The Journal of Young Explorers

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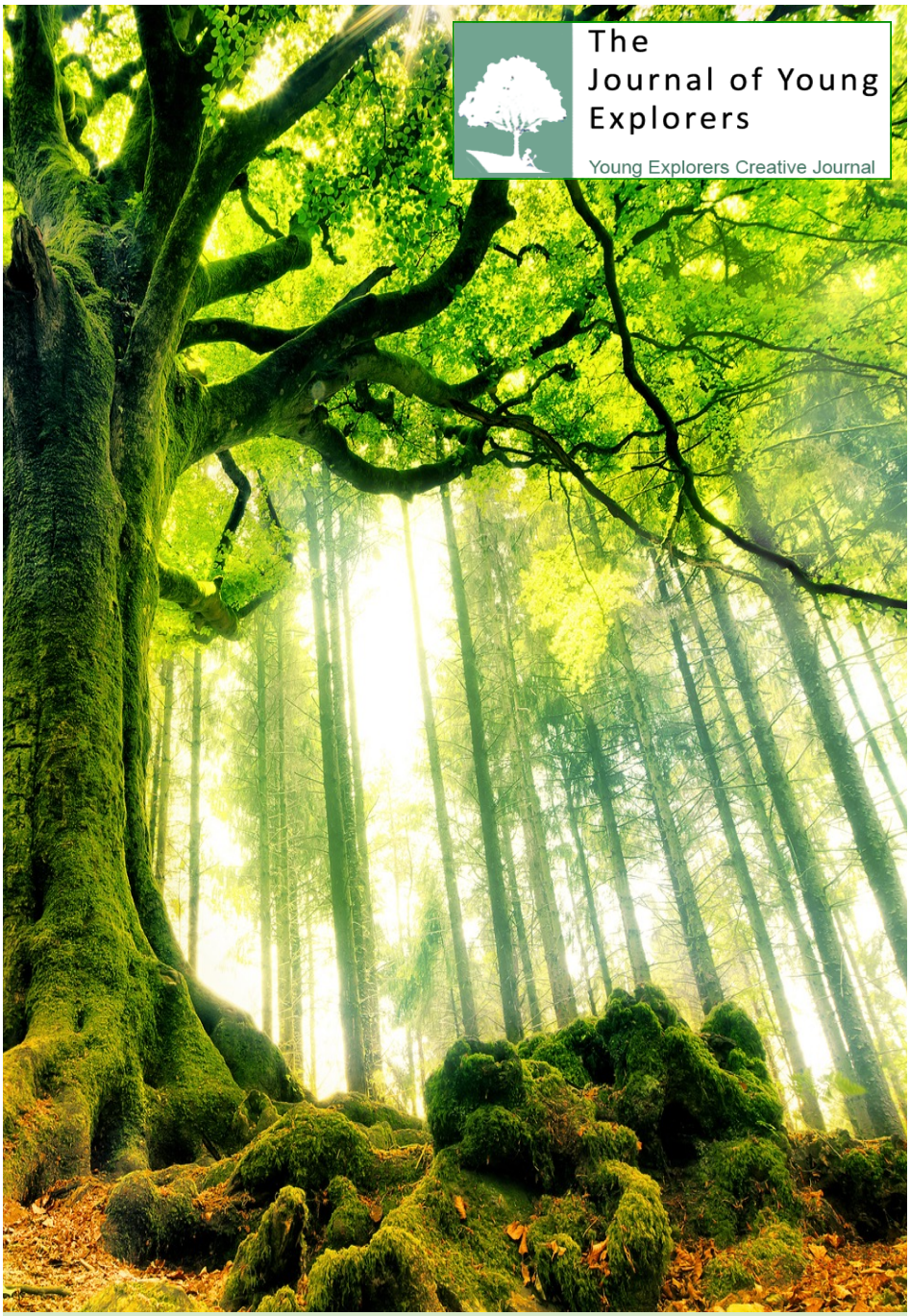

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170 Brookline Ave. Unit 413
Boston. MA 02115

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info@nycsef.org

www.nycsef.org

Delving into Thoughts and Ideas

Rather than committing to a set concept, a true explorer delves into many intriguing thoughts, ideas, and questions, investigating almost as a detective would. The JYE, the mind of an explorer welcomes the vastness of its questions, without worrying about specific technicalities and delivering answers immediately. An explorative approach to learning is adventurous and liberating— endless discovery without judgment nor scrutiny. It is the ideal way to view new possibilities!

For some, having an explorer's mind is an innate quality; simply one idea can branch out to multiple other possibilities for other thoughts and feelings. The explorer's train of thought is less similar to a locomotive running on a straight track but is rather like a sprouting plant that grows multiple branches and leaves. While it may seem difficult to redesign an entire way of thinking, everyone can adapt an explorative mind by learning several tips.

It is imperative that your project is on a subject that you find fascinating and would want to investigate further. Because projects require lots of time and effort, be sure that you can stay invested through the duration of the investigation. Getting ideas can be difficult and may be the hardest part of your project; however, focusing on certain essential questions during the search can make finding a final topic a successful process. Answering questions about everyday interests and hobbies will help identify a subject that can captivate your attention.

Board Members of JYE

A Letter from the Editors in Chief

Dear Contributors and Reviewers,

We are delighted to present this year's edition of The Journal of Young Explorers, a collection of several student-written essays showcasing the wonderful breadth of academic curiosity! Founded upon the basis of adventurous thinking and questioning, The Journal of Young Explorers hopes to foster a creative spirit in many fields of learning.

It is an honor to receive such a number of insightful and thought-provoking pieces from the exceptional minds of high school and undergraduate students. Your submissions are reviewed thoroughly and held to an incredibly high standard. JYE considers work that is not only well-composed, but also ambitious and representative of unbridled academic thinking. Showcased in this issue are essays from both the US and abroad that incorporate many disciplines of academic research, ranging from natural sciences to business and economics. Each piece embodies the diligence of the innovative authors that dedicate themselves to scholarship and exploration.

The Journal of Young Explorers aims to highlight the incredible capability of students and encourage an unconventional, explorative approach to learning. As you read this issue of JYE, consider the privilege of gleaning wisdom from carefully conducted academic research as well as the enthusiastic dedication of all the young, yet incredibly knowledgeable contributors. When compiling this issue, the editors at JYE truly valued the enriching information presented in the impressive student-written pieces. We hope you have a similar experience that may even inspire you to be featured in the journal in the future!

Lastly, we would like to express gratitude towards the Managing Editors and the JYE Editorial Board members for their dedication. The large group of reviewers demonstrated exceptional diligence and enthusiasm while creating this issue. The editors contribute not only their insight but also their time. JYE would not succeed without their continuing support.

Thank you for all of your continued interest and support. It has been an honor to serve as the Editors-in-Chief of the JYE, The Journal of Young Explorer. We are thrilled to provide these fresh perspectives on research to our readers and hope to continue to put our fresh ideas and passions in future journals.

