites discussion and exploration, it does not directly depict the horrors of the natives as Las Casas’ piece does. Perhaps a viewer, after being stimulated by the piece, will research the Jesuits, but perhaps not. *How to Build Cathedrals* is beautiful and inviting, but it is not a fair way to demonstrate the plight of the natives because it doesn’t tell the entire story, but rather provides a symbolic representation of history. Additionally, the enchanting nature of the work seems morbid at times. The image of children in the museum playing with the coins, a representation of blood money earned from murder and destruction, is a saturnine idea, but also demonstrates how the work may be viewed more as a toy rather than a place of scholarly discussion and learning.

Conclusion

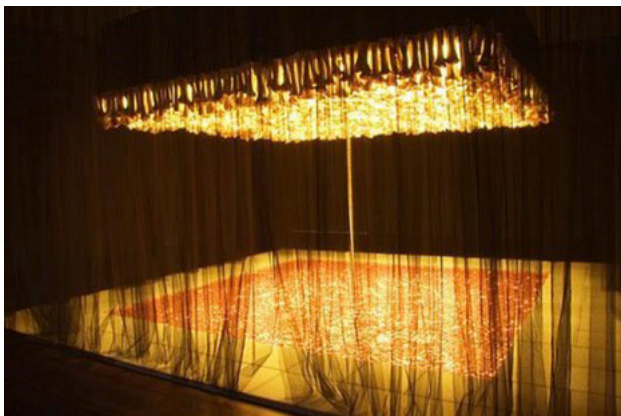
How to Build Cathedrals and *A Short Account* are proven to be effective in engaging readers, but not for presenting a complete and accurate story of genocide. They are successful in that Meireles’ medium allows for accessibility and discussion and Las Casas’ writings utilized violence to create a sympathetic piece of writing. However, while the work’s medium does allow the works a unique way to tell the story of the explorer and native relations, they ultimately fail as pieces of historical documentation because their story isn’t accurately told.

Las Casas' account, written biasedly to persuade Charles I, is possibly romanticized and altered. The account caters to the rights of the natives, but the work cannot be justified if it is possibly fraught with error and manipulation. Similarly, Meireles' piece fails to tell the story of the natives because it is only a visual symbolic representation. The message of the work is easy to interact with, but also easy to ignore. And, because the installation only represents one aspect of the Jesuit missions, the rest of the story of the natives is left for the viewer to find out on their own.

Moreover, while the genre may offer differing aspects of or perhaps a new vision of an event, it cannot tell the whole story due to the physical limitations of its nature. For example, Las Casas' *A Short Account*, a piece written to persuade, is inherently biased and hyperbolized, while Meireles' installation is bound to a visual medium due to the nature of art itself, limiting the information it can present. In order to properly obtain a fair view of a mass murder the audience must look beyond one specific work to others pieces where the issue is represented in different ways. Only once many genres are combined, such as comparing *A Short Account* and *How to Build Cathedrals*, can a fuller message be realized, thus creating a fair and complete representation. A viewer cannot understand the story of genocide through *How to Build Cathedrals* alone; they need *A Short Account*, as well as other historical documents, writing and art pieces in order to gain a complete and unbiased image of genocide. Thus, the story of massacre cannot be told by an installation or a historical account alone; they must work together to create a complete and fair image to begin to reattribute the victims that history has thus far failed.

Figure 1:

Missão/Missões [Missions/Missions] (How to Build Cathedrals).
Cildo Meireles, 1987. 600,000 coins, 800 communion wafers,
2,000 cattle bones, 80 paving stones, and black cloth.
The Jack S. Blanton Museum of Art, Austin. Courtesy of Blanton
Museum of Art.



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“Sentinel of Liberty”: Captain America on the Home Front in WWII

*The University
of Texas
at Austin*

*Undergraduate
Research Journal*

*Volume 14
Number 1
Fall 2015*

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The US and Second World War

In *Captain America Comics* no. 1, two servicemen approach President Roosevelt with misgivings about the war. Roosevelt responds, “What would you suggest, gentlemen? A character out of the comic books?”¹ Captain America made his first appearance just months before America’s entry into the Second World War. The average boy-turned-superhero takes on Hitler in the first issue, leaving no question as to where his allegiance lies. While Captain America reflects a nationwide surge in nationalism on the eve of war, there are subtler forces at work that shape the making and message of these comics. Race, technology,

Great Depression ideals, and nationalism all come into play in *Captain America Comics*, often revealing the darker side of wartime patriotism.

Jack Kirby and Joe Simon created Captain America in 1940. Their backgrounds shaped the superhero's message. Jack Kirby was born in 1917 in New York's Lower East Side.² A second-generation Austrian immigrant of Jewish descent, "Jacob Kurtzburg" Kirby later changed his name to Jack Kirby because, as he put it, he "wanted to be an American." His poverty-stricken neighborhood was filled with violence, much of which would later fill the pages of his comic books. Fights broke out everywhere. In one interview, he reminisced about one particular "climb-out fight." "A climb-out fight," he recalled, "is where you climb a building. You climb fire escapes. You climb to the top of the building. You fight on the roof, and you fight all the way down again." Kirby also encountered anti-Semitism, which had the ironic effect of making him feel not bitter but thankful that America was a place where "people of all different backgrounds had to live together."³ Kirby's love for American diversity and his Jewish heritage later motivated him to draw a patriotic superhero who would take on the greatest anti-Semite of all time, Adolf Hitler.⁴

Like Kirby, Joe Simon grew up in the Lower East Side and was the son of a poor Jewish immigrant.⁵ The two men lived across the street from each other, and both had fathers who worked as tailors.⁶ Simon attended university and worked on the art staffs of a few newspapers before taking a job at Fox Comics where Kirby also worked. Simon recognized Kirby's artistic talent immediately, so when Kirby asked him if he were interested in working on some side projects, Simon jumped at the chance. Simon recalled, "Jack had a great flair for comics. He could take an ordinary script and make it come alive with his dramatic interpretation. I would write the script on the [illustration] boards as we went along, sketch in rough layouts and notations, and Jack would follow up by doing more exact penciling."⁷

A few months into their collaboration, Joe Simon conceived of the idea of a star-spangled superhero who would fight for America against Hitler himself. "Captain America was created for a time that needed noble figures," Kirby once said. "We weren't at war yet, but everyone knew it was coming. That's why Captain America was born; America needed a superpatriot."⁸ Simon likewise felt that Americans should enter the war even though most Americans opposed intervention in what was a European conflict. When asked about his motivations for creating Captain America, Simon explained, "...opponents to the war were all quite well organized. We wanted to have our say too."⁹ Simon and Kirby believed that the best way to have their say was through comic books because, as Kirby put it, "Comics is [sic] an American form of art that anyone can do with a pencil and paper."¹⁰ The comic book they created would become one of the most popular of the war years.

The first issue of *Captain America Comics* appeared in March of 1941, nine months before the United States entered the World War. Isolationist sentiment still dominated public opinion but not the cover of issue no. 1. It features Captain America punching Hitler square in the jaw as Nazi soldiers fire at him from all sides. The story opens on a group of Nazi

saboteurs bent on destroying American factories in order to thwart the war effort. When President Roosevelt learns of the sabotage, he tells the reporting officials of a possible solution, one of the “upmost secrecy.”¹¹ Roosevelt leads the officials to a heavily guarded laboratory where they meet a frail young man named Steve Rogers. Steve is approached by the head scientist, told that he is “about to become one of America’s saviors,” and injected with a “strange seething liquid.” A miraculous transformation results. Steve grows taller, stronger, and smarter. He is now, readers learn, “The first of a corps of super-agents whose mental and physical will make them a terror to spies and saboteurs.”¹² As it turns out, Hitler’s Gestapo has infiltrated the laboratory and open fire. Steve defeats the Nazis easily.¹³ Once a scrawny boy unfit for service, Steve Rogers is now Captain America, “a symbol of courage to millions of Americans.” He and his young sidekick Bucky invite readers to join them on future adventures.¹⁴

In the first issue, Kirby and Simon gave Captain America characteristics that set him apart from other popular superheroes and made him accessible to readers. First, unlike Superman or Batman, Steve Rogers was neither born with superhuman powers nor heir to a super fortune. In fact, he was so weak that he failed his physical and was unable to enlist. Steve may have transformed into a robust superhero, but he also knew what it was like to be powerless, a feeling that probably would have resonated with many young readers.¹⁵ Second, Kirby’s vivid drawings involve the reader in the narrative. Captain America often violates the boundaries of his panel frame, virtually leaping from the page to the next scene.¹⁶ Captain America also looks at and speaks directly to the reader and thus breaks the familiar fourth wall of the form.

Finally, Kirby and Simon say nothing about Captain America’s ethnicity. Steve Rogers is phenotypically white, but unlike Superman or Tarzan, his ethnic origins play no part in his backstory. By masking Captain America’s ethnicity, Kirby and Simon suggest that patriotism has no national origin in America.¹⁷

Captain America and his fellow superheroes provoked a backlash. Sterling North, literary editor of the *Chicago Daily News*, joined the critical choir, calling comics crude and a danger to children’s sensibilities, condemning parents who allowed their children to read comics, and labeling comic book publishers “completely immoral.”¹⁸ Isolationist groups such as the American First Committee and the German American Bund opposed Captain America’s



interventionist message, and went so far as to harass Kirby and Simon outside their studio in the McGraw-Hill building.¹⁹ As Simon recalled, "...we got a lot of...threatening letters and hate mail. Some people really opposed what Cap stood for." The creators were undeterred, and, in Simon's words, "felt very good about making a political statement...and taking a stand against Nazism."²⁰ Their stand would face new challenges with the onset of the war.

The United States entered World War II in December of 1941, and the comic book industry mobilized with the rest of the country. The Office of War Information issued directives to news outlets and suppliers of popular culture, asking them to raise America morale by, for example, incorporating "the phrase 'end of the war is in sight'...as frequently as possible."²¹ Rival comic book publishers took advantage of Captain America's success by filling newsstands with their own flag-waving superheroes, including Uncle Sam, the Star-Spangled Kid, and even Miss America.²² The government rationed publishers' paper by reducing the allotment given to publishers by 15 to 20 percent.²³ Captain America even lost his creators to military service. In 1943 Joe Simon volunteered for the United States Coast Guard. That same year, Kirby was stationed in the Fifth Division, Third Army, and served under General Patton on the European front.²⁴ The brutality Kirby saw in war differed from the violence of the lower East Side, and like those earlier experiences, later manifested itself in his comics. In an interview with *The New Nostalgia Journal*, Kirby justified his use of violence, explaining, "I used to walk around and watch the dead bodies in the field...I feel what I'm doing in my comics is violent, but my kind of violence...violence, basic raw violence in which violence is inflicted in a mindless terrible way, I can't see."²⁵ As the war progressed and *Captain America Comics* kept filling newsstands, the hero developed his message on violence, patriotism, and what it meant to be an American.

Captain America quickly became Marvel's best-selling comic and most popular comic book character. Marvel sold approximately a million copies of *Captain America Comics* per month throughout the war, a sizable chunk of the roughly 15 million comic books being sold each month.²⁶ Comic books even accompanied the troops overseas. *The New York Times* estimated that one fourth of the magazines read by servicemen were comic books.²⁷ In 1944, 41 percent of men between the ages of eighteen and thirty read more than six comic books a month. Forty-four percent of those in training camps read more than six comic books a month while 13 percent read comic books occasionally.²⁸ The economy boomed and parents, now with income to spare, were finally able to give their children what the Great Depression had denied them. Those children often spent their money on comic books.²⁹

Captain America Comics retain themes typical to Great depression popular culture. During the Great Depression, comic books often depicted crusades against corporate greed and deceit. The heroes of these comics fought against what Roosevelt called "economic royalists."³⁰ When he was not fighting Nazis, Captain America often engaged in similar battles against selfishness and fraud. In "The Case of the Fake Money Fiends," Cap dresses up as a small town farmer in order to track down a local mob of counterfeiters.³¹ "The Return of the Red

Skull” features two “hard faced thugs” who dress up as Bucky and Captain America to trick the public into paying to see them. Eventually, the Red Skull finds the superhero impersonators and, mistaking them for the genuine pair, hangs, them. The frauds are neither saved nor mourned, exhibiting a lack of sympathy for anyone who would cheat a fellow American out of a dollar.³² The surprise villain of “The Riddle of the Red Skull” is Mister Naxon, the head of a large aircraft organization who kills important American officials in exchange for the Nazis’ promise to make him the Greater Reich’s Post Minister of all American industry.³³ These tales reinforce the New Deal assumption that unsupervised, unregulated business will become a corrupt menace.³⁴

Children made up a large portion of Captain America’s readership. For the young boys and girls of WWII, Steve Rogers was the manifestation of whatever member of their families who had been sent overseas. Steve’s heroics as Captain America provided a picture of war and soldiers that allowed these kids to imagine their loved ones fighting valiantly, very much alive. *Captain America Comics* even gave them their own role to play in the war effort by portraying them as brave defenders of the homeland. In “The Killers of the Bund,” Bucky assembles his young friends and tasks them with locating the German-American Bund’s secret hideouts. The Sentinels are shown listening at windows, on watch for traitors to the American cause.³⁵ Pages advertising entrance into Captain America’s fan club, known as the “Sentinels of Liberty,” were featured in nearly every issue of *Captain America Comics*.

These young readers had money to spend on the club’s membership cards and badges. An April 1944 census survey revealed that 20 percent of schoolboys between fourteen and fifteen years of age had jobs and that 40 percent of those between sixteen and seventeen years of age did as well.³⁶ Kirby and Simon were not simply catering to young readers for their money. At the end of “Captain America Battles the Camera Fiend and His Darts of Doom,” the Captain looks directly at the reader and says, “All boys and girls are Sentinels of Liberty whether they wear the badge or not. America is safe while its boys and girls believe in its creeds!”³⁷ While most children did not have the opportunity to contribute to the war effort as directly as Bucky and his pals, Captain America’s quote identifies another vital role they played: a source of hope for the future and something worth fighting for.



In his fight to protect the American home front, the Nazis were Captain America's most formidable enemy. Nazis differed from Kirby and Simon's other villains. Unlike Oriental zombies, phantom hounds, or giant murderous butterflies, Nazis were literally men in uniform and did not immediately register as evil on a visual level.³⁸ Identification of the Nazis as a force of evil often began with graphic representations: grotesque physical features, heavy German accents, and the ubiquitous placement of swastikas.³⁹ Indeed, the number of swastikas incorporated into any scene featuring Nazis seemed limited less by where they would realistically be displayed and more by how many could fit onto the page.⁴⁰ Kirby and Simon made the identification of forces of good and evil even easier by featuring real people such as Hitler, Herman Goering, and General Edward P. King. This allowed readers to transfer their feelings for the actual men to their cartoon counterparts. Once characters had been identified as a certain moral valence, they exhibited behavior appropriate to their identification.⁴¹ Nazis are always manipulative and lethal. They instigate every conflict, forcing Captain America to respond and paralleling American entry into the war. Finally, their hubris is omnipresent and overblown.⁴² Nazi villains celebrate their success with plans to rule the Fatherland or claims of surpassing Hitler.⁴³ Captain America could not be more humble. He exhibits pride



not in himself, but in his nation. After the defeat of yet another Nazi, he proclaims, "...you can tell that Austrian paper-hanger this—tell him that our freedom has been threatened before and we're still around to tackle anyone who thinks he can take it from us now! Hitler and his loot-

crazed barbarians will find the farmer of Lexington and Concord very much alive in the spirit of every modern American!"⁴⁴

Not only were the Nazis Captain America's most formidable enemies; they were also his most common ones. This emphasis on Germany probably stemmed both from America's pursuing a "Europe-first" strategy and from the Jewish creators' preoccupation with the Holocaust and the fate of European Jewry. Other American enemies made their appearances. The most notable were the collaborators of Vichy France and the Japanese. In "The

Terror that was Devil's Island," Steve Rogers goes to Vichy France's POW prison to see his friend Tom Jason, who had been taken prisoner by the Germans during their occupation of France.⁴⁵ Steve finds Tom unshaven, emaciated, too scared to tell his friend what had been done to him. "Captain America in Murder Stalks the Maneuvers" features a Vichy Frenchman disguised as a representative of the Free French who replaces the fake ammunition to be used in the American soldiers' war games the following day with real ammunition. This scheme kills several men.⁴⁶

While the portrayal of the French focuses on their status as traitors, depictions of Japanese are overtly racist. The Japanese in "Meet Fang, Arch Fiend of the Orient" have apish faces, sharp teeth, and claw-like hands. They talk openly of torturing and executing their enemies. Their target in this particular comic is the friendly, wise Chinese emissary in Steve Rogers' charge, perhaps an allusion to the Japanese's brutal behavior in the Sino-Japanese war.⁴⁷



Edgar Snow, Mao Tse-tung's early biographer, captured the logic behind this depiction of the Japanese as primitive and animalistic in comparison to other races. "The individual Japanese," he wrote, "is aware of his unfortunate intellectual and physical inferiority to individual Koreans and Chinese...he is forever seeking ways of compensation." Many Americans saw the Japanese's brutality as a manifestation of this inferiority complex.⁴⁸