Sincerely,

Dr. Steve Chan, Callan Krevanko, and Daniel J. Morrison
Co-Editors-In-Chief

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How the Space Theory Transformed the History Discipline

Rebecca Vitenzon

Abstract – Gender, labor and race historians have made a strong case for space as a social construct. A Foucauldian framework of analysis of space has allowed historians to reveal histories of the subaltern, which are otherwise often ignored. Interactions in space are social relations, as individuals relate to the space around them in response to other individuals and societal norms. Even so, the materiality of space cannot be understated, as the built space impacts how those interactions are produced and unfold. The consideration of the materiality of space as an additional layer to social space, make spatial history a more effective and illuminating methodological approach.

Keywords – space theory, societal construct, social space, gender, labor, and history

I. Introduction

Although historian Leif Jerram has criticized historians for overusing imagined space, stating that space is the material physicality of location, gender, labour, and race, historians have used space as a social construct to successfully unearth otherwise hidden transcripts of power relations and resistance [1]. Rather than looking at 'imagined space' as in competition with 'built space,' a layered definition of space must be adopted. As Sewell has argued, space is imagined, experienced, and built [2]. Discursive imagined space can be defined as the ways in which individuals understand their environment, while experienced space is the 'material interactions between people and their environment.'[2] Finally, the built environment can be defined as the physical structures that occupy spaces [2]. These overlapping layers must be examined through a social constructivist Foucauldian lens, as space is fundamentally interlinked with the production and reproduction of 'economic, political, and cultural power,' and the reaction of those in power and of the subaltern to that power [3]. This relationship of space with power means that 'spatial relations are social relations' [4]. The extent to which spatial theory has effectively been applied by labour, gender, and race relations historians must be examined to establish its use in the discipline of history.

II. Capitalism and Class Division

When space is considered through the socially constructivist lens, individuals who would otherwise be seen as passive become agents, since the ways in which they relate to space impacts that space. This is especially evident when labours' relations to space are considered. Lefebvre argued that space is produced socially by the hegemonic class, asserting their dominance in society [4] Thus capital becomes the 'primary maker of the geography of capitalism.' [5] Lefebvre's theory was influenced by his Marxist approach, which became popular in economic geography in the 1970s in questioning the relationship between capital and space [5]. Lefebvre's focus on economic geography does not give enough agency to subaltern people existing and resisting within such elite-dominated spaces. In contrast, Herod has argued that in response to capitalist space, workers construct landscapes in a way which increases their social power and diminishes the power of capital [5]. Judith Butler similarly argued that public protests not only take place in the built space, but they also "reconfigure the materiality of space." By occupying spaces controlled by capital and those in power, the subaltern 'performatively lay claim' to the space and assert their right to it.

The reclaiming and coopting of space by workers in times of strikes has been explored by Percy. By comparing strikes in early twentieth century Chicago and London, Percy found that

workers asserted their existence and attracted attention to their cause by claiming public space [3]. Their alternative use of public space strengthened collective action as it impacted how they related to one another, strengthening working-class consciousness and solidarity. People understand space in relation to other people, even as the physicality of the space also impacts their relationship to space. For example, there were some crucial differences in how the strikes played out in London and Chicago due to the different physical configurations of these urban spaces. In Chicago, the grid street layout allowed strikes to spread faster and made maintaining picket lines easier. In contrast, the web of streets in London meant that workers used parades and mass meetings for more effective resistance [3]. In this case study, space was produced socially as strikers constructed an alternative public sphere in which they asserted their right to be in middle-class neighborhoods and to dominate the streets. Percy demonstrates how the materiality of space impacted that production. This demonstrates the effectiveness of thinking about space predominantly as socially constructed, but also considering built space.

III. Gender and Conceptualization of Women

Historians of gender have also made effective arguments for space as a social construct. Traditionally, public space has been constructed as belonging to men, with women being confined to the private sphere. Women breaking this barrier by entering public spaces was often thus seen as a trespass, both by those who sought to police them, and by women themselves. For example, in Chicago in the late nineteenth century, public drinking was seen as a masculine act, with only 'disreputable' women drinking in public [6]. Only the rise of commercial gender segregated spaces, gave upper and middle-class women the ability the ability to drink and push the boundaries of the private sphere. Such spaces still belonged predominantly to white, middle-class women, as African American women were often barred from entering them, as were working-class women [6]. This demonstrates the extent to which capital does play in a role in space formation, as Lefebvre has argued. The rise of consumerism in the late nineteenth and early twentieth centuries led to the creation of spaces which expanded the private sphere into the public one for women, demonstrate the power capital plays in determining spatial relations, even though such relations remain socially constructed.

Due to the conceptualization of women as belonging to the private sphere, women striking in public spaces has traditionally been treated both more severely and seriously. During the Polish Solidarity resistance strikes in Lodz in 1980, women marched with strollers and babies. These women not only claimed the physical public space, but also impacted how that space was imagined (both by them and others) by bringing objects of motherhood and the traditional private sphere into the public. As a result, the march in which they participated in was one of the most successful actions of the Solidarity Movement. The success of this march was predicated on a societal understanding of the streets as a public space in which mothers did not belong. By examining women in the Solidarity movement and their interactions with space, Kenney unearthed how women used popular understanding of public space to their advantage, reconfiguring the streets into sites of protest which shocked authorities and led to positive action.

Although Rosa Parks has been the traditional image of the American Civil Rights Movement, Kelley used space as a social construct in order to reveal an otherwise hidden transcript of resistance [7]. Kelley's examination of space has broadened the understanding of historians about the Civil Rights Movement, leading Hall to conclude that there was a 'Long Civil Rights Movement' which spanned decades rather than beginning and ending in the 1960s. Kelley used police reports to analyze how public transportation in Birmingham, Alabama in the 1940s became a theatre of daily resistance [7]. Driven by white drivers and policed by them and by white passengers, the bus was a white space in which race relations were rigidly

maintained. Drivers controlled who entered the supposedly public space, often passing by black passengers at stops [7]. Further, the space was hierarchical, as black passengers were forced to sit at the back of the bus or to stand. Kelley found that in response, black passengers would often speak loudly and cause a ruckus, aiming to make the white passengers, who were trapped in that space for the duration of the ride, uncomfortable [7]. Police records showed that black passengers could be arrested for any action that asserted their right to being in the space – from making noise, to sitting in the white-only seating area, to arguing with fellow white passengers or the bus driver [7]. Such resistance aligns with Butler's theories about 'performatively laying claim' to space in the struggle for freedom [9]. Kelley's analysis of the bus as a socially constructed space which reflected and reproduced the race relations present in American society deepens our understanding of those race relations, reconfiguring the struggle for Civil Rights from landmark moments like the March on Washington to the everyday spaces of black working-class resistance, like the bus.