Technology also figures prominently into this Manichean universe. Captain America and his fellow soldiers rarely wield anything more advanced than a rifle, while the Nazis employ all sorts of state-of-the-art weaponry. In "The Wax Statue that Struck Death," "...a secretly trained mechanized unit, organized by the mysterious wax man, works feverishly to complete and equip their streamlined, metal monsters in the underground factories beneath densely wooded forest..."⁴⁹ "The Return of the Red Skull" features the Red Skull's power drill which pierces concrete, destroys buildings, and kills thousands.⁵⁰ Chemical weaponry even makes an appearance in "Captain America and the Killers of the Bund," as one Nazi threatens the Captain, "I think you'll be interested to know dot after you're dead, ve are going to spray der entire zity mit zleep gas und den capture it. Ve vill den await der Feuhrer's invasion."⁵¹

Such differences in technology served two purposes. First, they reflected the actual differences in production between the United States and Germany. When it came to productivity, no country could match the United States. Henry Kaiser, developer of the Liberty Ship, was eventually dubbed “Sir Launchalot” for the huge number of ships he manufactured.⁵² When given the choice between quantity and quality, the Germans chose quality. Even German armaments minister Albert Speer acknowledged America’s “production miracle” and prophesized that “it would be evident to posterity that our outmoded, tradition-bound, and arthritic organizational system had lost the struggle.”⁵³ More to the graphic point, the incorporation of technology made for more exciting violence than the stereotypical gunfight or hand-to-hand combat. All that metal and machinery presented Captain America with a foe of corresponding strength and allowed the hero to show off his fighting finesse.⁵⁴

Allied victory in Europe signaled the end of *Captain America Comics*’ golden age. Stan Lee had replaced Kirby and Simon as the editor-in-chief before they were shipped off to war in 1943. It was he who took up the challenge of selling this beloved war comic to a postwar audience. Lee had begun work at Timely comics when he was just seventeen years old. He was related to Timely’s owner, Martin Goodman, so when Kirby and Simon were told to give the youngster a bit of work to do, the two comic veterans were annoyed by this blatant act of nepotism. Lee was determined to prove himself. The son of Romanian immigrants, Lee had grown up during the Great Depression and watched unemployment drag his father into a crippling depression. He resolved to work as hard as necessary to become indispensable at whatever job he took on.⁵⁵ Lee made few friends in school and would turn to comic books as an escape from his loneliness.⁵⁶ By age 15 he was repeatedly winning writing contests held by New York’s *Herald-Tribune*. After graduating from high school in 1939, Lee decided to approach Goodman about the possibility of a job and the chance to work with his heroes, the creators of Captain America.⁵⁷ Kirby and Simon tasked Lee with the unappealing job of writing the two pages of text *Captain America Comics* had to include in order to qualify for second-class mailing benefits. “Nobody wanted to do that stuff because nobody read it,” Simon remarked, “so Stan did it, and he treated it like it was the Great American novel.”⁵⁸

Lee was determined that Captain America’s rivalry with the Nazis continue despite their surrender to the Allies in May 1945. For a full year after the war’s end, Captain America would carry on fighting Hitler’s minions.⁵⁹ In the August 1945 comic “The League of Hate,” Nazi agents were still carrying out sabotage in the United States. Rather than assassinating American leaders or destroying industry, their aim was to, as Hitler put it, “spread propaganda for a soft peace” (Weiner 29). Other elements of the comic altered dramatically. Servicemen had composed a large portion of Captain America’s readership. Lee believed that the best way to retain this readership was to have Captain America’s storyline mirror veterans’ experiences returning home. “The Private Life of Captain America” appeared in November 1946 and established Captain America’s civilian identity. In this story, Steve Rogers and Bucky Barnes are honorably discharged from the army. Steve returns to his prewar

occupation as a social studies teacher at Lee High School, fighting common criminals as Captain America in his off time.⁶⁰

Despite the change, sales continued to suffer. In April 1948, Lee made another major alteration to the *Captain America* canon by giving the hero a new sidekick. In “Golden Girl,” Bucky is shot and hospitalized. The fall of this cherished character was meant to symbolize the loss the American people suffered during the war.⁶¹ Captain America recruits his long-time friend Betty Ross as his new sidekick, and she takes on the identity Golden Girl. Lee chose Golden Girl as Bucky’s replacement in the hopes of capitalizing on the popularity of female heroines and tapping into the female demographic.⁶² Lee’s efforts were in vain. Timely canceled Captain America’s monthly in 1949.⁶³

Censorship was an obstacle all comics in the postwar period faced. In 1954, psychologist Dr. Frederic Wertham published *Seduction of the Innocent* in which he argued that kids who read comic books were more likely to grow into delinquents. Wertham presented as evidence the youths he had worked with as a clinical psychologist. He asserted that the youths who regularly read comic books also were also those who committed the most acts of juvenile violence. The book received enough attention for the issue of comic book content to earn a congressional hearing.⁶⁴ The Senate Subcommittee on Juvenile Delinquency convened its “Comic Book Hearings” in April of 1954.⁶⁵ In response to the range of criticism presented at the hearing, several comic book publishers came together to form the Comics Magazines Association of America (CMAA). This association issued the Comics Code Authority (CCA) more commonly known as the Comics Code. Publishers who agreed to adhere to the Code’s stipulations received a seal informing the public that this particular comic book met the organization’s standards of decency. The Code prohibited comics from including excessive violence, depictions of drug use, criticism of the government, sexual imagery, or detailed portrayals of crime.⁶⁶ Publishers were at a loss. They risked losing readers’ interest by adhering to the Code, yet consumers would not buy comics that lacked the CMAA’s seal. Between 1954 and 1956, eighteen comic book publishers closed their doors.

The Comic Code proved a death sentence for many, but Stan Lee saw it as an opportunity. The Code required that comics be wholesome and moral, both of which were characteristic of *Captain America Comics*. Nazis were no longer a viable enemy for Captain America. Instead, Lee took a cue from the national anxiety mounting in response to the rise of Red China, the development of hydrogen bombs by the Soviets, and McCarthyism by making Captain America’s new enemy the forces of communism.⁶⁷ The first issues of the revival appeared in 1954. The top of each issue read “Captain America...Commie Smasher.” The rehabilitated Captain America’s adventures were as bombastic and political as those of the original series. In “You Die at Midnight,” Captain America breaks up a communist spy ring that had been attempting to extort information about America’s atomic research from a shipyard employee by threatening to murder his blind son.⁶⁸ The cover of issue #77 depicts Captain America fighting off a ship full of communists, flying through the air just

past a subtitle that reads, “Striking back at the Soviet.” This exaggerated form of warfare may have sold millions of comics during the war, but it did not appeal to the readers of what was now the Cold War era. “Captain America...Commie Smasher” was canceled that same year after just three issues.⁶⁹

Captain America Comics remained canceled until 1964. During the hiatus, the success of other superheroes revealed where Captain America had gone wrong in his abortive revival. Most comic book readers at this time were older than those of the 1940s. They were college students who craved complexity from their heroes. Kirby and Simon had returned to Timely comics, now known as Marvel, in the 1950s. The duo paid close attention to the psychological motivations of their new characters. In 1962, they debuted Spider-Man, an unpopular, awkward high school student with a tough home life. Hulk first appeared the same year. His struggle to protect those around him from his uncontrollable transformations into a green giant also made him a fan favorite. If the next Captain America revival was going to succeed, he was going to have to develop some of the same depth exhibited by the popular characters of the time.⁷⁰

Kirby and Lee worked together to give their beloved character complexity. They scrapped all the changes Lee had made to the canon since 1941. Steve Rogers was never a schoolteacher, Golden Girl was never the Cap’s sidekick, and the Captain had never fought the communists. They wrote a story that took Captain America and Bucky back to their last mission before the end of World War II. Near the story’s end, both the Captain and Bucky sit atop a missile heading straight for a major city. Cap realizes that he cannot deactivate the missile before it explodes. He tells Bucky to give up and let go of the missile, but Bucky refuses to doom the city. As Captain falls to safety, the missile blows up, killing Bucky. After crashing into icy waters, Cap is frozen in suspended animation. When he is unfrozen in 1964, he wakes to find himself an antiquated hero burdened by survivor’s guilt in an unrecognizably modernized world.⁷¹ Cap’s struggle to both cope with the past and adapt to the present was a hit with readers. Captain America quickly went from has-been hero to Marvel’s most popular character.⁷²

Captain America’s evolution reflects the transformation of American society during and in the decades following World War II. Before America entered the fight, *Captain America Comics* represented the interventionist element of a nation still clinging to isolationism. The comics produced during the war mirror several elements of life on the home front including mass production of war material, racism, civilian perception of the nation’s foreign enemies, and an inflated sense of nationalism. The end of the war forced Captain America to discard his role as an uncompromising crusader. Readership had matured and wanted characters with more emotional complexity than was typical of Cap up to that point. Another important element in the rejection of golden age Captain America lies in the unique nature of World War II. Captain America was born out of America’s most righteous war to date. No conflict since WWII has been so clearly justified. Captain America was designed to

represent good in a world divided between good and evil. When the postwar world proved to be more gray than black-and-white, the Captain was forced to adapt and take on his own morally ambiguous past. Regardless of the evolution Captain America's message, his survival into the twenty-first century is indicative of the fact that America continued to see itself as a force for good. Captain America remains to this day a manifestation of America's desire for righteousness.

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Embracing Myth in Mrs. Dalloway

*The University
of Texas
at Austin*

*Undergraduate
Research Journal*

*Volume 14
Number 1
Fall 2015*

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Although Virginia Woolf references Classical myth and drama in most of her novels, she is perhaps most explicit in her allusions to Greek myth in *Mrs. Dalloway*. Centering on the eminently respectable, middle-aged Clarissa Dalloway, the novel traces a single day in the protagonist's life as she prepares for a party and reflects on the choices that led her to embrace a conservative lifestyle. Throughout this essay, I will use Woolf's debut novel *The Voyage Out* as a counterpoint to some of my arguments about *Mrs. Dalloway*. The earlier novel follows the extremely sheltered and virginal Rachel

Vinrace in a doomed coming-of-age story. The narrative ends with Rachel's tragic death from a tropical fever as a metaphorical flight from the atrocities of marriage and sex. The worldly Evelyn Murgatroyd operates as Rachel's foil and becomes the feminist inheritor of the narrative after Rachel's death. I suggest that reflecting on Rachel and Evelyn provides useful insights into Woolf's later characterizations of Clarissa Dalloway and Sally Seton. While Rachel and Evelyn reflect the mythical virgin goddess and Amazon types, the older Clarissa and Sally take on aspects of the mother goddess role.

As several scholars have noted, Clarissa is aligned with the goddess Demeter throughout *Mrs. Dalloway*. Woolf alludes to the goddess directly at least once, saying that the war "smashed a plaster cast of Ceres," but less obvious references to Demeter permeate the novel as well and accentuate Clarissa's status as a mother goddess figure (*Dalloway* 86). Consistently associated with vegetation, motherhood, and domesticity, she bears a strong resemblance to Demeter, despite having ambivalent feelings about her social role. This association underscores the extent to which Clarissa fulfills the part of Angel in the House (the respectable, domestic Victorian woman), denying her youthful inclination to mutiny against traditional social structures in favor of a conservative life as Richard Dalloway's spouse. It is important to note that *Mrs. Dalloway* is the first of her novels in which Woolf adopts the *internal* perspective of a woman who has been mythologized as a mother goddess figure, and is thus reduced to a symbol and deprived of freedom. Furthermore, Clarissa is still alive, unlike the idealized Theresa Vinrace of *The Voyage Out*, and can therefore consciously experience the process of becoming a mythic symbol. Lisa Tyler convincingly argues for Clarissa's identification with Demeter and interprets the Demeter-Persephone myth in *Mrs. Dalloway* as a commentary on how an oppressive patriarchy separates women from each other and from themselves. Tyler does not engage with Clarissa's understanding of herself as a mythologized woman, however, and I plan to expand upon this point. Clarissa is hardly passive in her role as a respectable wife and mother and seems curiously aware of the fact that she is being made abstract, almost inhuman, by allowing society to view her only in terms of this glorified function. Woolf exposes Clarissa's complexity and her awareness that the role of mother goddess can be constricting. I argue that by aligning Clarissa with Demeter, Woolf draws on a familiar ancient myth in order to expose a new one created by rigid social norms: the myth of the traditional feminine ideal. The Angel in the House is itself a myth that has real, damaging consequences for women. Clarissa manages to publicly inhabit this symbolic role while still protecting her inner life and identity. As Suzette Henke notes, the novel "offers a scathing indictment of the British class system and a strong critique of patriarchy. The work's social satire takes much of its force from ironic patterns of mythic reference" (125). Clarissa is not a perfect match for the Demeter type, however: her small, daily rebellions against the duties traditionally ascribed to women reveals her spiritual rejection of the goddess role, even as she continues to act out her part in public.

I. Identifying Demeter

A close reading of *Mrs. Dalloway* reveals that Clarissa's identity as a goddess figure is complicated and sometimes paradoxical. She combines aspects of mature wisdom and youthful purity. She feels "very young; at the same time unspeakably aged" (*Dalloway* 8). Evidently, she is intelligent and insightful; the narrator informs the reader that "She sliced like a knife through everything" and knows "people almost by instinct" (*Dalloway* 8-9). When she returns home, the maid, Lucy, takes "Mrs. Dalloway's parasol, handled it like a sacred weapon which a Goddess, having acquitted herself honourably in the field of battle, sheds" (*Dalloway* 30). Upon entering the home, the private domain, Clarissa sheds her public weaponry and more fully assumes the role of domestic goddess.

Clarissa evinces a kind of power and dignity that does not go unnoticed by those around her. While visiting Clarissa in her room, Peter Walsh feels that he does not speak to her, but "to someone raised up in the dark so that you could not touch her but must lay your garland down on the grass in the dark" (*Dalloway* 45). The fact that Peter, arguably her peer except in terms of gender, perceives her as somewhat divine suggests that Lucy's admiration for her is more than the respect of an employee for her employer. Yet Clarissa's strength stands in contrast to her mild, virginal qualities. Twice within three pages of her return home from town, she compares herself to a nun. She cannot "dispel a virginity preserved through childbirth which clung to her like a sheet"; she conceals her sewing from visitors "like a virgin protecting chastity" and sleeps in an attic room away from her husband (*Dalloway* 31, 40). As a goddess figure, Clarissa combines the dreamy, virginal model offered by a character like Rachel Vinrace of *The Voyage Out*, with a more active, mature attitude. The second is what helps align Clarissa with Demeter, as she takes on the role of the mother rather than that of the daughter.

Demeter, the Greek goddess of the harvest, presided over the fertility of the land and is strongly associated with motherhood due to the close bond she shared with her daughter Persephone. In the most famous myth surrounding these two goddesses, Persephone was abducted by Hades, god of the underworld, and taken to be his wife. Despairing at the loss of her daughter, Demeter refused to let the earth be fertile so that humankind was at risk of starvation. In order to protect the mortal world, Zeus commanded that Persephone be allowed to return to the surface, but because she ate the pomegranate seeds that Hades offered her, she must return once a year to the underworld. The myth provides an etiology for the changing seasons: winter reflects Persephone's retreat to the realm of Hades, and spring signals her return. The myth also reflects the pain that results from a daughter being taken away from her mother at marriage.

From the opening lines of the novel, Clarissa's likeness to Demeter begins to unfold; it is grounded initially in their shared association with plant life. In the first scene, Clarissa selects flowers for her party, and while in the florist's shop, she manifests a great familiarity and affinity for the abundant plants. A lengthy passage describes the multifarious blooms,

as if Clarissa examines every one. She loves them and the atmosphere they produce: “every flower—roses, carnations, irises, lilac—glows; white, violet, red, deep orange; every flower seems to burn by itself, softly, purely in the misty beds” (*Dalloway* 13). Though she is fascinated by all forms of life, Clarissa shares the isolation of the flowers burning by themselves in the florist’s shop. She finds it “absolutely absorbing; all this,” even as she watches with the feeling of an outsider “looking on...being out, out, far out to sea and alone” (*Dalloway* 8). This extreme individuality seems to mark Clarissa as distinct from normal people. She watches as if from above, much as Rachel Vinrace enjoys looking at “Human beings” with detached curiosity (*Voyage* 135). Yet if Clarissa identifies with the flowers’ aloneness, she also acknowledges a more collective, communal connection with others, imagining herself “laid out like a mist between the people she knew best, who lifted her on their branches as she had seen the trees lift the mist” (*Dalloway* 9). Moreover, Peter Walsh thinks of Clarissa as “cool, lady-like, critical; or ravishing, romantic, recalling some field or English harvest” (*Dalloway* 153). Clarissa’s sense of disembodied omnipresence points to Clarissa’s divinity, and the profusion of natural imagery embedded in her experience of the day strengthens her association with Demeter, goddess of the harvest and fertility.

The task of choosing flowers helps Clarissa ease her worries for her daughter Elizabeth, another goddess figure. Clarissa fears that Elizabeth is growing too attached to her tutor Miss Kilman. The tutor is immediately cast as Clarissa’s adversary, and her very name suggests her connection with violent, masculine energies, and to death itself. The catalogue of flowers recalls the opening scene of the “Homeric Hymn to Demeter” in which Persephone is “gathering flowers, roses, crocuses, and beautiful violets / all over a soft meadow; irises, too, and hyacinths she picked” (Athanasakis 1). This striking similarity reveals Clarissa’s likeness to Demeter and Elizabeth’s association with Persephone. Woolf emphasizes the latter connection by repeatedly describing Elizabeth in nearly Homeric terms:

People were beginning to compare her to poplar trees, early dawn, hyacinths, fawns, running water, and garden lilies, and it made her life a burden to her, for she so much preferred being left alone to do what she liked in the country, but they would compare her to lilies, and she had to go to parties, and London was so dreary compared with being alone with her father and the dogs. (*Dalloway* 135)

People are beginning to mythologize Elizabeth as a beautiful, marriageable girl in much the same way that they romanticize Clarissa as a wife and mother. Elizabeth’s disinterest in this kind of attention, perhaps particularly male attention, and her love of dogs and the country mark her as a potential Artemis figure. She seems to align neatly with the Greek virgin goddess of the moon and the hunt. This connection accentuates the novel’s examination of young women, including Elizabeth, Clarissa, and Sally, who do not want to enter into the patriarchal system of respectable marriage and heterosexuality. Yet Elizabeth’s equally valid association with Persephone, which most scholars emphasize almost exclusively, ties her to Clarissa and allows for the analysis of *Mrs. Dalloway* in light of mother-daughter myths.