Further, the eventual seeming acceptance of segregation in the United States by white middle-class people is also deepened by a spatial analysis predicated on social construction. Kruse found that white middle-class Americans in Atlanta in 1950s and 1960s responded to the desegregation of 'public' spaces by deciding they no longer wanted to participate in such spaces [8]. As a result, cities like Atlanta seemingly accepted desegregation – as a result of the reconfiguration of how public spaces were imagined. White middle-class Americans retreated to the private sphere and moved out of urban centers to the suburbs, essentially re-segregating cities. There was also an economic dimension to this conception of space, as white Americans refused to pay their tax dollars to spaces which African Americans could also use [8]. In contrast, the white working-class virulently remained opposed to desegregation because they used public spaces and did not have the economic power to leave them [8]. Desegregation thus exacerbated the divide between middle and working-class whites. Kruse's analysis upends the narrative of the successful Civil Rights Movement leading to the sudden end of segregation and change in opinions of white Americans, demonstrating that just as the African American struggle for freedom was a constant for decades, so was the white resistance to that struggle.

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How Racism Kills: Poussey Washington's Death in Orange is the New Black

Giselle Hengst

Abstract – Racism is one of the important social problems in the United States that must be addressed. Racism and its consequences are well highlighted in popular culture, including movies and shows, to further emphasize the effect of racism. This paper will discuss institutional racism and how it is demonstrated in the context of the judicial and prison system through an analysis of a show called Orange is the New Black. From analyzing one of the characters, Poussey, and her death, this research will discuss different ways racism could be manifested and the different forms of racism in an institution. This paper will also discuss the extreme outcome of racism in our society – death.

Keywords – institutional racism, popular culture, Orange is the New Black, societal norms and problems

I. Introduction

Racism, quite literally, kills. In the United States, racism is ubiquitous and stems from the legacy of race-based slavery. One area where racism is particularly salient is in the criminal justice system. Despite the constitutional promise of equal protection under the law, racist policies such as the War on Drugs have led to laws that disproportionately affect Black people such as severe penalties for drug use and possession, mandatory minimums, life sentences, and three strikes laws [1]. These policies are examples of institutional racism. Institutional racism is racism embedded in political and social structures, resulting in disadvantages for minorities based on socially assigned race [2]. On the other hand, personally mediated racism describes the prejudice and discrimination that occurs between people of different races [2]. Importantly, personally mediated racism upholds the social norms that prevent institutional racism from being eradicated. In the Netflix series *Orange is the New Black*, the death of a Poussey Washington, a young Black female inmate, demonstrates how personally mediated and institutional racism work together to allow her death to happen while simultaneously protecting the white correctional officers from being held responsible

II. Background Summary

In season 4, episode 12 of *Orange is the New Black*, Poussey Washington is killed by white correctional officer (CO) Bayley. The incident occurs during a protest against head CO Piscatella's inhumane ways of managing the prison. The inmates are gathered in the cafeteria and they stand on the tables, refusing to come down until changes are made. Piscatella orders his COs to get the prisoners down from the tables and chaos ensues. Suzanne, one of the inmates, begins freaking out and Piscatella orders Bayley to "Get that fucking animal out of here, now. Get her to Psych!" [3]. While Bayley tries to physically apprehend Suzanne, Poussey attempts to get Bayley off of Suzanne because Poussey knows Suzanne is mentally unstable and does not realize what she is doing. In response, Bayley pushes Poussey to the ground and digs his knee into her back. Despite Poussey's cries for him to get off of her, she ultimately suffocates and dies under Bayley's weight. Episode 13 focuses on the aftermath of her death by showing the inmates' reactions, as well as the conflict between Warden Caputo and the private, for-profit Management and Correction Company (MCC) in dealing with the situation.

III. Discussion

The most prominent examples of personally mediated racism come from CO Piscatella, who treats the inmates, especially the inmates of color, as animals. During the protest, he literally refers to

Suzanne as an "animal," evoking stereotypes about Black people that date back to the era of slavery [3]. By calling the inmates animals, he dehumanizes them and signals to the COs under his supervision to do the same. In doing so, he fosters an environment that allows Poussey to be killed because personally-mediated racism is considered acceptable. After the cafeteria has been cleared, Piscatella begins crafting a story to protect himself and the other COs from being found guilty for Poussey's death. He tells Caputo "[Poussey] was extremely violent. That's how we start right out of the gate. 'We were dealing with a violent inmate.' Don't give them anytime to start in with their victim's rights crap. Our man was doing his job. This was not about race. We can't have our inmates attacking our COs" [4] Caputo retorts "she weighed 92 pounds. She couldn't attack your shoe" [4]. Again, Piscatella is drawing upon stereotypes that paint Black people as aggressive, violent, and possessing super strength. Although Poussey could not have reasonably posed a threat to the COs, Piscatella attempts to use racist stereotypes to protect himself.

Meanwhile, CO Bayley is coming to terms with his actions while being driven home by CO Dixon. Dixon tells Bayley "Listen, it's not your fault man. I mean speaking as a big guy -- sometimes you just don't realize. I mean I've sat in chairs that have broken right under me" [4]. In this instance, Dixon objectifies Poussey by comparing her to a chair. The violence against her is thus rendered acceptable because she is no longer considered a human with rights. Later, CO Coates laments that Bayley is "a kid" and that he is "all upbeat and shit, like a puppy. And now he's ruined. He'll be all fucked up forever" [4] Although Coates compares Bayley to a puppy, he does so through the use of a simile, rather than literally calling him an animal. While Poussey is being depicted as a violent animal, Bayley is being depicted as a kid and and incapable of harm. Coates's racist attitude prevents him from even realizing that Poussey's life is literally "fucked up forever."

The subsequent internal investigation of Poussey's death and the attempts to cover up the truth of the incident exemplify institutional racism. Although Caputo tries to get MCC to allow him to call the police, the MCC administrators tell him that "we'll call the police as soon as we have an angle" [4]. The MCC administrators are frustrated that they cannot find a reason to vilify Poussey. Poussey is in prison for a nonviolent crime -- trespassing and possession with intent to sell cannabis. Here, it is hard to ignore the fact that Poussey would likely not be in prison for this had she had been white. This is the result of institutionalized racism in the justice system, which leads to harsher punishments for Black people versus white people who have committed the same crime [1] Furthermore, as the administrators look on social media for criminalizing photos of Poussey, one of them pulls up a picture of her smiling with friends and describes it as "thuggy" [4]. Yet again, the use of the racialized term "thug" is a racist attempt to condemn Poussey.

The hierarchical structure of MCC keeps Warden Caputo from calling the police because he fears losing his job. The lack of an agreed upon plan about what to do results in Poussey's body being left on the cafeteria floor for over twenty-four hours. Not only was Poussey the victim of racism while she was alive, she is further victimized in death by the MCC's lack of action in the face of need. At the same time, the COs in the prison are shown agreeing to follow Piscatella's false narrative that Poussey had a knife and tried to attack CO Bayley [4]. The institutional culture at the prison promotes this kind of thinking, as the COs already view the inmates as lacking humanity and are committed to protecting their jobs rather than pursuing justice for Poussey.

In another scene, one inmate tells another "Things will change now, you know. That's what's so fucked up. Takes someone dying for them to do something" to which the second inmate responds "they ain't gonna do shit" [4]. This exchange illustrates the insidious nature of

institutional racism: because racism is embedded structurally into the criminal justice system, it is extremely difficult for any one event or person to put an end to it.

IV. Conclusion

Ultimately, *Orange is the New Black* illustrates how institutional racism and personally mediated racism coincide to produce racial inequalities in the criminal justice system. The show is an example of using a new medium to demonstrate the relevant and existing social justice problems in our society today [5]. Unfortunately, Poussey's death is just one instance where these forces come together to result in injustice for people of color. It is clear that racism can be a matter of life or death and that there are structures in place that uphold it as an acceptable norm. Poussey's death mirrors the terrible reality of mass incarceration and *Orange is the New Black* overall illustrates the various ways in which racism is manifested to protect those in power from any real consequences for their actions.

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Analysis of Substance Abuse and Impacts

Jihoon Kang Duong Dai Dinh

Abstract – In 2003, Hon Lik, a Chinese pharmacist and inventor, created what would become the first commercially successful e-cigarette [1]. Hon Lik's invention quickly swept across the continent, gaining popularity and ultimately being introduced to the European market in April 2006. From Europe, it was a quick hop across the pond to the United States. This new, "safe" form of smoking quickly spread throughout the states. This wave quickly formed a new, highly profitable industry. With such a rapid rise to popularity, governing bodies such as the Food and Drug Administration and Federal Trade Commission have not yet regulated this industry effectively. Although, steps are being taken to do so, the damage has been done. The vaping industry has successfully targeted the youth population, creating high rates of teen and adolescent addiction. Similar to the vaping epidemic plaguing the United States, in 2011, there were approximately 20.6 million people in the United States over the age of 12 with an addiction ranging from alcohol to inhalants and hallucinogens [2]. This number has only grown in recent years. This is why it is paramount to be able to model and predict which communities are most at risk and assess the true cost of addiction. Through complex mathematical modelling and analysis, the ability to assess the prevalence and impact of alcohol, nicotine, marijuana, and nonprescription drugs is available today.

Keywords – Substance abuse, nonfinancial and financial impacts, alcohol, marijuana, and tobacco.

I. Introduction

While the United States is currently experiencing an opioid epidemic with over 72,000 people dying each year from overdoses, there have also been increases in the use of other drugs such as nicotine, marijuana, and alcohol throughout the country. This is especially concerning due to an increasing proportion of the demographic is middle schoolers and high schoolers. Moreover, this is the first time in the history of the United States that the leading cause of death is opioid overdose (it surpassed vehicle crashes). It is important to understand the factors that lead individuals to use these substances so that the spread can be effectively combatted. This section addresses the problem of addiction in society. We focus on the United States specifically and limit our model to the following drugs: nicotine, marijuana, prescription drugs, alcohol. The problem is to create a model that can accurately predict the spread of nicotine. This is followed by the creation of a model that can be applied to different drugs with inputs depending on an individual's income, education level, and race. These factors were chosen because we determined them to be the most significant factors in terms of influencing people to do drugs. We would have also liked to include calculations involving environmental factors such as family use and ease of access but due to time and calculating restraints, we omitted these variables. Because of the advancement in technology, people try to find an alternative for smoking cigarettes. They found this alternative in vaping. As a result, cigarette sales are reaching an all-time low (as shown in the graph below). Overall, this indicates that the growth of vaping will more than replace the decreasing usage of cigarettes.

II. Analysis of the Problem; Model 1

Table 1. Percentage of E-Cigarette Usage in High School

	2011	2012	2013	2014	2015	2016	2017	2018
Overall	1.5	2.8	4.5	13.4	16	11.3	11.6	20.8

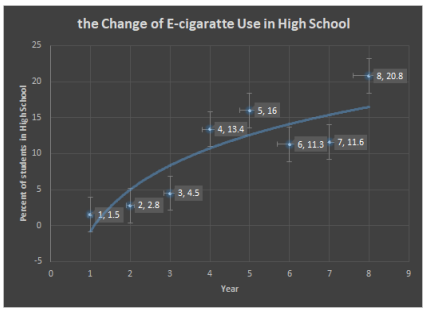

Figure 1. Graph of the Change of E-Cigarette Use in High School (Number 1 represents the year 2011 and so on; Standard Error is ±6.785897).

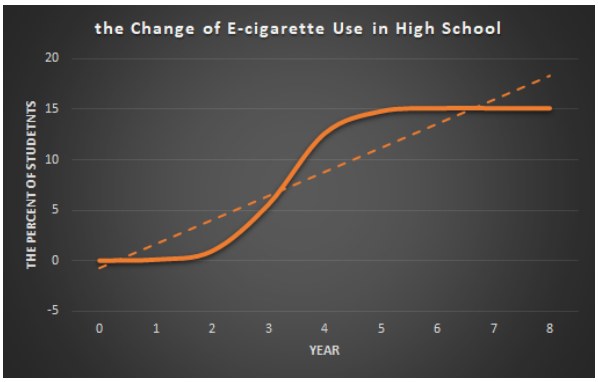

Figure 2. Graph of the Change of E-Cigarette Use in High School.

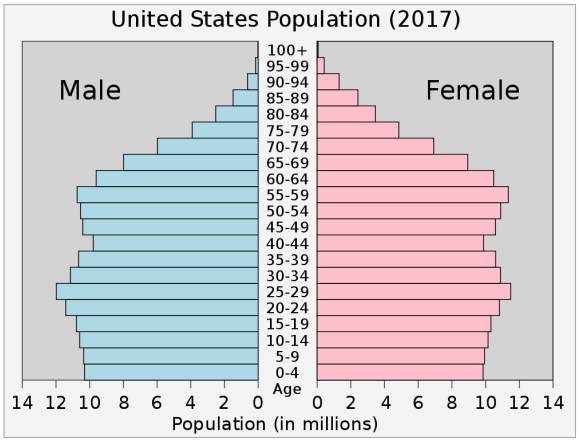

Figure 3. United States Population in 2017 distinguished by gender.

The model developed for part 1 details how the predicted growth of nicotine usage is anticipated to level off in the future as it currently is following a pattern of logistic growth. We use information provided to graph the function from 2011 to 2018. According to the data from the table, we create a logistic function (Figure 2) y = (15.1173)/(1+1111.39e^(-2.15689x)) by calculator. In order to minimize the number for y, we use 1 for 2011, 2 for 2012, 3 for 2013, and so on. Then, we plug 29 as the corresponding number for 2029 to x to find the percentage of high school students who vape for the next 10 years, which is 15.1173 percent. This number may not be correct because there is a rising number of events created dedicate to educate students to stop/prevent them from vaping.