The plot of *Mrs. Dalloway* also draws a connection between Clarissa and Elizabeth and the Demeter-Persephone story. Like Demeter, Clarissa is thoroughly distressed by her separation from her daughter. Her concerns for Elizabeth's well-being and loyalty thread throughout the narrative. They linger ever-present in the back of Clarissa's mind and trigger memories of her own youthful passions. Clarissa fears that Miss Kilman, whom she casts as "one of those spectres who stand astride us and suck up half our life-blood, dominators and tyrants," will steal Elizabeth from her much as Hades kidnaps Persephone and drags her to the underworld (*Dalloway* 12). For Clarissa, the threat of this symbolic hell consists in the loss of Elizabeth's affection and also in Elizabeth's exposure to Christianity through Miss Kilman. Clarissa laments that "Elizabeth, her own daughter, went to Communion" under the tutor's influence (*Dalloway* 11-12). Here, as in *The Voyage Out*, a conflict between Christianity and paganism is visible. Elizabeth's relationship with Miss Kilman even has a romantic or semi-erotic hue, as Clarissa calls her "Elizabeth's seducer; the woman who had crept in to steal and defile" (*Dalloway* 175). Despite Richard Dalloway's casual assurance that Elizabeth's affection for Miss Kilman is "only a phase...such as all girls go through," Clarissa wonders if it might be more serious, a matter of "falling in love" (*Dalloway* 11). Given Clarissa's youthful love for Sally Seton, which her devotion to Richard cannot rival in intensity, she knows from experience that this kind of love may be serious. Clarissa's understanding of Elizabeth is inextricably linked to her memories of her own adolescence, as she compares her ardor for Sally with Elizabeth's fondness for Miss Kilman. The novel formally reflects Clarissa's mental oscillation between past and present. From the first page onward, the narrator reveals how Clarissa's present everyday experiences, such as the sound of a squeaky hinge, plunge her into memories of her youth at Bourton. She knows that Elizabeth's relationship with Miss Kilman might be serious because she vividly recalls her own former passions. Lisa Tyler writes, "Clarissa, Sally, and Doris Kilman have all been read as lesbian characters" ("Loss of Roses" 63). However, I submit that the novel does not focus on love between women only because it is homosexual, but rather emphasizes it as a shared experience between young women and a bond of mutual understanding between mother and daughter. It is this kind of relationship that sustains Woolf's female characters even after they have married and become estranged. Clarissa, for example, continually returns to her memories of Sally at Bourton while she is discouraged by the coldness of her marriage to Richard. The narrator's access to these intimate relationships brings the reader into an often-overlooked community based on sororal solidarity.

Tyler's interpretation of the mother-daughter myth in *Mrs. Dalloway* as a commentary on the divisive power of an oppressive patriarchy holds true for most of the interwoven plots of the novel; however, her reading of the relationship between Elizabeth and Miss Kilman requires further nuance. Whereas I have chosen to examine Clarissa specifically as the central Demeter figure of the novel, Tyler convincingly identifies many other female characters as Demeter figures as well and analyzes the correlation between motherhood and

an affinity for vegetation as two aspects of fertility. She points to the sonic similarities between female characters' names, particularly "Rezia," "Clarissa" and "Ceres" as evidence that these women are connected through the mother-daughter myth and have suffered a separation from the sororal world ("Loss of Roses" 64). However, her interpretation may not adequately address the case of Elizabeth and Miss Kilman, one of the key iterations of the myth, since it is a woman, not a male representative of the patriarchy, who temporarily divides Elizabeth from her mother. Elizabeth briefly foregoes a relationship with one woman (her mother) in favor of a relationship with another woman (Miss Kilman). However, this differs from what Tyler describes as a woman's "initiation into compulsory heterosexuality" in marriage ("Loss of Roses" 63). In fact, though Miss Kilman's name associates her with violence and masculinity, her relationship with Elizabeth is similar to the romantic, sisterly sort celebrated elsewhere in the novel. It might be argued that Miss Kilman's interest in Elizabeth is partially motivated by her resentment of Clarissa. She knows that Clarissa fears losing Elizabeth and wants to make her suffer. However, Miss Kilman also manifests genuine affection for Elizabeth, so it seems hasty to dismiss their relationship as Richard does. Yet there is no indication that Elizabeth feels obligated to cast aside a lesbian relationship in favor of a heterosexual one. Clarissa's separation from Sally Seton provides a much more coherent instance of a woman's "initiation into compulsory heterosexuality" that tears her away from lesbian love ("Loss of Roses" 63). Nevertheless, the myth of Persephone's abduction comes full circle at the end of the novel when Elizabeth abandons Miss Kilman and returns to Clarissa's party, just as Persephone returns from the underworld in the spring. Woolf even describes Elizabeth's journey home in terms of Olympus, as Elizabeth notices the clouds having "all the appearance of settled habitations assembled for the conference of gods above the word" (*Dalloway* 139). Elizabeth's return appears even more powerful than Persephone's, in fact, because she does not need her mother or anyone else to rescue her as Persephone does, but returns of her own volition. As Tyler point out, Woolf uses the Demeter-Persephone myth to "subvert the traditional heterosexual romance plot" in which "the conventional expectation for a woman character is that she be involved (often passively) in a heterosexual romance with a man whom she ultimately marries" ("Mother-Daughter Passion" 74). To take this a step further, I would add that *Mrs. Dalloway* does not contain a single romance plot that comes to fruition by the end of the novel. Elizabeth leaves Miss Kilman, and while Clarissa and Sally remember their love for one another, they make no attempt to revive it. Woolf's decision to engage with a cast of middle-aged characters who have already solidified their adult lives goes a long way toward making the conventional romance plot irrelevant. However, as if to note how central this plot is to a conservative mindset, Woolf allows Clarissa to feel "unseen; unknown; there being no more marrying, no more having children now" (*Dalloway* 11). Despite her reservations about traditional womanhood, Clarissa still partially understands her identity as a series of traditionally feminine life stages: virginity, marriage, and moth-

erhood. To replace the old romance narrative, Woolf focuses on the powerful relationships between women, particularly between mothers and daughters.

Clarissa's divine status lends her a great deal of power in the domestic sphere. Pausing on the landing during the preparations for her party, she assembles "that diamond shape, that single person" as if she must draw herself together from every corner of the house, like a goddess assuming human form (*Dalloway* 38). She seems omnipresent in this scene, and also omnipotent, as she muses that "a mistress knows the very moment, the very temper of her house!" (*Dalloway* 38). This power is linked to Clarissa's understanding of her domestic life in terms of pagan religious devotion. Her intense commitment to social arrangements, gatherings, and parties calls to mind the Eleusinian Mysteries, a "religious cult of ancient Greece" devoted to Demeter "whose mysterious rites were known only to initiates" ("Loss of Roses" 60). Her dinner party forms part of a "mystery or grand deception practised by hostesses in Mayfair from one-thirty to two, when, with a wave of the hand, the traffic ceases, and there rises instead this profound illusion" (*Dalloway* 104). However much Peter Walsh may deride Clarissa's parties, she considers them an act of creation, an "offering; to combine, to create" (*Dalloway* 122). As Suzette Henke points out, "Clarissa's devotion is directed not to the patriarchal Jehovah of the Judaeo-Christian tradition, but to a composite ancestral figure whose primary aspect is maternal" (127). Following her mother's death, Clarissa's parties "serve as a perpetual tribute to the absent mother, creative acts of social artistry based on the primary model of family affiliation" (Henke 127). Woolf's construction of the party as a mirror of the Eleusinian Mysteries bolsters a reading of Clarissa in terms of the myths surrounding Demeter in particular, and allows Clarissa's godhead to be manifest in her social, unifying powers.

Woolf's extended allusion to the myths surrounding Demeter emphasizes Clarissa's social role, her external appearance and standing in the eyes of polite society. To an observer, even someone as intimately familiar with her as Richard, she *appears* to fulfill the role of the mother goddess or Angel in the House. The presence of the ancient myth embedded within the narrative serves to reveal its modern parallel, the perfect wife and mother; however, Clarissa's occasional deviation from this mode is central to Woolf's commentary on the restrictive nature of traditional gender roles.

II. Woman Reduced to Symbol

The fact that Clarissa appears as a potent social goddess may be misleading if it urges the conclusion that she has any real sense of personal freedom or empowerment. Many scholars, including Lisa Tyler, seem to concentrate on illuminating the similarities between Clarissa and Demeter, as if Clarissa has completely surrendered to the pressures of patriarchal control and traditional gender roles. Admittedly, the sacrifice of Clarissa's identity and freedom to the demands of a patriarchal society is crucial to Woolf's depiction of a respectable upper middle class woman's life. I argue, however, that Clarissa's resistance to

this Victorian system is equally important and not necessarily incompatible with a reading grounded in the myths surrounding Demeter. Clarissa's frustrations and little mutinies suggest that the traditional feminine ideal is a socially constructed myth that can have damaging effects on women's lives. Henke asserts that Clarissa refuses "to conform to the stereotypical patterns ascribed to [her] sex" but attributes this only to Clarissa's homosexuality (134). Such an argument, though strong in many respects, ignores the aspects of Clarissa's character that do align with the mother goddess role, and fails to acknowledge Clarissa's internal struggle to balance traditional femininity with personal independence. Woolf's rewriting of the Demeter figure in *Mrs. Dalloway* reveals the harmful results of restricting women to traditional gender roles and idealizing them as abstract symbols such as Virgin, Wife, or Mother. Like Theresa Vinrace in *The Voyage Out*, who has died before the narrative begins and haunts the novel as an absent model of female perfection, Clarissa Dalloway is mythologized based on her social role and deprived of her individuality and autonomy. This is an inherently social process dependent on the perceptions of others, and Woolf directs our attention particularly to the perceptions of men or the patriarchal system in general.

Like many men in Woolf's novels, Peter Walsh pictures "the ideal woman as a great nurse who comforts and soothes, who offers sensuous gifts flowing from a warm, fertile body" (Henke 131). He expects all women to be this way, which is a fundamental reason that Clarissa refused to marry him when they were young. Yet even with his infantile, stereotyped image of womanhood, Peter acknowledges that "there's nothing in the world so bad for some women as marriage...and having a Conservative husband, like the admirable Richard" (*Dalloway* 41). He can see, upon meeting Clarissa again, that her life with Richard has somehow muted her. It irritates Peter that Clarissa has swallowed so much of the "public-spirited, British Empire, tariff-reform, governing-class spirit" that he associates with Richard, and he laments the fact that "With twice his wits, she had to see things through his eyes—one of the tragedies of married life. With a mind of her own, she must always be quoting Richard" (*Dalloway* 76-7). In one of the most striking examples of how a woman's individuality can be erased in marriage, Clarissa muses about what it means to be Mrs. Dalloway, "not even Clarissa any more; this being Mrs. Richard Dalloway" (*Dalloway* 11). Her married name "designates a fictitious persona, a social mask that disguises the former Clarissa Parry" (Henke 130). The same idea reappears at the party, this time with Lady Rosseter "(who had been Sally Seton)" (*Dalloway* 181). Woolf uses the custom of changing a woman's name at marriage to critique the basic cultural assumption that a woman's identity is not fixed and should dissolve into that of her husband. The perfect wife is revealed to be a myth or façade distinct from the real women forced to conform to its design.

In the process of assuming the lofty position of wife, Clarissa has lost much of her identity, and she is not the only one. If, as Lisa Tyler argues, there are numerous Demeter figures in *Mrs. Dalloway*, then there are also many women who have dwindled into shallow reflections of their mythologized social roles. For example, Rezia Smith contemplates Lady Bradshaw's fate,

which can reasonably be applied to many of the older women in the novel: “Fifteen years ago she had gone under. It was nothing you could put your finger on; there had been no scene, no snap; only the slow sinking, water-logged, of her will into his. Sweet was her smile, swift her submission” (*Dalloway* 100). Lady Bruton, too, who “could have worn the helmet and shot the arrow, could have led troops to attack” is “Debarred by her sex” (*Dalloway* 180). Despite their inner lives, their talents, and their desires, these women are placed upon the pedestal of ideal womanhood and deprived of agency and individuality. At its base, *Mrs. Dalloway* depicts the struggle to maintain a female identity in a male-centric culture and criticizes the Victorian social tendency to view women only in terms of their domestic social function. The ideal woman, in fact, does not exist. She is a composite myth that society lays over the identities of real women. Woolf’s consistent allusion to Greek myth highlights the long history of idealizing women as symbols representing abstract virtues, especially the all-giving mother goddess. By rewriting these ancient stories, she challenges the lingering myths of Victorian social and domestic ideology with a modernized, feminist approach to the Classics.

Yet Clarissa’s sense of self is not quite as overwhelmed as her outward behavior might at first suggest. She either cannot or will not fulfill the feminine ideal as described by Peter or Richard, which requires a social performance of wifely duties and a mental and spiritual abdication of the woman’s will in favor of her husband’s. When she was younger, Clarissa’s disinterest in performing the role of the ideal woman was even more pronounced. Only with women does she “feel what men felt,” the passion that Peter naively believes no woman can experience (*Dalloway* 32). Clarissa describes her love for Sally as pure and disinterested, “not like one’s feeling for a man” (*Dalloway* 34). The novel stresses this sense of sisterly connectedness, and in taking on Clarissa’s internal perspective, the narrator reveals the limitations of Peter’s understanding. In the present, Peter cycles through his masculine drama in which he loses Clarissa to Richard. The reader, in contrast, is immersed in Clarissa’s complex actuality that includes her past and present self. Recognizing its ability to destroy their intimacy, Clarissa and Sally “spoke of marriage always as a catastrophe” (*Dalloway* 34). Yet both women marry, perhaps inevitably, given the social pressures of the time. Just as they had feared, marriage seems to make their romantic relationship and their continued intimate friendship untenable.

Even as a married woman, however, Clarissa balks at the more spiritually costly demands of traditional femininity. While she is happy to throw her parties and appear as a respectable man’s wife, Clarissa never surrenders her inner self. She defends the need for mental and emotional space between people:

...a solitude; even between husband and wife a gulf; and that one must respect...for one would not part with it oneself, or take it, against his will, from one’s husband, without losing one’s independence, one’s self-respect—something, after all, priceless. (*Dalloway* 120)

Moreover, she often performs the roles traditionally assigned to women only to the letter. For example, she marries Richard Dalloway and has one child with him, but seems to

refuse to do any more than that. Reflecting on Sally Seton and her five sons, Peter thinks, “Now all that Clarissa had escaped, unmaternal as she was” (*Dalloway* 190). Clarissa sleeps alone like a nun in her attic room, rather than with Richard, for “really she preferred to read of the retreat from Moscow. He knew it” (*Dalloway* 31). Still, Clarissa feels that she has somehow failed Richard as his wife by not catering more to his desires, whether for emotional support or physical intimacy. She is painfully aware of what the feminine ideal means and the ways in which she declines to fulfill it. To his credit, Richard gives Clarissa the physical and emotional space she needs. Alone in her attic room, she can unwind, reminisce about Sally Seton, and read stereotypically masculine memoirs without being interrupted by the call of domesticity. Richard insists that she sleep “undisturbed” in the wake of her illness (*Dalloway* 31). Although the nature of this illness is never explicitly discussed in the novel, it is suggested that Clarissa was the victim of a flu epidemic that caused her to suffer physically and mentally, as many of Woolf’s heroines do. Clarissa appears to accept the rest cure prescribed by her doctors and Richard partially because it allows her to escape some of her wifely obligations, such as sleeping with Richard. Her willingness to comply with the doctor’s orders therefore points to her deep-seated dissatisfaction with the role of Angel in the House. She cannot reject it entirely but sees its faults and limitations. Her precarious balancing act between traditional womanhood and private self-respect therefore leads her to a compromise that combines her social duties with a mental rejection of the goddess role: “Those ruffians, the Gods, shan’t have it all their own way,—her notion being that the Gods, who never lost a chance of hurting, thwarting and spoiling human lives were seriously put out if, all the same, you behaved like a lady” (*Dalloway* 77).

It is only by preserving a strict division between her inner and outer lives that Clarissa manages to go on with relative satisfaction. Even when looking at herself in the mirror, she notes the disparity between what she knows of herself and what others see. Her reflection only looks right “when some effort, some call on her to be her self, drew the parts together, she alone knew how different, how incompatible and composed so for the world” (*Dalloway* 37). This moment at the mirror also reveals that Clarissa is aware of her mythologized state; to some extent, she is what others make of her, the symbol of a woman, more than an individual with private thoughts and feelings. Clarissa’s self-awareness on this point is almost unique among Woolf’s female characters. She seems to possess a level of self-consciousness unmatched by other prototypical mothers like Mrs. Ramsay in *To the Lighthouse*, and it is this quality that allows Clarissa to rebel quietly and subtly against the myth of the ideal woman. Clarissa embraces this double identity, since it permits her to keep part of herself separate and untainted, even if some people perceive her as cold or oddly unfeminine as a result. It allows her to cry bitterly in her bedroom when Peter Walsh accuses her of being “the perfect hostess” but to continue being the perfect hostess nonetheless (*Dalloway* 7). It is a public surrender but a private victory.