An alteration in this model that could more accurately depict the expansion of vaping could include increased education about its dangers which would slow its growth. As seen in Figure 1, the model closely follows the data found on the high school vaping data provided in the question. The data would follow a line of best fit calculated with a logistic regression formula because the percent of users must reach a limit as it cannot exceed 100%. Figure 3 demonstrates the age demographics of the United States which we use to determine how the percentage of growth translates into sheer numbers in terms of age. For example, if 15% of individuals use nicotine for a given year, we can multiply this by the number of individuals in their age groups and get how many people use nicotine.

III. Analysis of the Problem; Model 2

The model created determines the likelihood of an individual to use a given substance takes into account the race, education level, and income of an individual. Initially environment was intended to be included in the model, but it was not able to effectively integrated into the model. For the three chosen factors, data was collected from various sources for how each one correlates with the use of nicotine, alcohol, marijuana, and un-prescribed opioids. The following is assumed:

1. Race, income, and education levels are the only variables that affect substance abuse tendencies, and there is no correlation between the variables. Education is the most important factor, followed by income, and lastly race. The justification for this comes from our research.
2. It is assumed the high school used in the example model of Question 2 follows the demographic averages of the city of Los Angeles. Los Angeles was used because of its high socioeconomic diversity, ethnic diversity, and regional diversity within the city.
3. It is assumed that gender plays a negligible role in the probability of substance abuse, which has been confirmed by the National Institute of Health in many circumstances.

Table 2. Substance Use and Different Populations

	Substance			
Race	Nicotine	Alcohol	Marijuana	Illegal Prescriptions
Black (1)	16.5	20.1	26.1	30.45
White (2)	16.6	24	39.9	42.8
Hispanic (3)	10.7	24.1	24.1	46
Asian (4)	9	21.4	21.2	25.6
	Substance			
Education Lv	Nicotine	Alcohol	Marijuana	Illegal Prescriptions
College Grad (1)	4.5	69.1	5.3	27.02

Some College (2)	18.9	63.3	10.5	17.43
HS Grad (3)	19.7	38.9	9.5	22.7
Some HS (4)	24.1	36.8	9	2.33
	Substances			
Income Bracket	Nicotine	Alcohol	Marijuana	Illegal Prescriptions
<$40,000 (1)	32.2	2.23	13	6.3
$40,000-48,000 (2)	26.8	4.37	10	5.7
$48,000-60,000 (3)	26.4	4.6	10	4.7
$60,000-84,000 (4)	18.8	5	9	3.3
>$84,000 (5)	12.1	5.76	9	2.7

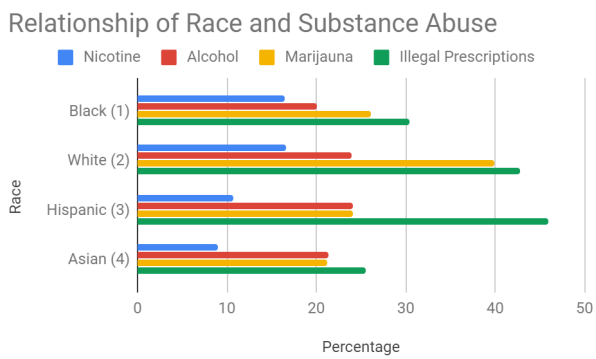

Figure 4. Relationship between race and substance abuse.

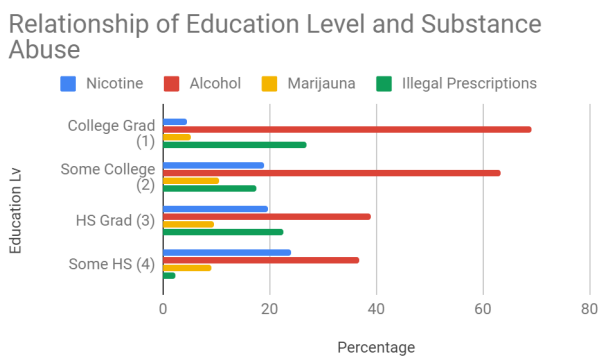

Figure 5. Relationship of education level and substance abuse

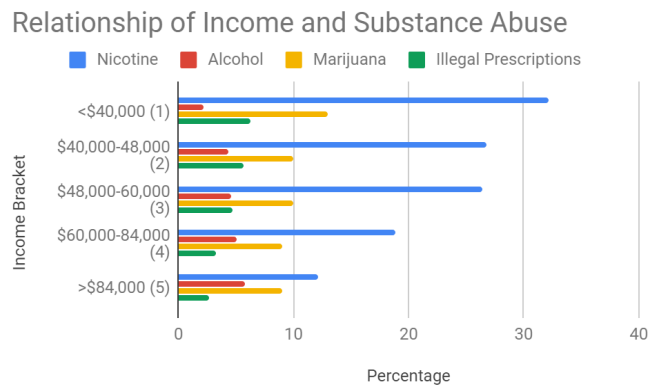

Figure 6. Relationship of Income and Substance Abuse

Using the model to predict the amount of substance abuse in a senior class of 300 located in a high school in Los Angeles, California. The race distribution in Los Angeles is 47.7% latino, 27.8% white, 13.5% Asian, and 8.3% African American. We are assuming that this distribution holds true for the senior class. All of the students in the sample would fall under the "Some High School" education level. Roughly, the income distribution in Los Angeles for the brackets we chose is 40%, 8%, 12%, 10%, and 30%. To apply these statistics to the class of 300, each student is randomly assigned a race and income, and they all have the same education level. Race and income are not completely independent of each other, but for this model we assume there are no correlations.

To determine what drugs each kid would use, each individual would be subjected to a probability test from each of his demographic percentages. For example, all Asian students in the high school with an income range of $48,000-$60,000 would have a 22.35% chance of using nicotine (the weighted mean of the students' race, education level, and income percentages). This number is calculated from the code we created that can be found in the appendix. This process would be completed for each unique combination of demographics, and then the number of students for each unique demographic would be multiplied by each unique percentage (more information about how we calculate can be found below). If there were 10 Asian kids with an income range of $48,000-$60,000 then the model predicts (.2235 x 10) that approximately 2 kids from that specific demographic would use nicotine. The sum of all of these different values from all of the unique demographics would give the total number of kids in the school using nicotine. The same process would then be redone using the data from the three other drugs.

We use the formula $\frac{\Sigma w * j}{\Sigma w}$ where "w" is weight (weight for race is 1, income is 2, and education is 3 as it is the most significant factor), and "j" is the percentage of each category. In order to calculate the percentage of Asian

students in the high school with an income range of $48,000-$60,000 who are smoking, we use (3*24.1 + 2*18.8 + 1* 9)/(1+2+3) = 22.35%. All the number can be found on the table.

TABLE 3. EXPLISIT AND IMPLICIT COST

	Explicit Costs		Implicit Costs		
	Tax per Capita	Average Cost	Health Factor Multiplier	Relationships	Illegal Activity Multiplier
Nicotine	$1.70x	4.47x	1.05	1.05	1.25
Mary Jane	n/a	10x	1	1.1	1.4
Alcohol	1.71x	8.55x	1.1276	1.2	1.2
Opoids	n/a	15x	1.0025	1.5	1.5

IV. ANALYSIS OF THE PROBLEM; MODEL 3

The impact of each substance is calculated by factoring it's cost in terms of actual cost per dosage, loss in productivity, illegality in terms of number of arrests, medical costs, relationship cost, and mental toll on the individual. These are added to the model which provides multipliers and additions to the respective cos if available. For example, illegality of the substance is a multiplier based on number of arrests relating to the substance, while medical cost is an addition based on average cost to treat illnesses related to the substance multiplied by the illnesses prevalence in users.

Below is an equation to quantify the impact of each drug in terms of explicit and implicit costs. This circumvents the impacts listed below, but both are important to understanding how the impacts of each of the substances goes beyond what is listed in the equation. (Tax per capita X # of users) + (avg cost X # of users) X relationship multiplier X illegality multiplier = Total cost / Impact.

V. NON-FINANCIAL IMPACTS OF SUBSTANCE USE

Alcohol

Alcohol is responsible for many car/vehicle accidents. A study from Columbia University shows that drinking while driving multiplies the chance of fatal accident by 14 times. The chance will increase significantly if driving and drinking alcohol with another drug (the risk is multiplied by more than 23 times).

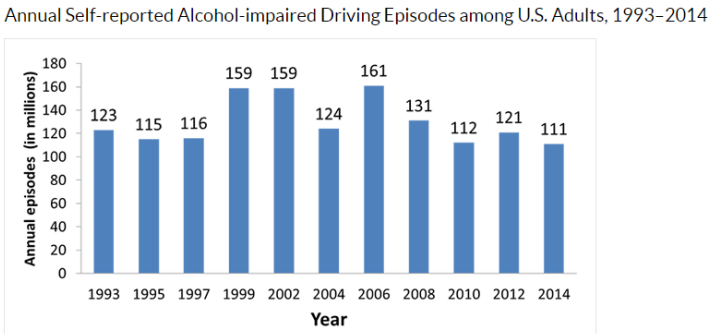

Figure 7. Graph of self-reported alcohol impaired driving episodes in the United States.

Alcohol is also responsible for many aggressive behaviors as shown the the graph below:

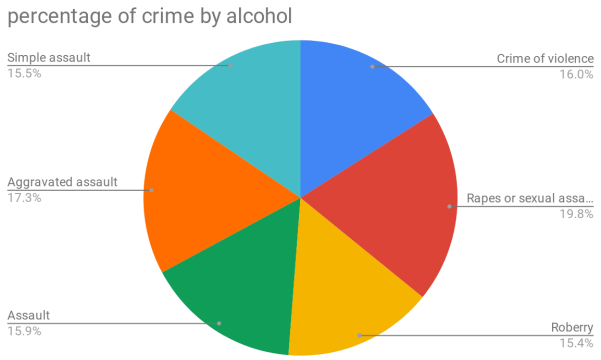

Figure 8. Percentage of different crimes after alcohol use.

In addition, Alcohol can also heighten the dangers of other drugs, and alcohol can also be used to combine with other drugs (graph below -- according to DAWN).

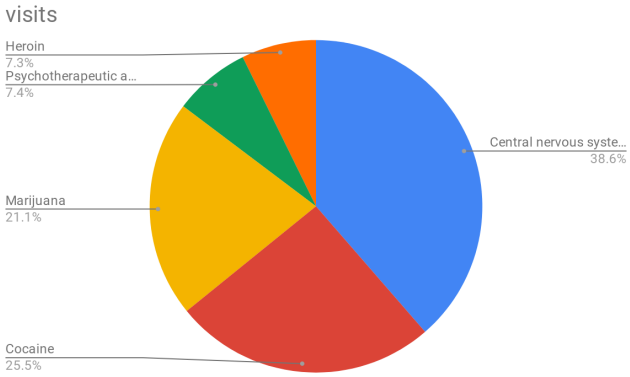

Figure 9. Percentage of alcohol use with other drugs.

If it is combined with cocaine, it can increase the risk of heart attack and overdose. One of the main reasons people drink beer, wine, and other forms of alcohol to relax and wind down at the end of the day, and although it's not recommended, some people use alcohol to self-medicate through tough periods in their lives. The majority of people can use alcohol for most of their lives without having any

problems with it, but for those who struggle with addiction, the consequences can be deadly. The Centers for Disease Control and Prevention estimate that excessive drinking causes 88,000 deaths each year and one in 10 deaths among working-age US adults (ages 20 to 64). Alcohol is also capable of making people more aggressive, and it's a factor in about 40 percent of violent crimes, according to the National Council on Alcoholism and Drug Dependence.

Marijuana

Marijuana is legal in various states throughout the United States, including Michigan. The main risk of marijuana is developing a dependence on it, which can lead to excessive amounts of time of impairment that severely limits ones functionality. The risk of abuse is made worse by the widespread perception that pot is harmless: since many marijuana users believe what they're doing won't hurt them, they feel much more comfortable falling into a habit of using the drug to get the euphoric high that lets some people relax by enhancing everyday activities, including music, food, and sex. There is research and anecdotal evidence that suggests marijuana could be used to treat several medical problems, such as pain, nausea and loss of appetite, Parkinson's disease, inflammatory bowel disease, PTSD (post-traumatic stress disorder), and epilepsy. Despite this, and although marijuana is safer than most other drugs on this list, it's not harmless. It can have a seriously negative impact on a person's productivity at work or school by causing memory loss and hallucinations.

Tobacco

Tobacco leads to more disease than any other drug. It is the main cause of lung cancer which killed over 20,000 people in 2011 alone. The CDC has declared tobacco as the deadliest drug as it accounts for 480,000 deaths in the United States annually. The nicotine found in tobacco is highly addictive, leading to strong dependencies on users.

Opioid-based prescription painkillers

The most common risk of opioid-based prescription painkillers is fatal overdose. In order to reduce their pain, most of people will accidentally take too many. People who mix prescription painkillers with other drugs make more overdose happen. According to CDC, 31 percent of prescription painkiller-linked overdose deaths in 2011 were linked to benzodiazepines. Risk is also increased by alcohol and muscle relaxants. What's more, painkillers, narcotic bowel syndrome, increased risk of bone fractures and might cause the hormonal imbalance. Moreover, prescription painkillers are highly addictive. People use it because of it can efficiently alleviate pain. According to the CDC, more than 16,200 people died of overdoses in 2013.