Overall, Clarissa seems to have managed better than Sally Seton, who was actually the more revolutionary of the two when they were young. While Clarissa was hopelessly naïve and knew “nothing about sex—nothing about social problems,” Sally was much more worldly (*Dalloway* 33). She covertly slipped Clarissa a copy of William Morris, and together they schemed about founding societies for reform. In many ways, the relationship between Clarissa and Sally is a rewriting of the connection between Rachel Vinrace and Evelyn Murgatroyd. However, by the time Sally appears at Clarissa’s party, she has married, produced five strapping sons, and her voice is “wrung of its old ravishing richness; her eyes not aglow as they used to be” (*Dalloway* 181). Clarissa always half expected Sally’s “daring, her recklessness” to end in “her death; her martyrdom; instead of which she had married” (*Dalloway* 182). Clarissa seems just as taken aback by Sally’s marriage as Sally is about Clarissa’s, and the close association between martyrdom and marriage in this sentence is highly suggestive.

Elsewhere in the novel, Rezia Smith’s thoughts point to the similarity between marriage and death with ominous clarity. She thinks to herself, “Every one has friends who were killed in the War. Every one gives up something when they marry” (*Dalloway* 66). The parallel structure of the sentence suggests the equality of these two forms of loss. Although she appears reasonably happy, Sally has given up her youthful, feminist vigor and become the mythic Lady Rosseter. As if to make it undeniably transparent that patriarchal society has wrung the rebellious spirit out of her, Woolf follows up with a specific example of a man attacking Sally for her progressiveness, for her claim to a voice. Sally once accused Hugh Whitbread “of kissing her in the smoking-room to punish her for saying that women should have votes” (*Dalloway* 181). This detail is far more distressing than the characters’ response to it would suggest. At the time, Clarissa managed to convince Sally not to “denounce him at family prayers,” and at the party Sally herself greets Hugh as “her old friend” (*Dalloway* 181). However, the idea that he kissed Sally as a form of chastisement reflects in miniature the patriarchy’s oppression of women both mentally (by denying them the vote) and physically (by denying them control over their bodies). Since she was more openly defiant than Clarissa, Sally may have felt the pressure to conform to traditional gender roles even more keenly. While Clarissa’s choice of a double life makes it hard for her to connect with her old friends again, it serves the vital purpose of protecting her inner self.

Clarissa’s dedication to preserving her true self leads her to feel a confused sense of admiration for Septimus Smith when she hears that he has killed himself. Suffering from PTSD and tortured by the memory of his friend Evans who was killed in battle, Septimus represents the public, first-hand victim of World War I, while Clarissa can be said to embody the private, domestic victim of war. They indicate opposing responses to tragedy, as Septimus chooses death to end his misery, and Clarissa chooses life despite her unhappiness. Though not necessarily a double for Clarissa in her Demeter guise, Septimus exemplifies a destructive, death-centered perspective juxtaposed to Clarissa’s insistence on the enjoyment of life and the fulfillment of social duties. Yet in death, Septimus succeeds in protecting

the thing “that mattered...Death was defiance” (*Dalloway* 184). Whereas Septimus escapes from a society guilty of terrible abuse, of “forcing your soul,” Clarissa fears that she has sacrificed her integrity and allowed her inner self to be “wreathed about with chatter, defaced, obscured” (*Dalloway* 184-5). In other words, she has grave doubts about her role as a mother goddess figure. Clarissa seems to equate Septimus’s suicide with her decision to live a respectable life as Mrs. Dalloway and feels “somehow very like him—the young man who had killed himself” (*Dalloway* 186).

Death would offer Clarissa a means of escape, a way to cast off the role of symbolic mother goddess, but when she looks through the window and sees the old lady going to bed next door, Clarissa finds the strength to choose life over death. The old woman is an “eternal figure of the female spirit...emblematic of the feminine life-force that endures and creates” (Henke 143-4). The old lady recalls Clarissa’s mother, who maintains a noticeably absent presence throughout the novel, and who is pictured only briefly “walking in a garden in a grey hat” (*Dalloway* 176). Seeing the woman helps Clarissa to regroup and muster her pride in herself. No longer haunted by Septimus’s suicide, she even feels “glad that he had done it,” as if his sacrificial death allows her to rediscover the goodness in life (*Dalloway* 186). Henke goes as far as to say that “as a pagan fertility goddess, [Clarissa] accepts the sacrifice, thereby displacing the father God of the Judaeo-Christian tradition” symbolized by the Christ-like Septimus (143). At the end of the novel, it is Clarissa’s brand of female-oriented devotion that emerges triumphant. Taking up the mantle of divine splendor, she returns to her party to embrace life as her guests look up with the “terror,” “ecstasy,” and “excitement” of worshipers, “For there she was” (*Dalloway* 194).

Balanced uncertainly between the pull of traditional femininity and a desire for personal freedom, Clarissa Dalloway stands as a quietly subversive feminist character. She is neither as brazenly progressive as Evelyn Murgatroyd or the young Sally Seton, nor as conservative as Mrs. Ramsay; Clarissa forges a middle path toward spiritual survival. Her close association with Demeter emphasizes her partially-embraced role as a mother goddess figure and reveals the Victorian layer of social myth-making that confines women within the bounds of idealized womanhood. However, the contrast between her inner and outer lives proves that she has not utterly surrendered to the demands of patriarchal society. Woolf’s depiction of her character is highly sympathetic. Although Clarissa’s choice to embrace a conservative life as Richard’s spouse is presented as complex and problematic, Woolf does not disparage it. In fact, Clarissa’s conservatism can be interpreted as a kind of rebellion in itself, since she uses it to protect herself and maintain her identity. Clarissa represents a valid form of femininity poised between tradition and the need for change; the narrative does not force radicalism on her, but suggests a more modern, feminist trajectory for the next generation embodied by Elizabeth.

In *Mrs. Dalloway*, Woolf addresses the effort to preserve female individuality and autonomy in the face of a society bent on reducing women to abstract, mythical ideals. The

novel focuses on the connections between women—between mothers and daughters and between lovers. As Henke puts it, the novel “tacitly questions tyrannical authority in all its forms, from nationalistic power-mongering to conjugal appropriation” (128). The narrator submerges the reader in Clarissa’s fluid identity and uses the intimacy between reader and character to create a sororal community. The memories of her past relationship with Sally and her current relationship with Elizabeth bolster Clarissa in her daily life, even when these sisterly bonds stretch or break under the strain of external social pressures. Quietly, in the background of dinner parties, politics, and the hum of city life, Woolf reveals a kind of sisterhood that sustains her female characters and aids them in resisting oppression on every level.

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*“A Torment to Lay Upon the Damn’d”:
Demonological Characterizations
of the Cannibal and Witch
in Shakespeare’s The Tempest*

*The University
of Texas
at Austin*

*Undergraduate
Research Journal*

*Volume 14
Number 1
Fall 2015*

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The historical sources of *The Tempest*, as well as its invocation of generic conventions of the travel narrative and other New World literature, lend the play to historicist modes of interpretation. In the last few decades, most scholarly readings of the play bring those characters most directly associated with the New World, the monstrous native Caliban and his mother, the witch Sycorax, into a contemporary context where they represent the voiceless victims of Western colonialism. These readings, however, often overlook the critical symbolic roots of the characters, the tropes of the “cannibal” and “witch,” as

well as their demonological and Satanic associations, all of which would have been familiar to Shakespeare's audience. These tropes, through their association with the oppressed figures of natives and women, are the previously unspoken foundation for any complete postcolonial or feminist reading of the text.

As European colonists moved into the New World, they engaged in the systematic categorization and definition of the groups they encountered in such a way as to render these populations distinct and "other" from themselves; at home, they did the same in the European witch-hunts, justifying the slaughter of thousands. They accomplished both of these goals through the use of rhetoric that made the Other, whether an American native or a European woman suspected of witchcraft, into a metaphorical "monster," something less than human. The tropes of the "cannibal" and the "witch" swiftly became common in New World literature, and Shakespeare adopts them in *The Tempest* to draw upon the conscious and unconscious fantasies of the European audience. Moreover, by juxtaposing the cannibal and witch with the Montaignean glorification of the natural world that subtends *The Tempest*, Shakespeare forces a recognition of the anxieties and tensions inherent in European perceptions of colonialism and the New World.

The Demonological Roots of the Other

Shakespeare's use of the cannibal and the witch in *The Tempest* may at first glance appear to be a linking of two unrelated Renaissance fantasies. However, there are key structural similarities between New World travel narratives and the literature of European witch-hunts: namely, their use of monstrous imagery to create a demonized Other. The tropes of the cannibal and the witch provided an opportunity to explore phobias embedded in patriarchal and colonial European culture, such as the fear of both corporeal and cultural consumption that informs the characterization of the cannibal, and the fear of female sexuality that informs the characterization of the witch. For the cannibal, there is the travel literature of the New World which defines the "savage" native as an Other distinct from the European group along the lines of political organization, religious belief, cultural practice, and appearance. Such acts of categorization for the sake of reinforcing group identity would later be termed a "science of the other" or a "heterology" by de Certeau.¹ For the witch, there is the European phenomenon of "demonology" which was similarly used to legitimize the enterprise of "witch-hunting" during the 15th through 17th centuries.

The complementary development of the two tropes is most evident in the structural and thematic overlap between New World travel literature and demonological writings. In many ways, one can think of demonology itself, from the modern perspective, as a heterology in the vein of de Certeau, a science for systematically creating difference between group identities, and one that bears a great resemblance to the system of native categorization employed in the literature of the New World. In his *Writing of History*, de Certeau notes this resemblance; although "travel literature has not yet been studied systematically as a

great complement to and displacement of demonology... the same structures are common to both.”² This connection later appears in a more developed form in the work of Mello e Souza, who draws upon de Certeau’s concept of heterology when she writes, “the threat of the other was defined and classified in the most negative and derogatory terms available within the cultural confines of the conquerors and colonizers of America. The discovery of New Worlds not only rekindled the symbolism of the marvelous, but also reinforced European demonology.”³ The use of spiritual and demonological rhetoric to categorize the exotic character of the New World appears in a number of contemporary writings, such as Ludwig Lavatar’s “Of Ghostes and Spirites Walking by Nyght,” (1572) which states that “in the Newe World... there is nothing more common than, not only in the night time but also at noone in the midday, to see spirits apparently, in the cities and fields, which speake, command, forbyd, assault men, feare them, and strike them.”⁴ The same source explicitly demonstrates the connection in the European mind between the cannibals of the New World and the evil spirits of demonology: “They which sayle on the greate Ocean sea make reporte, that in certayne places where the anthropophagi doo inhabite, are many spirites, which do the people there very muche harme.”⁵ The distinct relationship between the tropes and the cultural rhetoric used to explain and define them can also be seen in travel narratives, such as Jean de Lery’s use of imagery of the witches’ Sabbath to explain the ritualistic dancing of the Tupinamba⁶, or Andres de Olmos’s appointment to the New World as the first bishop of New Spain on the basis of his status as an experienced witch-hunter in Europe.⁷

The cultural function of heterological discourse in delineating the boundaries between the civilized European and the monstrous cannibal or devilish witch explains the consistent and widespread use of demonological discourse in New World and early modern literature. By categorizing cannibals and witches’ powers through demonology, Europeans claimed control over the “misfortunes, temptation, religious conflict, and spiritual ambiguity” which characterized European life at the time.⁸ This relationship can be seen, for example, in the way the fantasy of the cannibal deals with group (and individual) fears of “devouring, dismemberment, and rage”.⁹ By fixing such chaotic forces within a carefully delineated method of categorization, the objects of anxiety are given controllable boundaries and structures. At the same time, they are defined as the Other, distant and separate from one’s own group. De Certeau explicates the psycho-social stakes of this process of categorization in his *Heterologies*:

[W]hen [the cannibal] sidesteps the identifications given to him, he causes a disturbance that places the entire symbolic order in question. The global delimitation of ‘our’ culture in relation to the savage concerns the entire gridding of the system that brushes up against the boundary and presupposes... that there is a place for every figure.¹⁰

This period in Renaissance Europe was historically and psychologically fraught. It was a time of religious and political upheaval at home, and the European concept of self was blurred by the growing boundaries of the known world. These circumstances effectively

demanded the creation of new narratives and new categories of the Other against which to define the European group identity. As such, the integration of such fantastic figures as the cannibal and the witch into the dramatic structure of *The Tempest* is a reflection of the forces that spurred their very creation: the demonological process of establishing an Other.

Caliban, the Devil's Son

Given the historical roots of *The Tempest*, it is no surprise that the work incorporates a number of tropes from 16th and 17th century travel narratives, such as the shipwreck, the presence of spirits, and the mysterious island.¹¹ Chief among these, of course, is the character of Caliban, who seems specifically designed to represent the American native. As detestable as Caliban might be to the other characters in the play, who describe him in almost exclusively bestial terms, Shakespeare's dialogue presents Caliban as the victim rather than the villain.¹² Caliban's claim of ownership over the island, which, he says to Prospero: "thou tak'st from me" (I.ii.331-2), invokes the situation of the native in "the natural world" employed by Montaigne in his essay, "On Cannibals." Additionally, Montaigne's contrast of the "noble savage" and the "barbarous European" is suggested in Caliban's regret at having welcomed the European Prospero to the island – "I loved thee and show'd thee all the qualities of the isle... cursed be that I did so!" (I.ii.343-347). This reversal of roles in which the Europeans are shown as "savage" also brings to mind the documents of native mistreatment and exploitation then recently published by Las Casas (1552) and Montaigne (1580). Drawing upon these relationships, many contemporary scholarly readings of *The Tempest* focus on the dynamic between Prospero (the anagrammatic "oppressor") and Caliban (the "cannibal") as having "acquired renewed currency as a social-political metaphor on colonialism and cultural imperialism."¹³ In these readings, Caliban, "loser of his birthright and recipient of an imposed foreign language – has been restamped," his attempted rape of Miranda and his treachery against his master Prospero overshadowed by the fact of his exploitation and slavery.¹⁴

These readings astutely identify Caliban's characterization as something like Montaigne's "noble savage." However, they overlook the demonological and Satanic associations of the character, and their relationship to the European idea of the savage. These associations would have been especially familiar to the play's first audience, King James's court. Shakespeare scholar Jacqueline Latham has shown that King James I's *Daemonologie* was a major source for the creation of Caliban.¹⁵ Moreover, the descriptions throughout the text of Caliban as a deformed half-human, half-monster hybrid directly reference the popular "bestiaries" of the 15th and 16th centuries. Just as such tomes were used to characterize American natives as something other than "human" by ascribing to them traits of "animality or deformity," they were also used to invest Caliban the native with a recognizable animalistic or monstrous descriptor.¹⁶ In particular, Trinculo's description of Caliban as a "puppy-headed monster" (II. ii.154) likely derives from the mythical dog-headed flesh-eating creature, the "Cynocephalus"

lus,” perhaps by way of Columbus or Marco Polo, both of whom wrote about such creatures in their travel narratives.¹⁷ Another possible origin for Caliban’s monstrous appearance is suggested by Trinculo’s description of him as resembling both a man and a fish (II.ii.25). In his 1597 travel narrative, Friar Joanno Dos Sanctos described the discovery of such creatures in the New World: “a sea monster which we saw neere the River Tendanculo... eares of a dog, armes like a man without haire, and at the elbows great finnes like a fish; two short feet nigh his tayle, plaine like a great Apes... [the Cafres] had thought him (they said) the sonne of the Devil.”¹⁸ This theme of Satanic parentage is consistent with the textual lineage of Caliban’s character, whom Prospero claims to have been “got by the devil himself upon [his] wicked dam” (I.ii.324-326). In this light, Caliban’s attempted rape of Miranda suggests another source in the demonological figure of the incubus, a creature who “sometimes a devil, [...] takes the form of a man in order to seduce women to illicit sexual relations.”¹⁹

Caliban’s lack of language when Prospero and Miranda arrive on the island and the imposition of Prospero’s language onto him are central to many postcolonial readings of the character. Greenblatt points out that the colonial standard for “civilized language” rejected utterly the existing language of native societies and judged them by “whether they had been able to master a language that ‘men’ could understand.”²⁰ As such, Caliban is described as “gabb[ling] like a thing most brutish” (I.ii.51); this feature also has its roots in the demonological. A passage from Reginald Scot’s 1584 “Discourse of the Nature and Substance of Devils and Spirits” demonstrates the close relationship between the devilish incubus, the witch-like figure of the corrupting woman, orality and language, and the marginalization of foreign cultures:

...another sort [of devil] are the incubi and succubi, of whom it is reported that the Hunns have the original, being begotten betwixt the incubi, and certain magical women whom Philimer the King of the Goths banished into the deserts, whence arose that savage and untamed nation, whose speech seemed rather the mute attempts of brute beasts than any articulate sound and well-distinguished words.²¹

Sycorax the Corruptor

Just as Caliban has become a common figure in postcolonial readings of *The Tempest*, the absent figure of his mother, the witch Sycorax, is often the subject of contemporary feminist readings of the text. In such readings, the complete absence of Sycorax from the text and her consequent invocation only through the memories of Prospero is textually significant, demonstrating the ways in which figures of patriarchal power such as Prospero silence the feminine voice.²² Notably, even though Sycorax and Prospero are both exiles from their homes, Prospero still maintains a powerful sovereignty over the island as a master of slaves²³, as the custodian of Miranda’s virtue, and as a figure with the ability to define Sycorax in her absence.²⁴ Such readings coincide with the postcolonial readings of the text; the marginalizing of Sycorax, the wild figure who must be conquered, and the fixation upon

Miranda, the virgin who must be protected before being systematically consumed, recall representations of the New World itself as a feminine body in writers such as Columbus and Vespucci.²⁵

As with the postcolonial readings of Caliban, recognizing the origins of the witch trope in Sycorax's character strengthen feminist readings of the play. Just as Shakespeare drew upon the origins of the cannibal figure in his depiction of the native Caliban, he similarly drew upon the demonological figure of the witch to perform a heterological function, characterizing Sycorax with symbols which would have been readily recognized by his audience (again, especially the first audience of King James and his court). Even the most cursory reading reveals clues which associate Sycorax with the European witch, such as her "mischiefs manifold and sorceries terrible/To enter human hearing" (I.ii.264-265) and her command of such traditionally Satanic animals as "toads, beetles, [and] bats" (I.ii.347). Just as Caliban's appearance is rooted in demonological origins, the characterization of Sycorax also emerges from the categorizations of demonology. This emergence is notable because, in many ways, the Western representation of the witch is an outgrowth of the Western fantasy of the cannibal. Zika notes the existence of engravings from the late 1580s which show congregations of witches feasting on the corpses of children alongside native cannibals; clearly, the later conception of the witch as a demonic sexualized female had its roots in the representative metaphor of the "savage figure" as "an evil mother, who killed and ate young children."²⁶ Over time, the trope of the witch would evolve into a metaphor of "anti-nurturing" with prominent visual iconography of sagging milk-less breasts and inversions of common "mother and child" compositions.²⁷ The trope began as a representation of "the transgression of natural feminine and maternal tendencies" and eventually expanded into a metaphor of "a moral disorder, based on a female sexuality which is perceived as essentially aggressive."²⁸ It is plain how such metaphors inform the characterization of Sycorax. Her representation as a "blue-eyed hag" (I.ii.36) not only calls upon folkloric associations of the "evil eye"²⁹ but also the evil mother who, like Medea³⁰, stifles patriarchal lineage through the murder and consumption of children, and whose corrupt sexual congress with evil spirits represents the antithesis of Miranda's idealized "pure" sexuality. In short, despite her silence, the witch Sycorax may be seen as "the disembodied symbol of men's most terrible fears," a symbolic status that is attainable only because of her placement in Europeans' demonological categorizations.³¹

The Public Consumption of the Play

Thus far, Shakespeare's use of monstrous qualities to characterize Caliban and Sycorax draws upon similar monstrous rhetoric employed in the literature of the New World. However, this monstrous characterization is also notable as a response to other prominent characterizations of the New World popular in Europe at the time. The most significant of these is Montaigne's essay, "On Cannibals." This essay, written in 1580, popularized the

trope of the “noble savage.” In 1562, Montaigne had met a New World native, supposedly a cannibal, who had been brought back to France by the explorer Villegaignon. From the account given by this native, as well as that given by one of Montaigne’s servants who had spent a decade in the New World, Montaigne developed an appreciation for what he saw as a “noble” way of life, characterized by cooperative labor and living in harmony with nature. In his essay, Montaigne contrasts this noble existence against the European way of life, which he denounces for its corruption and usurpation of the natural world. He does this by citing examples of native nobility such as the lack of slaves and rigorous social classes in their societies. The critic Dudley Marchi has noted a textual dynamic at work in this famous essay which mirrors the cannibalistic theme. Montaigne, he argues, produces “a cannibalistic dynamism in his writing” by absorbing the narratives of the Other, analyzing those narratives through the lens of Western thinkers such as Plato, Seneca, and Virgil (all quoted in “On Cannibals”), and then producing a dialectical response that “refuse[s] ethnocentrism and subvert[s] Eurocentric intolerance by counteracting hegemonic ideologies.”³²

When Shakespeare employs the use of European tropes in his play, he does so in a manner similar to Montaigne, using the tropes with a critical awareness of their origin and the role they play in European anxieties. For instance, when Shakespeare characterizes Caliban not only as the feared demonic cannibal of travel narratives, but also as a victimized and sympathetic figure whose land has been consumed, he exposes the fear of cultural consumption that led Europeans to create monstrous fantasies of the Other as a tool against which to define their own identity. In doing so, Shakespeare engages with the cannibalistic textual dynamic employed by Montaigne, who “mediates between an utopic vision of the New World and a... criticism of the French and European political order while manipulating the character of anthropophagy within the event of writing in order to produce ‘cannibalism’ as a textual dynamic.”³³

As a work of fiction, however, *The Tempest* carries this textual dynamic of cannibalizing historical discourse for literary purposes even further than could be done by the travel narratives or Montaigne’s essays. In his *Heterologies*, de Certeau states that “literature is the theoretic discourse of the historical process... [...] a logical discourse of history, the fiction which allows it to be thought.”³⁴ In other words, through incorporating the demonological heterologies inherent in the European idea of the New World, as well as specific tropes such as the ship-wreck and Montaigne’s discourse on nature, into the plot of *The Tempest*, and then displaying that incorporated content to a European audience, Shakespeare is, consciously or not, showing that audience a truly comprehensive image of European society at this point in history. This image is one which seeks to include not just the self-constructed narrative of Europeans as noble and civilized men heroically subjugating demons and savages, but also the contradictions that complicate that narrative.

Despite working in fiction, Shakespeare uses many of the conventions associated with non-fictional forms such as the travel narratives of Columbus, de Lery, and Staden, or the

essays of Montaigne, turning them to his own dramatic purposes. Upon seeing Caliban, Trinculo comments that...

...[in England] would this monster [Caliban] make a man; any strange beast there makes a man. When they will not give a doit to relieve a lame beggar, they will lay out ten to see a dead Indian (II.ii.26-32).

This line not only uses the language of the travel narrative, marking Caliban as a “strange beast” who is not quite a man, but also draws attention to the popular demand for such narratives among Europeans. This juxtaposition brings the content of travel narratives, and their attendant tropes, into question by showing the literary, rather than purely historical or anthropological, character of these writings.

Trinculo’s commentary is followed by Gonzalo’s fantasy of recounting the tale of the island to the people of Naples:

If in Naples
I should report this now, would they believe me?
If I should say I saw such islanders...
Who, though they are of monstrous shape, yet note,
Their manners are more gentle-kind than of
Our human generation, you should find
many – nay, almost any (III.iii.27-34).

Here, Gonzalo imagines telling Naples about the noble and well-mannered character of the natives, and asserts that no one would believe him. The people of Naples would seemingly prefer a sensationalist tale of the superiority of European society. Both of these speeches invoke the divided nature of the travel narrative, as the authors of such narratives were torn between a desire to titillate (and sell copies) and a desire to convey historical or anthropological truth. When the play is performed for an audience, its structural and metaphorical invocations of those earlier works force the audience to recognize the literary character of works previously seen as authoritative, non-fictional documents of history and anthropology. By dramatizing the tropes used in the literature of the New World, Shakespeare is effectively appropriating those works and then going one step further by preparing them for mass public consumption as well. Like Montaigne, he is consuming narratives of European superiority and placing them alongside problematic characterizations of Europeans, using the juxtaposition to deliver a dialectical critique.

If one considers *The Tempest* as not just a popular entertainment but also a work that, through its public consumption, performs a type of critique, then elements of the play such as the two speeches above, or Gonzalo’s speech on utopic society (II.i.148), have a double function. Not only do they directly quote Montaigne’s glorification of the natural world in his “On Cannibals,”³⁵ but they also coincide with the characterizations of Caliban and Sycorax to illustrate the tensions between that glorification and the negative social perceptions of the

New World inculcated by travel narrative. As an example of this tension, one might consider that while Caliban is characterized in such a way that he unmistakably draws upon the European trope of the cannibal, it is an incomplete characterization. He shows every aspect of the cannibal except the most central one; never in the play does he eat human flesh or even mention it as a practice. By drawing upon such tensions, *The Tempest* recognizes the endemic nature of these monstrous tropes, their origin in European anxieties of consumption and moral corruption, and situates them in the emerging context of a critique that used the natural world of the native as a means to illuminate the “barbarism” of Europe itself. As “Shakespeare transfigures these different sources from written report into dramatic action,” he does more than repeat the sensational tales of his predecessors; as the fantasies of Trinculo and Gonzalo make clear, he “reflect[s] on European responses to the various shapes and shades of human otherness.”³⁶ These responses, laid before the audience through the play, constitute an arena in which the Other is confronted at last not as cannibals or witches but as a reflection of one’s own fears, a dark image of the self “against whom the most painful battles are played out.”³⁷

The ending of the play provides the best example of how this troublesome concept of “the natural,” as both the frightful symbol of the native’s rejection of civility, as well as the glorified antithesis to the demonic supernatural, aids the integration of Montaigne into the play’s complicated mixture of psychological fantasies. Prospero can be read in terms of Montaigne’s veneration of the natural over the European, as Prospero represents a fantasy of being able to control, shape, and define the wild and untamed natural world. However, the fact that he does this through supernatural (or even demonic) means presents a paradox for the audience to consider. Prospero represents the rebuttal to Montaigne through the European dominance over nature, but he does so in a way that reveals his own close relationship to the demonic qualities Europeans condemn. Because of the particular interactive nature of a theatrical performance, this paradox is presented in a way that demands the audience’s active judgment. In Prospero’s famous epilogue, he effectively denies the audience an ending to the play. The audience must provide, through their applause, a happy ending in which Prospero’s actions are vindicated and order (but not natural order) is reinstated as he regains his title and lands. Alternatively, the audience can provide, through their withholding of applause, a tragic ending in which Prospero the oppressor is undone by his inability to relinquish control over the natural. The paradox suggested by situating Montaigne next to monstrous depictions of natives is made explicit in that choice. Should the audience choose to condemn Prospero, they acknowledge the value of the demonic and cannibalistic Other antithetical to their own group identity. Should they choose to vindicate Prospero, they legitimize the conscious use of the demonic to control an unknown and frightening nature. In this latter case, they would be acknowledging their own complicity in the creation of that demonic and cannibalistic Other for the same purpose: the control of the unknown and frightening New World. Any audience that attempts a resolution of this paradox must come face to face with the discovery of their own group identity within the monstrous.

The demonological reading of the play's source material is critical because it reveals the ways in which *The Tempest* operates in a context of historical conflict. When viewing the play through a modern lens by applying a postcolonial or feminist reading, it is necessary to recognize the ways in which the play itself reveals an awareness of the conflicted status of figures such as Caliban and Sycorax. Shakespeare's play "undermines [the] old certainties" of the European audience by asking them to acknowledge the problematic nature of their group identity and its associated fantasies, through the public performance of those fantasies in a work of historically-informed literature.³⁸ When an artist such as Shakespeare explicitly portrays the fears of a social group in a publicly consumed work of art, the purpose is typically to "purge the evil from the social body, and restore society to a state of health and purity" through the voicing of those fears.³⁹ Reinforcing group identity through satirizing or lampooning – and thus diminishing – threats to that identity has been a function of literature at least since Aristophanes. Shakespeare is not doing only that, however. His use of the cannibal and witch in *The Tempest* isn't meant to reinforce European group identity, but to provide the means by which to critique it. This critique goes beyond that delivered by Montaigne, who points out faults in European society by way of comparison to some of the peaceful practices of New World societies. Shakespeare not only points out faults and contradictions in the European ideas of the cannibal and witch, but shows how the most feared aspects of those creations originate within the Europeans themselves. By revealing the contradictions in these social fears of the Other through their embodiment in Caliban and Sycorax, Shakespeare's play draws attention to the origins of those fears. Through interacting with the play, the audience is asked to consider whether those fears are properly situated in the Other at all, or whether they are simply misplaced European anxieties, wrongly projected onto the New World and its inhabitants. In this way, Caliban and Sycorax, the symbols of evil for many Europeans, must be recognized by the audience as challenges to the authority of demonological heterology and, by extension, European categorizations of themselves and the New World. Future postcolonial and feminist readings which incorporate these demonological sources and the complications presented by the play, may read Caliban and Sycorax not merely as victims of oppression, but as mirrors which reveal the monstrosity of their own oppressors.

Endnotes

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5. Lavater, *Ghostes*, 75. Also quoted in Hankins, "Caliban," 795.
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Evolutionary Game Models of Optimal Nuclear Weapons Strategies

*The University
of Texas
at Austin*

*Undergraduate
Research Journal*

*Volume 14
Number 1
Fall 2015*

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ABSTRACT

In this paper I investigate the theoretical underpinnings of nuclear proliferation and disarmament arguments through game theoretical models. I then simulate evolutionary games of these models using genetic algorithms to predict whether or not simple-minded agents would over time reach the equilibrium strategy defined by each theory. After adding a stochastic parameter to the model to account for possible nuclear war or catastrophe, I find that the equilibrium strategy profile consists of a mixture of armed and disarmed strategies rather than converging to either completely armed or completely disarmed,

as in the first model. These results suggest that if nations behave similarly to actors in an evolutionary game model, then as long as the probability of nuclear war or catastrophe is less than one, global disarmament, if it occurs, will not be a stable equilibrium.

Introduction

Since their creation, nuclear weapons have sparked fierce debate among military strategists and politicians over the costs and benefits of possessing nuclear arms. Proponents of nuclear weapons armament argue that nations that possess nuclear arms can successfully deter threats from other nations, thus avoiding conventional warfare and leading to greater global stability (Rauchhaus 2013). Proponents of global disarmament reject this argument and claim that the existence of nuclear weapons will ultimately lead to catastrophe, either due to the escalation of conflict between nuclear powers or due to the misuse of a nation's command and control systems (Shultz 2007, Schlosser 2013). In this paper I investigate the theoretical underpinnings of the proliferation and disarmament arguments through game theoretical models. I then simulate evolutionary games of these models using genetic algorithms to predict whether or not simple-minded agents would, over time, reach the equilibrium strategy defined by each theory.

Debates Over Nuclear Disarmament

One of the most compelling arguments for the possession of nuclear weapons is grounded in Deterrence Theory. This theory claims that a nation can deter another nation from upsetting the status quo by preparing a threat of retaliation such that the cost of upsetting the status quo would exceed any potential benefits (Quackenbush, 2009). Kenneth Waltz (1981) and others have argued that due to the extremely high costs of nuclear war, nations armed with nuclear weapons can successfully deter other nations from mounting an attack. Todd Sechser and Matthew Fuhrmann (2013) used empirical data to examine the effectiveness of nuclear deterrence and found that while nuclear weapons could not be used to blackmail enemy states, they were effective in deterring threats from other states, thus providing further support for deterrence theory. Deterrence proponents conclude that the presence of nuclear weapons can, somewhat paradoxically, reinforce international peace rather than incite conflict.

However, in recent years, a growing number of scholars and military experts have begun to make arguments for global nuclear disarmament. In 2007, George Shultz, William Perry, Henry Kissinger, and Sam Nunn published an op-ed article in the *Wall Street Journal* in which they advocated for nuclear disarmament. The authors claimed that while nuclear deterrence remained an important strategy for many nations, these nations' reliance on nuclear deterrence has become "increasingly hazardous and decreasingly effective." They also noted that a deterrence strategy would fail against non-state terrorist groups possessing nuclear arms, thus leading to new challenges in the nuclear era. Shultz *et al.* warned

that inferior command and control systems used by new nuclear states may fail to prevent catastrophic nuclear accidents similar to those that almost occurred during the Cold War, leading to extremely negative outcomes for nations in the long term. Many U.S. presidents have also advocated for disarmament, including President Barack Obama who in 2009 vowed to take steps towards global nuclear disarmament, although he has received little support from global leaders (*The Economist* 2009). Critics such as Sergei Karaganov (2010) argue that the movement towards “Global Zero,” or a world without nuclear weapons, is an ideal that cannot be achieved or sustained.

The arguments for and against nuclear disarmament are often based on the idea that nuclear powers arrive at certain conclusions through rational decision-making, although it may be incorrect to assume that all military decisions are strictly rational. This paper contributes to existing research by analyzing several variations on deterrence theory to test whether selective evolution of a population of nuclear states will arrive at the same conclusions proposed by the theories above. I also expand on the evolutionary game model with genetic algorithms from *Computational Economics* by David Kendrick, P. Mercado, and Hans Amman (2006). The original model only allows for two strategies per player. I alter this in Experiment 2, allowing each player to choose from one of four strategies. Then in Experiment 3, I add a stochastic parameter to the model to allow for uncertainty.

Methodology

To test deterrence theory and arguments for nuclear disarmament, I used an evolutionary game model with genetic algorithms and alter the model over the course of three experiments to more closely simulate the complexity of real world scenarios (Kendrick, Mercado, and Amman, 2006). I first tested a simple deterrence game with no probability of nuclear catastrophe. I then altered the model to test more sophisticated strategies according to deterrence theory. Finally, I included a stochastic variable in the model to account for the probability of nuclear catastrophe. The design and results from each experiment are listed below.