VI. Financial Impacts of Substance Use

Alcohol

Alcohol can cost $5-9 per drink. A six-pack of beer may cost around $5 to $15, depending on the brand, and depending on how much is consumed, this can add up extremely fast. Under the influence of alcohol a person may be tempted to spend unwisely. People drinking at home may be tempted to make online purchases or other expenditures that they otherwise would not have considered. Medical expenses may rise, as alcohol can affect a person's immune system, leading to a greater susceptibility to illness.

Alcohol-related problems, including issues with the liver and pancreas, can build over time and lead to costly medical expenses. The CDC estimates that excessive alcohol consumption cost the United States $223.5 billion in 2006. These costs were attributed to lost workplace productivity, healthcare expenses, motor vehicle crashes, criminal justice expenses.

Smoking

Days without Smoking	Money Saved
+1	+$36
+2	+$72
+7	+$250
+30	+$1,100
+90	+$3,300
+180	+$6,600
+365	+$13,000

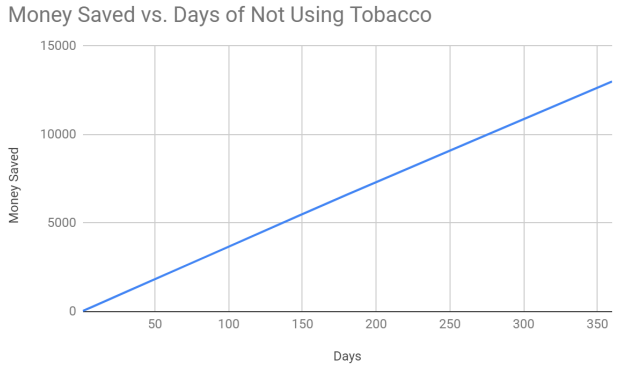

Figure 10. Graph between the amount of days without tobacco and money saved.

VII. Conclusion

From the information above, we conclude that the most dangerous substances are: Tobacco, Opioid-based Unprescribed Painkillers, and Alcohol, while the least dangerous is marijuana. This is deduced from a combination

of its health impacts, explicit and implicit costs of using. While marijuana is the least dangerous according to our model, it still possesses significant dangers to productivity, safety, and cognitive function.

Our models functioned on several assumptions. We assumed that nationwide trends are directly applicable to all individual populations, which may not be the case. A study can be conducted to provide evidence of drug usage in specific areas across the country in order to pinpoint our data. The spread of nicotine abuse as well as the abuse of other drugs is on the rise throughout the country. This is especially alarming in the younger generation as model 2 suggests. The amount of high school seniors predicted to be using these substances indicates a societal issue that needs to be addressed in order to prevent damage to today's youth and lower these numbers for later generations. The impact of these drugs, while varied between them, signifies how abuse can quickly lead to poverty and strain on the economy that must support them.

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The Mob Effect: How a Politically Motivated Trope Became the New "American Genre"

Liana DiCarlo

Abstract – The convergence of history and popular media is apparent in many forms. Music can protest ideologies and television can reflect social feelings of a generation. In the same way, movies have the power to propagate stereotypes and continue them on for generations to come. When the topic of Italian-Americans comes up, what often comes to mind is food, family and the darker, but just a prominent side of organized crime affiliation. Every notable Italian-American themed film seems to include this key formula. The formula itself can be examined in how it has evolved on screen, and to what extent that this representation matters in the public perception of a group of people. By exploring the history of Italian-Americans and the history of Italian-American representation together, insights can be drawn from the various levels of dynamic representation and the political ramifications of media. Part I of the paper will discuss some of the history of the film industry and the Italian-American representation.

Keywords – Italian-Americans, mobs, film, cinema, and genre

I. INTRODUCTION

Film has the opportunity to reach various audiences and affect their perception of groups of people. In "Italian-Americans in Film: From Immigrants to Icons," Carlos Cortés discusses the unintentional educational aspect that popular film has on the public's opinion on ethnic groups. The text draws mostly on examples in film from the period that he is discussing at the time. He touches on the revisiting of *The Godfather* saga, with the new version including a note about how these films are "not representative of any ethnic group." [1] This is discussed with a certain irony, as Cortés argues that it is clearly supposed to represent Italian-Americans. The comparison and connection of media and ethnic history is an interesting comparison because it shows the reciprocal relationship between media and historical events. Cortez explores media representation more closely raising questions on understudied or mis-studied parts of history because of their representation.

II. EARLY ITALIAN-AMERICAN REPRESENTATION

Instead of looking at the history of Italian-American cinematic representation and the history of the Italian-American immigrant to modern experience as two separate histories, intertwining them offers insights into the influences they have on each other. This offers a lens into ethnic representation in popular media and its possible political effects both in the past and the present. Anti-immigrant media created under the guise of entertainment was purely politically motivated. This was common in the height of Italian-American immigration between 1900-1910 [2]. However, even media made purely for entertainment affects the political hearts and mind of a people, and in turn can affect the political choices they make. The trope of crime and ethnic groups is not at all just prevalent in groups of Italian descent, but instead plagues many different groups of people seemingly grouped outside of the idea of the average upstanding American citizen. Looking at Italian-American representation specifically is beneficial as a case study in this however, because of the vast collection of mob media and its current place as a mainstay in American media.

In order to discuss the changes in representation over the years, one must look to the beginnings of this filmic trope connecting Italian-Americans to organized crime. The same representation that was used to negatively represent the mass immigration of ethnic groups

from the late 1800s and the early 1900s soon targeted the second wave of Italian immigration [3]. This wave was mostly southern-Italian laborers and farmers, in contrast to the earlier immigration wave of northern-Italian artisans during the 1800s [4]. In the period between 1900 and 1915, more Italians immigrated to the United States than from any other country in this immigrant wave, at 3 million people [5]. The fear of an onslaught of immigrants that speak a different language, practice a different religion and come from working class levels of society rallied the usual fear of immigration. After 1915, however, the numbers of Italians immigrating stayed almost completely consistently under 100,000 a year [5]. With this slowing down in Italian immigration, and immigration to the United States overall, anti-immigration sentiments against Italians can begin to wean as they enter the fabric of the American working class during the 1920s [5]. Italian-American immigration to the United States followed a similar pattern to other "white" ethnic groups of that era. Faced with the same tropes of undercutting labor wages and participating as "scabs" in strikes, they were seen as a threat to the working order of society [6].

The early 1900s representation of Italian-Americans in film included humorous or saddening tales of poverty and the immigrant experience [7]. As anti-immigration feelings grew, these tales of poverty began to include tales of crime, and then organized crime. The connection of immigrants and criminality in media "did not arise organically from society but were consciously constructed, often by the state, to define working class groups as criminals and a threat to order." [7] The state supporting media that describes immigrant working class communities in a negative light have a dual purpose. Firstly, they can pit classes against each other, with a "us versus them" mentality. The hope is that perhaps they would identify with groups in higher socioeconomic groups, of which members of the state usually reside. The second purpose is to demonize immigrant population to further anti-immigration sentiment. This anti-immigration sentiment and the onslaught of poverty that swept in with the depression began the negative Italian-American negative gangster portrayal. However, this is not without some historical accuracy. With the beginning of prohibition and then the rise poverty of the Great Depression organized crime was a problem, yielding infamous names such as Al Capone and Lucky Luciano.