Experiment 1: Simple Deterrence Game

I first used a simple deterrence game to simulate the equilibrium strategies in a world where states can choose either nuclear armament or disarmament. The evolutionary game model uses binary strings to identify a sequence of strategies for each nation. In my version of the evolutionary game model, the values “0” and “1” correspond to the two possible states, “armed,” and “unarmed.” I assume that changing policies and governments enable nations to switch between “armed” and “unarmed” from one period to the next. Each individual game is thus comprised of two nations in conflict, each either armed with nuclear weapons or unarmed with nuclear weapons. In this simple example, there are three events that can occur:

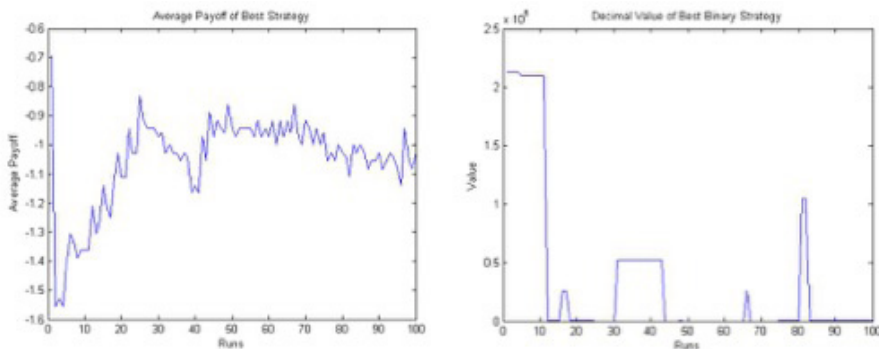
1. Armed vs. Armed: This will result in a cold war in which both countries are harmed, but not as much as in conventional warfare.
2. Armed vs. Unarmed: This will result in the unarmed nation conceding to the armed nation.
3. Unarmed vs. Unarmed: This will result in conventional warfare.

I then defined the payoff matrix as:

	Armed	Unarmed
Armed	(<u>a</u> , <u>a</u>)	(b , c)
Unarmed	(c , b)	(<u>d</u> , <u>d</u>)

Where $d < c < a < 0 < b$, and the payoff of the best response for each player based on the moves of the other player is underlined. The payoffs are defined based on the utility of each outcome for each player relative to other outcomes. A cold war, although costly for both nations, is preferable to conventional warfare or being coerced by a nuclear power, thus the payoff “a” is greater than both “c” and “d”. In this case, the dominant strategy for both players is to obtain nuclear weapons capabilities. The cost of conventional warfare is presumably less than the cost of the concessions that an unarmed nation must make to an armed nation, thus “d” is greater than “c”.¹ The Pareto optimal solutions in this game are {Armed, Armed}, {Unarmed, Armed}, and {Armed, Unarmed}. The dominant strategy for both nations is {Armed}, thus a rational player should obtain nuclear weapons regardless of the decisions of the other player. To test whether the evolutionary game reaches the dominant strategy in equilibrium, I ran the model in MATLAB and input the following values for each variable: $\langle a, b, c, d \rangle = \langle -1, 1, -2, -3 \rangle$

A simulation of this game yielded the following results:



The payoffs quickly converged to the area around -1 and the best strategy after 100 runs was: “000000000001000000000000” which corresponds to possessing nuclear weapons in (almost) every period, a strategy profile almost identical to what a rational player would choose. The average payoff for the best strategy profile in this simulation was -1.

Experiment 2: Complex Deterrence Game

When there exists an asymmetry in nuclear weapons between nations, the outcome of a conflict depends on which nation is acting as the aggressor (Sechser and Fuhrmann 2013). For example, if a nuclear state is attempting to coerce a non-nuclear state through “nuclear blackmail,” the threat often fails, and the aggressor resorts to conventional warfare (Sechser and Fuhrmann 2013). On the other hand, if a non-nuclear state is acting as an aggressor against a nuclear state, the nuclear state can use the threat of nuclear retaliation to deter conventional warfare (Sechser and Fuhrmann 2013). Because the simple model in Experiment 1 assumed that both countries were initiating the conflict, it failed to make this distinction.

Using this logic, I added a layer of complexity to the existing model by allowing each nation to pursue a strategy of “armed” (0) or “unarmed” (1), along with being “offensive” (0) or “defensive” (1). The payoffs for possible scenarios are similar to the original model, except an armed nation can no longer coerce an unarmed nation with a nuclear threat. Instead, an armed offensive nation in conflict with an unarmed nation will result in conventional warfare. Likewise, an armed but defensive nation will deter an attack from an unarmed offensive nation. Finally, if both nations pursue defensive strategies, the conflict will not result in an attack from either side, regardless of whether the countries are armed or unarmed. I then defined the new payoff matrix as:

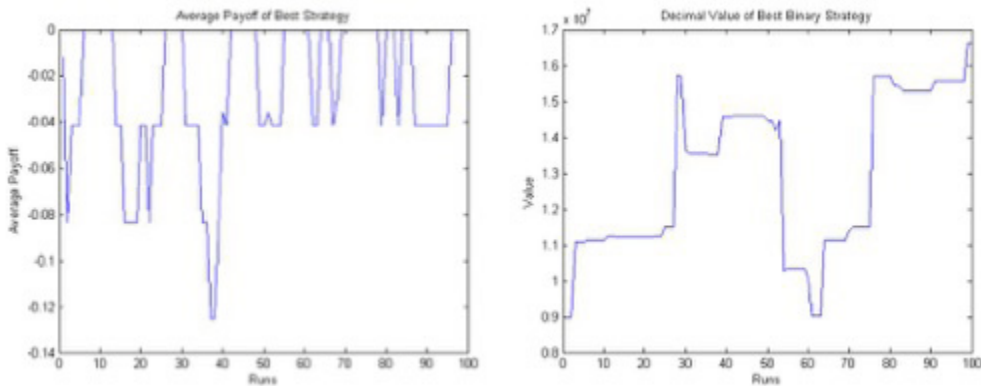
	AO	AD	UO	UD
AO	(<u>a</u> , <u>a</u>)	(a, <u>a</u>)	(d, d)	(d, d)
AD	(<u>a</u> , a)	(<u>0</u> , <u>0</u>)	(<u>0</u> , <u>0</u>)	(<u>0</u> , <u>0</u>)
UO	(d, d)	(<u>0</u> , <u>0</u>)	(d, d)	(d, d)
UD	(d, d)	(<u>0</u> , <u>0</u>)	(d, d)	(<u>0</u> , <u>0</u>)

In this new scenario, each strategy corresponds to a pair of integers rather than one integer:

$$\{AO, AD, UO, UD\} = \{00, 10, 01, 11\}^2$$

I then modified the model so that the algorithm would read and interpret each pair of numbers as a unique strategy rather than reading one number by itself. To avoid re-reading the same numbers, I then added a command to shift the mask twice instead of once after each iteration.³ The final code is listed in the appendix under Experiment 2.

A simulation of this game yielded the following results:



The simulation selected the sequence “11110110111101111110111” as the best profile, which corresponds to the following strategy: {UD, UO, UD, UD, UD, UD, UO, UD, UD, AD, UO, UD, UD}. This model did not converge to a single repeated strategy, which is most likely related to the fact that no strategy strictly dominates the other strategies in the payoff matrix. Additional simulations of this model yielded similar strategies, with “AD,” “UD,” and “UO” appearing often. The strategy “AO” rarely appeared in the best strategy profile, which is likely due to the fact that it is only weakly Pareto optimal if the other player also plays “AO.” The average payoff of the best strategy is zero.

The results from this simulation are similar to the current strategies of nations around the globe, with unarmed nations engaging in offensive and defensive strategies, while stable nuclear powers engage in mostly defensive strategies. In the final experiment, I add instability to the model to see how nuclear armament is affected.

Experiment 3: Complex Deterrence Game with Uncertainty

Advocates for global disarmament cite the inherent risks with nuclear weapons as a main argument against nuclear weapons (Shultz 2007). One of the sources of this risk is brinkmanship; for a nuclear threat to be taken seriously during either the cold war or a confrontation between a nuclear state and a non-nuclear state, it is not necessary that the nuclear state commit to the deliberate use of nuclear weapons, but only that the nuclear state allows for the possibility of accidental escalation to the use of nuclear weapons. Another source of risk is thorough accidental nuclear catastrophe, when the failure of a nation’s command and control system results in the detonation of a nuclear warhead on the nation’s own land.⁴ Additional sources of risk include the possibility of rogue states gaining nuclear weapons capabilities, or nuclear states with command and control systems that leave their weapons vulnerable to extremist groups. Disarmament advocates claim that this uncertainty leads to negative outcomes for all nations in the long run, and thus rational nations should push for global disarmament (Shulz 2007). I modify the payoff matrix from Experiment 2 to account for the risks associated with possessing nuclear weapons.

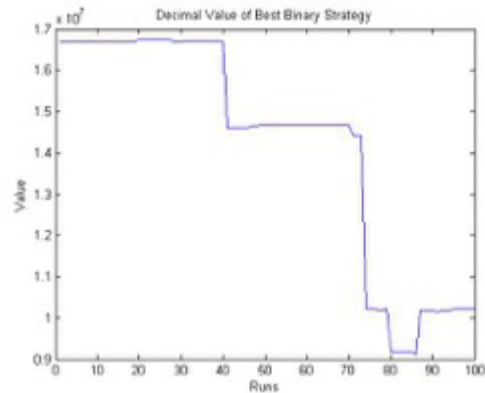
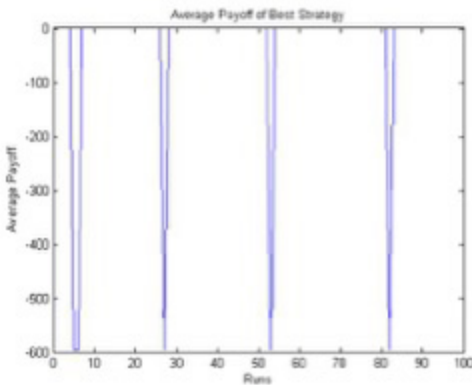
	AO	AD	UO	UD
AO	$(a-u*f, a-u*f)$	$(a-u*f, a-u*f)$	$(d-u*f, d-u*f)$	$(d-u*f, d-u*f)$
AD	$(a-u*f, a-u*f)$	$(u*g, u*g)$	$(u*g, u*f)$	$(u*g, 0)$
UO	$(a-u*f, a-u*f)$	$(u*f, u*g)$	(d,d)	(d,d)
UD	$(a-u*f, a-u*f)$	$(0, u*g)$	(d,d)	$(0,0)$

In this case, “u,” short for “unstable” is an indicator variable defined as:

$$\text{unstable} + \begin{cases} 0 & \text{if } rand < 1 - r \\ 1 & \text{if } rand > 1 - r \end{cases}$$

The variable “r” refers to the probability of a nuclear catastrophe. Thus if r = .001, then in 999 of 1000 possible nuclear incidents, the indicator variable will equal 0 and the payoffs will be identical to those in experiment 2. Likewise, in one out of every 1000 possible incidents, government instability or poor command and control systems will result in nuclear catastrophe. The variables “f” and “g” equal the cost of nuclear warfare and nuclear catastrophe, respectively.⁵

After adding the uncertainty indicator variable and risk payoffs to the model and setting up the model so that r = .999, f = 100,000, and g = 50,000, I obtain the following results:



The final code for this model is listed in the appendix under “Experiment 3.” The simulation selected the sequence “100110111110011110101010” as the best profile, which corresponds to the following strategy: {AD,AD,AD,AD,UD,UO,AD,UD,UD,AD,UO,AD}

Once again, the model does not converge to a single strategy. Neither does the model converge only to unarmed strategies, despite the risk associated with nuclear weapons. A significant increase in the probability of catastrophe leads to a decrease in the instances of armament strategies in the best profile, but even for high levels of risk, the best profile occasionally includes armament strategies. This results in nuclear catastrophe within the first 10 iterations of the model. Additionally, the average payoff for the best strategy is

significantly lower than in the previous experiments, with the average best payoff computed to be -7.

Discussion and Limitations

In this paper I have analyzed how an evolutionary game model with genetic algorithms responds to various theories of nuclear deterrence and disarmament. In the first experiment, I tested a simple game in which states could choose either armed or unarmed strategies with no risk of nuclear war or catastrophe. The evolutionary game simulation resulted in all strategies converging to the state {armed, armed}, which is the dominant strategy for both players in this game.

In the second experiment, I tested a more complex game in which states could choose to be either offensive or defensive, in addition to being armed or unarmed. In this game, there exist numerous Pareto optimal solutions, and the strategy profiles generated by the simulation continued to fluctuate between various strategies even after 100 iterations of the simulation. The optimal strategy profile often consisted of various combinations of {armed, defensive}, {armed, offensive}, and {armed, defensive}. The only strategy that rarely appeared was {armed, offensive}. This scenario better reflects the current state of nuclear armament; since the creation of nuclear weapons, many nations have chosen not to build nuclear weapons, in which some nuclear states have relinquished nuclear weapons capabilities. Additionally, nuclear states rarely pursue aggressive strategies, although this does occur occasionally.

In the third experiment, I tested the complex game again but included a stochastic element of uncertainty to allow for the possibility of nuclear warfare or nuclear catastrophe. Despite the extremely high cost of nuclear catastrophe and war, in my model the probability of such incidents was sufficiently low so that armament continues to be a viable strategy. Even when the probability of nuclear incidents increased, armament continued to be a component of the best strategy profile.

The results from the final experiment showed that if nations behave similarly to actors in an evolutionary game model, then as long as the probability of nuclear war or catastrophe is less than one, some nations will continue to pursue strategies involving nuclear armament. The implication of this state of affairs is that even if instances of nuclear catastrophe and nuclear war between nations occur, subsequent nations will continue to revive nuclear armament, and that global disarmament, if it occurs, will not be a stable equilibrium. Thus if global leaders hope to eliminate nuclear weapons, it is essential that they create a treaty that imposes costs upon nuclear states that exceed the strategic benefits of nuclear weapons.

While these models provide an important new perspective on the evolution of nuclear weapons strategies over time, it is subject to numerous theoretical and practical limitations. The model does not consider the possibility of unarmed states forming military alliances with armed states, a common occurrence in international politics. The model also does not

include the cost of proxy wars that may be fought by nuclear states, such as the numerous proxy wars that occurred during the Cold War. Factoring in the cost of proxy wars, in addition to the other costs of cold war, could make cold warfare more costly than conventional warfare, a possibility that is not considered in the model. A key assumption of this model is that every state, both stable and unstable, is capable of building nuclear weapons. Due to the strict monitoring of nuclear weapons materials and other international safeguards for such programs, it is possible that stable nuclear states can prevent unstable states from building weapons, although this point is subject to debate. Finally, recent attacks such as the terror attacks in the U.S. on September 11th suggest that nuclear states cannot deter conventional attacks from unarmed stateless terrorist organizations. These events refute a key component of deterrence theory, and suggest that these models may not accurately predict equilibrium strategies for scenarios involving stateless terrorist organizations.

Future research should generate models that model the relative costs of conventional warfare versus cold war. These models should also allow for the possible existence of nuclear alliances and stateless terrorist organizations to analyze how the presence of these groups could affect the composition of optimal strategy profiles.

Endnotes

1. This assumes that an unarmed nation will concede to the demands of an armed nation such that these demands are less than the cost of a nuclear attack multiplied by a probability (p) that the armed nation would resort to a nuclear attack if defied, such that: $c = E[\text{cost}] = p * (\text{cost of nuclear attack}) < d$.
2. Note that A = "0" and D = "1," but the strategy "AD" corresponds to the pair "10." This is because the fitness function reads the strategy profile from right to left.
3. Thus the strategy "1110" would be read as "01" and "11" instead of "01," "11," and "11."
4. Although catastrophes of this nature have not yet occurred, there have been numerous documented near-miss occasions of accidental bombing on U.S. soil due to a failure of command and control systems (Schlosser 2013).
5. In cases of unstable governments and brinkmanship, where armed states threaten nuclear attack, the cost of nuclear warfare (f) is higher than in cases of poor command and control systems, where armed states risk the cost of nuclear catastrophe on their own land (g).

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Appendix

Experiment 1 fitness_gagame Code

```
function [fit,bestind,bestfit] = fitness_gagame1(genepool,popsize,clen);
```

```
payoffs(1,popsize) = 0;
```

```
a = -1; %Payoff if country is armed and enemy is armed (cold war)
```

```
c = -2; %Payoff if country is unarmed and enemy is armed
```

```
b = 1; %Payoff if country is armed or unarmed and enemy is unarmed
```

```
d = -3; %Payoff if country is unarmed and enemy is unarmed (conventional warfare)
```

```
% Loop for player1
```

```
for k1 = 1:popsize;
```

```
    strategyp1 = genepool(k1);
```

```
% Loop for opponents (player2)
```

```
for k2 = 1:popsize;
```

```
    strategyp2 = genepool(k2);
```

```
    if (k1 ~= k2)
```

```
        mask = 1;
```

```
        %Loop for games
```

```
        for k3 = 1:clen;
```

```
            actionp1 = bitand(strategyp1,mask);
```

```
            actionp2 = bitand(strategyp2,mask);
```

```
            mask = bitshift(mask,1);
```

```
            % armed, armed
```

```
            if (actionp1 == 0) & (actionp2 == 0)
```

```

        payoffs(k1) = payoffs(k1) + a;
    end
    % unarmed, armed
    if (actionp1 > 0) & (actionp2 == 0)
        payoffs(k1) = payoffs(k1) + c;
    end
    % armed, unarmed
    if (actionp1 == 0) & (actionp2 > 0)
        payoffs(k1) = payoffs(k1) + b;
    end
    % unarmed, unarmed
    if (actionp1 > 0) & (actionp2 > 0)
        payoffs(k1) = payoffs(k1) + d;
    end
end % end loop games

end % end if

end % end loop opponents

end % end loop player1

fit = payoffs;
[top topi] = max(fit);
bestind = genepool(topi);
bestfit = top;

Experiment 2 fitness_gagame Code
function [fit,bestind,bestfit] = fitness_gagame(genepool,popsize,clen);

payoffs(1,popsize) = 0;
a = -1; %Payoff if country is armed and enemy is armed (cold war)
c = -2; %Payoff if country is unarmed and enemy is armed
b = 1; %Payoff if country is armed and enemy is unarmed
d = -3; %Payoff if country is unarmed and enemy is unarmed (conventional warfare)

% Loop for player1 and isolate a pair of strategies
for k1 = 1:popsize;
    strategyp1 = genepool(k1) ;

```

```
% Loop for opponents (player2) and isolate a pair of strategies
for k2 = 1:popsiz;
strategyp2 = genepool(k2);

if (k1 ~= k2)
    mask = 1;

    %Loop for games, by twos
    for k3 = 1:2:clen;
    actionp1 = bitand(strategyp1,mask);
    actionp2 = bitand(strategyp2,mask);
    mask = bitshift(mask,1);
    actionp1b = bitand(strategyp1,mask);
    actionp2b = bitand(strategyp2,mask);
    mask = bitshift(mask,1);

    % ARMED VS ARMED
    % armed and aggressive, armed and aggressive (cold war)
    if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 0)
        payoffs(k1) = payoffs(k1) + a;
    end
    % armed and defensive, armed and aggressive (cold war)
    if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 0)
        payoffs(k1) = payoffs(k1) + a;
    end
    % armed and aggressive, armed and defensive (cold war)
    if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + a;
    end
    % armed and defensive, armed and defensive (negotiate)
    if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + e;
    end

    % UNARMED VS ARMED
    % unarmed and aggressive, armed and aggressive (conventional war)
    if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 0)
        payoffs(k1) = payoffs(k1) + d;
    end
end
```



```
% unarmed and defensive, armed and aggressive (conventional war)
if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d;
end
% unarmed and aggressive, armed and defensive (negotiate)
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e;
end
% unarmed and defensive, armed and defensive (negotiate)
if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e;
end

% ARMED VS UNARMED
% armed and aggressive, unarmed and aggressive (conventional war)
if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d;
end
% armed and defensive, unarmed and aggressive (negotiate, deterrence)
if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + e;
end
% armed and aggressive, unarmed and defensive (conventional war)
if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + d;
end
% armed and defensive, unarmed and defensive (negotiate)
if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e;
end

% UNARMED VS UNARMED
% unarmed and aggressive, unarmed and aggressive (conventional war)
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d;
end
% unarmed and defensive, unarmed and aggressive (conventional war)
if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d;
```

```

    end
    % unarmed and aggressive, unarmed and defensive (conventional war)
    if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + d;
    end
    % unarmed and defensive, unarmed and defensive (negotiate)
    if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + e;
    end
end % end loop games

end % end if

end % end loop opponents

end % end loop player1

fit = payoffs;
[top topi] = max(fit);
bestind = genepool(topi);
bestfit = top;

```

Experiment 3 Code

```

function [fit,bestind,bestfit] = fitness_gagame2(genepool,popsize,clen);

payoffs(1,popsize) = 0;
a = -1; %Payoff if country is armed and enemey is armed (cold war)
c = -2; %Payoff if country is unarmed and enemy is armed
b = 1; %Payoff if country is armed and enemy is unarmed
d = -3; %Payoff if country is unarmed and enemy is unarmed (conventional warfare)
e = 0; %Payoff if both countries are defensive (negotiation) or when a defensive armed country
faces an aggressive unarmed country (deterrence)

% Loop for player1 and isolate a pair of strategies
for k1 = 1:popsize;
    strategyp1 = genepool(k1) ;

    % Loop for opponents (player2) and isolate a pair of strategies
    for k2 = 1:popsize;

```

```
strategyp2 = genepool(k2);

if (k1 ~= k2)
    mask = 1;

    %Loop for games, by twos
    for k3 = 1:2:clen;
        actionp1 = bitand(strategyp1,mask);
        actionp2 = bitand(strategyp2,mask);
        mask = bitshift(mask,1);
        actionp1b = bitand(strategyp1,mask);
        actionp2b = bitand(strategyp2,mask);
        mask = bitshift(mask,1);
        random = normrnd(0,1);
        if random > .999
            unstable = 1;
        else unstable = 0;
        end

        % ARMED VS ARMED
        % armed and aggressive, armed and aggressive (cold war)
        if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 0)
            payoffs(k1) = payoffs(k1) + a - unstable*100;
        end
        % armed and defensive, armed and aggressive (cold war)
        if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 0)
            payoffs(k1) = payoffs(k1) + a - unstable*100;
        end
        % armed and aggressive, armed and defensive (cold war)
        if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
            payoffs(k1) = payoffs(k1) + a - unstable*100;
        end
        % armed and defensive, armed and defensive (negotiate)
        if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
            payoffs(k1) = payoffs(k1) + e - unstable*50;
        end

        % UNARMED VS ARMED
        % unarmed and offensive, armed and offensive (conventional war)
```

```
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d - unstable*100;
end
% unarmed and defensive, armed and offensive (conventional war)
if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d - unstable*100;
end
% unarmed and offensive, armed and defensive (negotiate)
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e - unstable*100;
end
% unarmed and defensive, armed and defensive (negotiate)
if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e;
end

% ARMED VS UNARMED
% armed and aggressive, unarmed and aggressive (conventional war)
if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d - unstable*100;
end
% armed and defensive, unarmed and aggressive (negotiate, deterrence)
if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + e - unstable*50;
end
% armed and aggressive, unarmed and defensive (conventional war)
if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + d - unstable*100;
end
% armed and defensive, unarmed and defensive (negotiate)
if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e - unstable*50;
end

% UNARMED VS UNARMED
% unarmed and aggressive, unarmed and aggressive (conventional war)
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d;
end
```

```

    % unarmed and defensive, unarmed and aggressive (conventional war)
    if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 0)
        payoffs(k1) = payoffs(k1) + d;
    end
    % unarmed and aggressive, unarmed and defensive (conventional war)
    if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + d;
    end
    % unarmed and defensive, unarmed and defensive (negotiate)
    if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + e;
    end
end % end loop games

end % end if

end % end loop opponents

end % end loop player1

fit = payoffs;
[top topi] = max(fit);
bestind = genepool(topi);
bestfit = top;

function [fit,bestind,bestfit] = fitness_gagame2(genepool,popsize,clen);

payoffs(1,popsize) = 0;
a = -1; %Payoff if country is armed and enemy is armed (cold war)
c = -2; %Payoff if country is unarmed and enemy is armed
b = 1; %Payoff if country is armed and enemy is unarmed
d = -3; %Payoff if country is unarmed and enemy is unarmed (conventional warfare)
e = 0; %Payoff if both countries are defensive (negotiation) or when a defensive armed country
faces an aggressive unarmed country (deterrence)
f = 100000; %Cost of nuclear war
g = 50000; %Cost of nuclear catastrophe
% Loop for player1 and isolate a pair of strategies
for k1 = 1:popsize;
    strategyp1 = genepool(k1) ;

```

```
% Loop for opponents (player2) and isolate a pair of strategies
for k2 = 1:popsiz;
strategyp2 = genepool(k2);

if (k1 ~= k2)
    mask = 1;

    %Loop for games, by twos
    for k3 = 1:2:clen;
        actionp1 = bitand(strategyp1,mask);
        actionp2 = bitand(strategyp2,mask);
        mask = bitshift(mask,1);
        actionp1b = bitand(strategyp1,mask);
        actionp2b = bitand(strategyp2,mask);
        mask = bitshift(mask,1);
        random = normrnd(0,1);
        if random > .999
            unstable = 1;
        else unstable = 0;
        end

        % ARMED VS ARMED
        % armed and aggressive, armed and aggressive (cold war)
        if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 0)
            payoffs(k1) = payoffs(k1) + a - unstable*f;
        end
        % armed and defensive, armed and aggressive (cold war)
        if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 0)
            payoffs(k1) = payoffs(k1) + a - unstable*f;
        end
        % armed and aggressive, armed and defensive (cold war)
        if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
            payoffs(k1) = payoffs(k1) + a - unstable*f;
        end
        % armed and defensive, armed and defensive (negotiate)
        if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
            payoffs(k1) = payoffs(k1) + e - unstable*g;
        end
    end
end
end
```

```

% UNARMED VS ARMED
% unarmed and offensive, armed and offensive (conventional war)
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d - unstable*f;
end
% unarmed and defensive, armed and offensive (conventional war)
if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d - unstable*f;
end
% unarmed and offensive, armed and defensive (negotiate)
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 0) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e - unstable*g;
end
% unarmed and defensive, armed and defensive (negotiate)
if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 0) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e;
end

% ARMED VS UNARMED
% armed and aggressive, unarmed and aggressive (conventional war)
if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + d - unstable*f;
end
% armed and defensive, unarmed and aggressive (negotiate, deterrence)
if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 0)
    payoffs(k1) = payoffs(k1) + e - unstable*g;
end
% armed and aggressive, unarmed and defensive (conventional war)
if (actionp1 == 0) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + d - unstable*f;
end
% armed and defensive, unarmed and defensive (negotiate)
if (actionp1 == 0) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 1)
    payoffs(k1) = payoffs(k1) + e - unstable*g;
end

% UNARMED VS UNARMED
% unarmed and aggressive, unarmed and aggressive (conventional war)
if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 0)

```

```
        payoffs(k1) = payoffs(k1) + d;
    end
    % unarmed and defensive, unarmed and aggressive (conventional war)
    if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 0)
        payoffs(k1) = payoffs(k1) + d;
    end
    % unarmed and aggressive, unarmed and defensive (conventional war)
    if (actionp1 == 1) & (actionp1b == 0) & (actionp2 == 1) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + d;
    end
    % unarmed and defensive, unarmed and defensive (negotiate)
    if (actionp1 == 1) & (actionp1b == 1) & (actionp2 == 1) & (actionp2b == 1)
        payoffs(k1) = payoffs(k1) + e;
    end
end % end loop games

end % end if

end % end loop opponents

end % end loop player1

fit = payoffs;
[top topi] = max(fit);
bestind = genepool(topi);
bestfit = top;
```


Circuit Optimization for an Auto Ranging Bio-Impedance Measurement System

*The University
of Texas
at Austin*

*Undergraduate
Research Journal*

*Volume 14
Number 1
Fall 2015*

Matthew Normayle

ABSTRACT

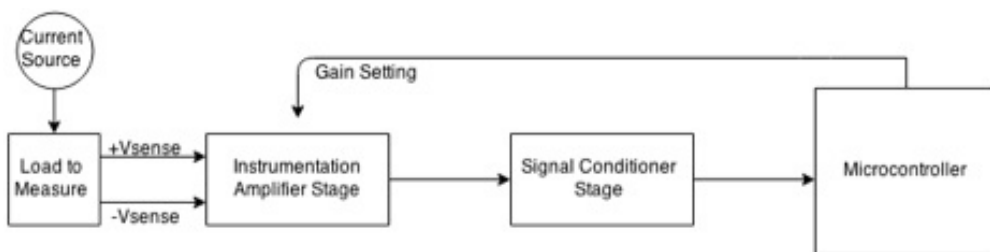
A bio-impedance measurement system is proposed for applications in cardiac ablation treatment.

The system will measure the admittance across heart tissue models with high accuracy, using auto ranging circuit techniques to reduce common mode noise. The instrumentation amplifier (INA) stage of the system's circuit best suppresses noise at high gain levels. To utilize this, the system's microcontroller will automatically increase INA gain when the input voltage is less than a specified cutoff value. Experiments were performed to determine the cutoff value that yields maximum noise suppression for the system. The results of the experiments show the optimum cutoff value

is slightly greater than the mean input voltage. The signal conditioner stage of the measurement system's circuit must filter out unwanted frequencies and properly attenuate the voltage signal for microcontroller sampling. Experiments were performed to determine approximate filter designs that reject maximum noise with minimal degradation to the desired 20 kHz voltage signal. The optimum filter design for the signal conditioning stage are shown to be a first-order Butterworth high pass filter with cutoff frequency of 5 kHz, and a third-order Chebyshev low pass filter with cutoff frequency of 29 kHz. Proper design and experimentation in the instrumentation amplifier and signal conditioning stages will yield a system that can accurately measure a parallel resistance-capacitance (RC) load ranging between 200 Ω to 1,800 Ω and 100 pF to 10,000 pF.

Introduction and Motivation

Cardiac arrhythmia is a disorder in the cardiac muscle system responsible for regulating heart function. A common method of treatment for drug-resistant cardiac arrhythmia is radio frequency (RF) cardiac ablation. This treatment deposits high doses of energy to kill aberrant cardiac cells that cause the arrhythmia [1]. The necrosis of these cells is currently detected using electrocardiogram (EKG) signals [5]. Le [5] suggests that the EKG signal can mislabel ectopic cells as dead when they are merely stunned. To solve this issue, Le explored the Admittance-Ablation Catheter approach. This approach involves the design of a catheter that can measure the admittance of heart tissue. Admittance, an essential electrical property, can more accurately suggest whether a cell is normal, stunned, or necrotic [5]. Le has designed a bio-impedance measurement system capable of measuring admittance in a cardiac cell model. His system can measure RC loads that range from 300 Ω to 1600 Ω and from 100 pF to 10,000 pF; but, the system is not always accurate at the extremes. The desired improved system can accurately measure loads varying from 200 Ω to 1800 Ω and 100 pF to 10,000 pF. To meet those requirements, a novel auto-ranging system is proposed. The system will determine when the measured load is below a specified admittance and adjust the gain of the instrumentation amplifier to improve accuracy. A high level depiction of the system is shown below.

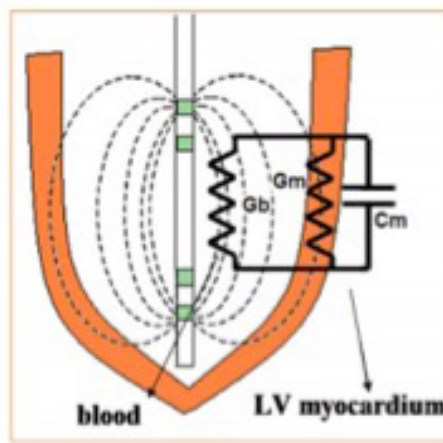


The focus of this paper is the design of the instrumentation amplifier and signal conditioning stages.

Background

Heart tissue can be modeled as a parallel resistor-capacitor (RC) load [5]. Admittance is the ratio of complex current and voltage, and thus the admittance of such a parallel RC load can be determined by sending a known alternating current through it and measuring the voltage across it using an analog to digital converter. The figure below depicts the heart cell model, where G_m represents the resistance of the cell and C_m represents the capacitance of the cell. G_b is the resistance contribution of the blood.

Figure 1: Resistance-Capacitance Model of a Heart Cell {5}

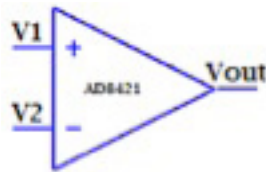


A microcontroller with an analog to digital converter can be used to sample voltage difference across G_m and C_m . The digital Fourier transform of these values can determine the resistance, capacitance, and admittance of the heart cell. The novel aspect of the measurement system design is not the microcontroller software - but the circuit bridging the load and the microcontroller. The focus of this research is on the optimum design of said circuit. The measurement system's circuit is comprised of an instrumentation amplifier stage and a signal conditioner stage. The instrumentation amplifier stage detects and amplifies the initial voltage difference across the load. The signal conditioner stage rejects unwanted voltage signals from the electrocardiogram, and attenuates the desired voltage signal to be processed by the microcontroller. To minimize error, experiments were conducted to determine optimum design for these circuit stages.

Instrumentation Amplifier Stage

The instrumentation amplifier stage is the first aspect of the measurement system's circuit. The task of the instrumentation amplifier is to measure the voltage across the load, amplify it, and reject as much common mode noise as possible. In essence, an instrumentation amplifier outputs the scaled difference of two input voltages.

Figure 2: Model of an Instrumentation Amplifier



$$V_{out} = A_d (V_1 - V_2) \text{ where } A_d = \text{differential gain in V/V}$$

Especially in biomedical applications, the accuracy of a measurement system is adversely affected by common mode voltage [5]. Common mode voltage is a voltage signal that is present at both input nodes of the instrumentation amplifier. In theory, this should have no effect on the output of the amplifier. In practice, some common mode voltage is passed through the instrumentation amplifier. The microcontroller later samples this common mode voltage in combination with the desired voltage signal, causing the desired voltage signal to appear higher in magnitude. An INA's ability to suppress common mode noise is quantified by its common mode rejection ratio (CMRR). The CMRR is the ratio of differential gain of the amplifier and the common mode gain of the amplifier.

$$CMRR = 20 \log_{10} \frac{A_d}{A_c} \text{ dB where } A_c = \text{common mode gain}$$

Increasing the differential gain (A_d) of the instrumentation amplifier is an extremely effective way to reduce system common mode noise. However, the differential gain is limited by the maximum output voltage of the amplifier, which is ± 10.4 V for this amplifier. The input voltage magnitude multiplied by the differential gain cannot exceed and should not approach this value too closely. The possible range of input voltage magnitudes for this system is shown below.

The maximum realizable amplifier gain is equal to the max amplifier output voltage divided by the input voltage. Importantly, the lowest input voltage magnitude is -0.027 V and the highest input voltage magnitude is 0.252 V. Therefore, with a maximum amplifier output voltage of 10.4 V and a maximum input voltage of 0.252 V, the maximum gain of the circuit's differential amplifier for the highest input voltage is $\frac{10.4\text{V}}{0.252\text{V}} \approx 40$.

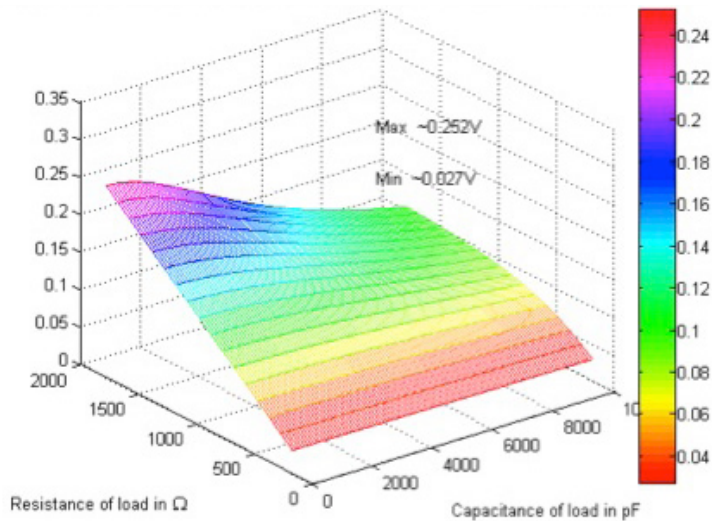
While 40 V/V is the maximum gain of the system for the highest input voltage, lower input voltage magnitudes can have higher gains. To take advantage of this, the system automatically adjusts the INA gain. When the microcontroller detects lower voltages, it will increase the gain of the instrumentation amplifier to reduce the adverse effects of common mode noise. The system will have two voltage gain values. The low gain value, used for high input voltages, will always have a value of 40 V/V. The high gain value, used for lower input voltages, will be determined based on the cutoff value of the lower input voltage range. The cutoff value is the maximum input voltage magnitude that is still considered to be in

$$|V| = |I| * \left| \frac{\frac{R}{jC\omega}}{R + \frac{1}{jC\omega}} \right| \text{ where } R = \Omega, C = F, \text{ and } \omega = \left(\frac{r}{s} \right)$$

Voltage magnitude across a parallel RC load [3]

Figure 3:

Graph of Voltage Magnitude across RC Parallel Load with 140 μ A AC Current Source



the low range of voltages. The question is, for the overall voltage input range of .027 V to .252 V, what is the optimum low range cutoff value? The optimum low range cutoff value, determined by the following experiment, yields a circuit with the maximum possible signal to noise ratio. The signal to noise ratio of this stage of the system is a function of the input voltage, common mode noise, and gain of the amplifier.

$$SNR = 20 \log_{10} \left(\frac{Amplitude_{Signal}}{Amplitude_{Noise}} \right) dB$$

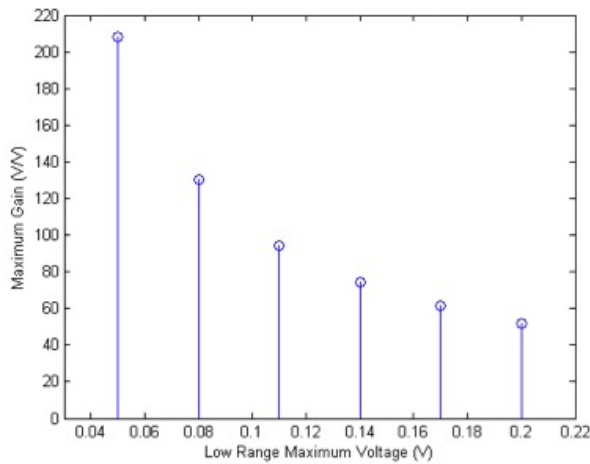
$$Signal = V_{in} * A_d \quad Common \ Mode \ Voltage = V_{common} * A_c$$

Experimentation with the Instrumentation Amplifier Stage

Experiments were performed to determine the low range cutoff value that yields the best signal to noise ratio across the entire input voltage range. The experiments were conducted using a SPICE (simulation program with integrated circuit emphasis) based program called Multisim. Six possible low range cutoff values were chosen at 0.05V, 0.08V, 0.11V, 0.14V, 0.1V, and 0.2V. The maximum instrumentation amplifier differential gain for each value was determined. For each potential low range cutoff, its associated maximum gain is the gain for

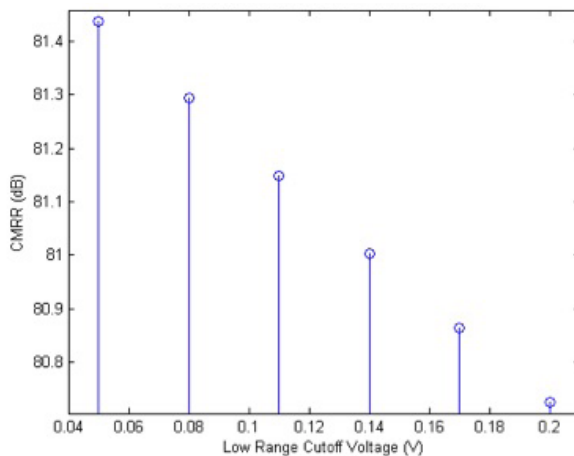
the entire low range of input voltages. A simulation was performed for each potential low range cutoff voltage. The simulated circuit contained two instrumentation amplifiers. The differential gain of each amplifier was set to the maximum possible gain for the low range cutoff. The input applied to one amplifier was a sinusoidal voltage signal, with amplitude corresponding to the low range cutoff voltage. The input applied to the other amplifier was an intentional common mode voltage.

Figure 4: Low Range Maximum Voltage versus Maximum Gain



The simulation was performed, and the ratio between differential gain and common mode gain was compared for each low range cutoff voltage.

Figure 5: Low Range Cutoff Voltage versus CMRR

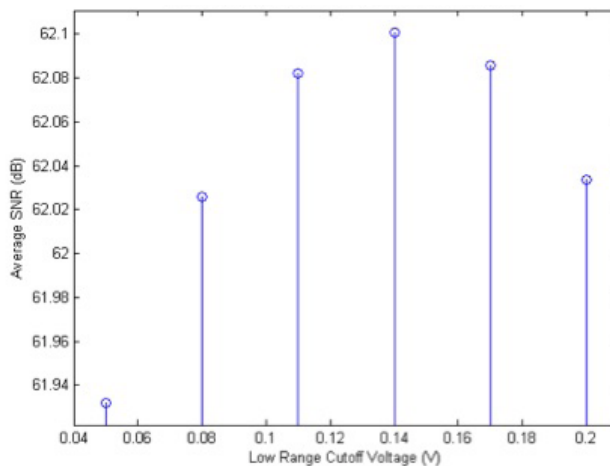


Finally, the signal to noise ratio of the system was analyzed for each low range cutoff voltage. Referring to the formulas above, the signal to noise ratio in this instance is:

$$SNR=20 \log_{10} \left(\frac{V_{in} * A_d}{V_c * A_c} \right) \text{ dB}$$

The input voltage ranged from $\sim 0.027 \text{ V}$ to $\sim 0.252 \text{ V}$, as shown earlier. The differential gain for each input voltage is dependent on whether that input voltage falls above or below the low range cutoff. If the voltage falls below, its differential gain is indicated by the earlier calculations for low range maximum gain. If the voltage falls above, the differential gain is always 40 V/V . The common mode gain will change as differential gain increases at a rate dependent on the amplifiers CMRR. Thus, a low range cutoff’s average SNR is a function of the maximum gain for that low range cutoff and the common mode rejection ratio at that gain. A smaller low range cutoff voltage will yield a higher differential gain and better CMRR for that range. However, the key insight is that fewer voltage values in the full range will be affected by that improved CMRR. Multiple low range cutoffs were tested to approximately optimize the cutoff value, and the results are displayed below.

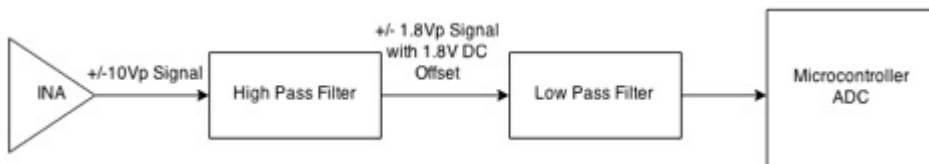
Figure 6: Low Range Maximum Voltage versus Average SNR



The optimal low range cutoff is near the mean of the full voltage range, at around 0.14 V . Placing the low range cutoff near the middle of the full voltage range allows for the best balance of improved CMRR and quantity of input voltages that take advantage of that CMRR. The instrumentation amplifier stage will be designed with a low range cutoff of around 0.14 V , and a corresponding low range gain of $\sim 80 \text{ V/V}$.

Signal Conditioner Stage

The latter stage of the auto ranging measurement system circuit is the signal conditioner stage. The purpose of this stage is to filter out the EKG and noisy high frequency signals, and to attenuate the desired voltage signal for processing by the microcontroller. In a practical application, the system will pick up the EKG voltage signal of the cardiac tissue. Since we wish to measure only the voltage signal induced by our current source, this EKG signal must be filtered out. The EKG signal only have significant energy at frequencies less than 100 Hz, and a high pass filter is used to remove it [2]. Additionally, we use a low pass filter to remove noisy high frequency components larger than our 20 kHz voltage signal. A band pass filter is not used as, given the wide nature of our passband (-100 Hz to ~20 kHz), a band pass filter is not effective. The passband gain would be inconsistent, and the Q factor of the filter would suffer [6]. Thus, the basic filter design used for the signal conditioner stage is a high pass filter cascaded with a low pass filter. The high pass filter, in addition to removing the EKG signal, will attenuate and purposefully add a DC offset to the voltage signal.



To accurately determine the resistance and capacitance of the load to measure, the voltage magnitude and phase must be determined. However, in the high pass and low pass filter experiments to follow, accurate voltage magnitude measurements are emphasized over accurate phase measurements. This is due to the fact that the signal conditioning stage's noisy effects on the phase of the signal can be determined independent of the load to measure. Thus, the system's software can correct phase shifts caused by the system.

High Pass Filter Experimentation

The frequency that we wish to pass (20 kHz) is much higher than the low frequencies we wish to reject (<100 kHz). As a result, the design of the high pass filter is relatively simple. A first order, Butterworth filter with a -20 dB/Decade response will satisfy the design requirements [4]. Simpler circuits lead to less uncertainty from component tolerances [6].

Transfer function and Cutoff Frequency of a 1 – Pole High Pass Filter

$$H(s) = \frac{sCR}{sCR+1} \quad Fc = \frac{1}{2\pi RC} \quad [4]$$

The cutoff frequency is defined as the frequency which is attenuated 3 dB below the passband gain. With a -20dB/Decade response, almost any cutoff frequency greater than 200 Hz will adequately filter the <100 Hz EKG signal. Experimentation was performed on two separate filter designs. One filter had a cutoff frequency of 230 Hz, the other a cutoff frequency of 5000 Hz. The 5000 Hz cutoff frequency filter promises to filter more low frequency noise at the risk of a more attenuated 20 kHz signal. The designed filters are pictured below to highlight differences in component values.



Intuitively, the 5000 Hz filter would introduce more noise due to its component values. After simulation, however, the circuits are shown to have very similar noise levels. Additionally, the second filter’s higher cutoff frequency does not cause it to amplify or attenuate the 20 kHz, according to data collected using Multisim SPICE circuit simulation. A single point AC analysis was performed to measure the magnitude change and phase shift of the two proposed filters.

Additionally, a noise analysis was performed to compare the difference in output voltage noise between the two filters. Averaged results are shown below.

Simulation Data for High Pass Filter Configurations

	Filter 1 : fc = 230 Hz	Filter 2 : fc = 5000 Hz
Gain at 25 kHz	1.0000 V/V	1.0000 V/V
Phase shift at 25 kHz	-0.0406°	-0.0406°
Total output noise	.1428 * 10 ⁻¹¹	.1507 * 10 ⁻¹¹

It is clear from the data that there is not a significant downside to using the 5000 Hz cutoff filter. The added advantage of the 5000 Hz filter is that noise lower than 5000 Hz will be significantly attenuated. Thus, the signal conditioning stage will utilize a high pass filter with cutoff frequency 5000 Hz to filter out EKG signals.

Low Pass Filter Experimentation

The purpose of the low pass filter is to remove high frequency noise from the signal, while ensuring stability at the 20 kHz frequency. High performance in a low pass filter requires optimal placement of the filter cutoff frequency to filter out noise while not affecting the desired signal. Four low pass filters were designed for experimentation. They included two

second order Chebyshev filters, a first order Butterworth filter, and a third order Chebyshev filter. These filters are representative of the wide range of choices for the filter cutoff frequency. Since these low pass filters must pass the 20 kHz signal but reject frequencies relatively close to 20 kHz, a higher filter roll-off is desired. Filter roll-off is defined as the rate of change of signal attenuation of frequencies in the stopband of the filter. It is related to the number of poles in the filter's transfer function, or the order of the filter. A higher order filter means more poles and thus a steeper roll-off; but, it also means a more complicated and noisy circuit [6]. More component tolerance uncertainty will arise in higher order filters due to their more complex circuits. To determine the optimum cutoff frequency value and filter response we performed a circuit response analysis for a 20 kHz input voltage frequency, and another analysis varying over a 1 Hz to 100 MHz input voltage frequency. The amplification at the desired voltage signal frequency (20 kHz) and the phase shift for that frequency were determined from the first simulation. The data are shown below.

Simulation Data for Low Pass Filter Configurations

	2 Pole Chebyshev Fc ~ 25kHz	1 Pole Butterworth Fc ~ 3.6kHz	2 Pole Chebyshev Fc ~ 22kHz.	3 Pole Chebyshev Fc ~ 29kHz
Gain at 20kHz	.8321 V/V	.1679 V/V	.7620 V/V	.9672 V/V
Phase Shift at 20kHz	-74.6839°	-79.7924°	-84.8021°	-92.8474°
Worst Case SNR	-27.2920 dB	-30.1890 dB	-26.3420 dB	-25.0283 dB

The most important value measured is the worst case SNR. In this context, this value can be interpreted as the SNR for the system when it is being influenced by heavy noise at frequencies above 20 kHz. Unsurprisingly, the three pole Chebyshev filter yielded the best SNR. Due to its higher roll-off, the three pole Chebyshev more adequately filters noise while minimally attenuating the 20 kHz voltage signal. However, uncertainty from component tolerance cannot always be adequately simulated. While the use of a 3 pole filter seems promising in minimizing high frequency noise, additional live experiments need to be performed to determine the adverse effects of component tolerance. These effects will later be compared with the probabilistic presence of high frequency noise to decide between a three pole or two pole high pass filter response. For now, the 3 pole filter will suffice.

Discussion and Conclusion

In biomedical applications, noise due to common mode voltage and natural biological signals makes high performance system design difficult. Analog circuits always contain noise,

and biomedical devices are some of the most flagrant offenders. Through a combination of filters and amplifiers, the noise of a system can be subdued to produce accurate signals. These signals lead to systems that can expertly facilitate procedures like cardiac ablation, and have a direct impact on the health of society. To design a bio-impedance measurement system for use in cardiac ablation, extremely high accuracy is required. This requirement pushes the boundaries of simple filters' and amplifiers' capabilities. To improve accuracy, we proposed a system design that automatically adjusts circuit values based on input voltages. This is realized as an auto-ranging circuit, consisting of two important circuit stages. To properly design these stages, experiments were carried out to determine optimum low range cutoff and signal conditioning filter responses. The optimum low range cutoff was shown to be slightly above the mean of the possible input voltage values. This creates an instrumentation amplifier stage that maximally rejects common mode noise.

The signal conditioner stage of the circuit serves to attenuate unwanted frequencies, and will utilize a high pass and low pass filter cascaded together. The high pass filter element should have a frequency cutoff around 5 kHz. This does not interfere with the desired 20 kHz signal, while simultaneously filtering out low frequency noise such as the EKG. The low pass filter in the signal conditioner stage should be a 2nd or 3rd order low pass filter with a Chebyshev response, and a cutoff frequency between 25 kHz and 29 kHz. This allows for maximum signal to noise ratio when high frequency noise is introduced.

The next step for the completion of this project is to build the system using the optimum design plans determined in this study. The circuit will be physically constructed on a printed circuit board, and software will be written for the microcontroller. The process is under way right now. Once the system is physically realized, similar experiments will be performed on the physical system to fine-tune filter cutoff and component values. Once the system is complete, the needs for the system will be reevaluated. For use in the cardiac ablation treatment, the system will need to be re-engineered to have decreased size and power requirements. There are other applications of the system that would allow it to retain its macroscopic nature, including animal testing and organ transplant. All of this considered, there is a long way to go for this system to have any real impact on the medical field. However, the first step towards this system helping people is to determine an optimal initial design, and that is what we have done.

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