This time period of the 1920s and 1930s was ripe for an increase in organized crime for two glaring reasons. Firstly, there were large numbers of immigrant groups that had entered the United States but had yet to assimilate. As people do, they cluster with others like them, in this case, by ethnic background. A shared language and culture lead to communication and community. With the added situation of poverty and low levels of education in immigrant populations and the opportunity, organized crime was set up for success. The opportunity for abuse of the system surrounding prohibition was not just taken up by ethnic organized crime groups however, but instead the entire system was riddled with crime overall. Just four years into Prohibition and the bootlegging that came along with it, the Immigration Act of 1924 was passed [8]. This put quotas in place on immigration that would not be revised again until 1952 [8].The revision on this act being in 1952 demonstrates a diminishing fear of immigration to some degree, or at least to certain immigrants.

III. The 1970s and the End to a Mafia Film Hiatus

After this period of mass immigration and anti-immigration negative media portrayal, there was a lull in Italian-American representation in film. No longer needed as a political trope to encourage and reflect anti-immigration sentiment, Italian-Americans were entering the fold of American society without being plagued by the media connection of criminality.

This did not last forever though, with a new era of mob movies popping up in the 1970s, just 40 years after the last decade of significant negative criminal Italian-American representation. How these negative fear mongering portrayals turn to

glorified icons of American cinema, however, is tied to a specific timeline of the fabric of Americanization of immigrants during this 40-year lull. The 1970s was a decade of mob film revival which included the iconic mob themed, and mob influenced, film *The Godfather* which started the mob revival that would continue on for decades to come well into present day films and overall representation of Italian-Americans. This decade was 55 years after the end of the height of Italian immigration, and therefore the sons and daughters of these immigrants had grown up in America, specifically as Americans. Losing a lot of the culture that made immigrants "other" to the American populace, such as language, Italian-Americans had entered the fabric of "Americans." Only as the threat of immigration diminishes are they able to be glorified in American popular media.

The discontent with movies about Italian-Americans being ubiquitous with organized crime tropes extends further than just some of the community in America. In a 1972 Daily News article, *The Godfather*'s movie producer, Al Ruddy, discusses the making of the film. Topics include working with the director Francis Ford Coppola, choosing the actors and lastly, the public interaction that came into play for the setting of the scenes in Italy [9]. He states that they were unable to film scenes in Palermo, Italy that were supposed to be set there [9]. The reason he openly gives is that the public there is not open to mafia movies being filmed or associated with their area [9]. By openly stating this in an interview, Ruddy acknowledges the possible backlash of the Italian community, and therefore the possible negative feelings of the Italian-American community back in the United States. Instead, they had to film these scenes in a part of Italy that has more Greek influence, and therefore fewer negative feelings toward Italian mafia association [9]. This is an example of the negative feelings that were associated with the portrayals of Italian-Americans and their Italian roots in the media by only being portrayed as mob associated. The fact that even Italians not in America were not friendly to the idea of being associated with a mob movie is all the more striking because they are not the Italian population that is being directly harmed, but instead the sons and daughters of Italians who had left for America decades before.

The public interference in the making of this classic movie does not stop at the border of Italy. The founder of the Italian-American Civil Rights League of the 1970s, Joe Colombo, had also persuaded Ruddy to remove certain words from the script that he found offensive to the Italian-American community [10]. He felt that the media targeted Italian-Americans and painted them negatively as mobsters. Ironically enough, Colombo himself was a very prominent mobster outside of his activist facade. The Italian-American Civil Rights League also worked to pressure the FBI to not use words such as "mafia" and "cosa nostra" in reports and they succeeded in obtaining a Justice department order [11]. The pressure from the league was bolstered by its relatively large membership and use of prominent names, such as a Frank Sinatra benefit concert. This raises questions on if this pressure to remove certain words from the FBI reports and from the script of *The Godfather* was due to Colombo's power as a mobster or the power of the League. The threat to change the script was successful regardless, but not mentioned by Ruddy in the interview, bringing to question the possible hesitation of the producers to share this information. This adds a new layer to the portrayal of Italian-Americans, as one of their biggest proponents of positive representation was in fact what they were being "unfairly" represented as.

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The Effect of Oxidizing and Reducing Agents on the Amount of Chemiluminescence Produced by *Phaseolus vulgaris* Sprouts

Debolina Chanda

Abstract – In 1955, a light emission by plants (luminescence) was first discovered by Colli and Fachinni (Colli and Fachinni, 1954). The breaking down of oxygen free radicals, which are byproducts of metabolism, causes this luminescence. Oxygen free radicals (reactive oxygen species) serve an important role in cellular function. They serve as signal transmitters for molecules from cell to cell. In this experiment, oxidizing and reducing agents were used to neutralize and stabilize the production of reactive oxygen species. As a result, production of reactive oxygen species was either sped up and more were created or slowed down, where less was created. Luminol solution was used to measure the light intensity of the plants. The purpose of this experiment was to determine if there was a direct correlation between the amount of reactive oxygen species present in *Phaseolus vulgaris s*eedlings and the amount of chemiluminescence they emit. The plants that were soaked in hydrogen peroxide, had a light reaction that lasted the longest. Whereas, the plants that were soaked in water had a light reaction whose duration was the shortest. It was determined that the higher the amount of reactive oxygen species in an organism, the more chemiluminescence it emits. This demonstrated that a chemiluminescence assay can be used to determine the levels of reactive oxygen species produced by an organism. High levels of reactive oxygen species may be threatening to an organism if the levels are not monitored.

Keywords – chemiluminensce, Luminol, oxidization, reduction, and *Phaseolus vulgaris*.

I. INTRODUCTION

The cell in the human body requires a place to store the used electrons that drive energy in the respiration processes. When the electrons have given up their energy, they are combined with oxygen to form water. Since the electrons are given away to the oxygen molecules, it is said that the oxygen becomes "reduced", which forms water (H_2O), a completely harmless substance, in the process. In its normal state, oxygen has two unpaired electrons in separate orbitals of its outer shell. This indicates that two electrons are required for each water atom. When one of the electrons is lost or only one electron is given to each oxygen molecule, a free radical is created. These are known as reactive oxygen species.

Rreactive oxygen species are molecules containing the element oxygen which are chemically reactive. They are formed as a natural byproduct of metabolic processes. The primary reactive oxygen species is the superoxide anion, which is created by th eimmune system in phagocytes to use against invading viruses and bacterium.

Plants and other living organisms constantly produce reactive oxygen species in their mitochondria, chloroplasts, and other organelles because of their metabolic processes such as photosynthesis and respiration. These reactive oxygen species function as signaling molecules, which transmit information between cells. The most concerning radicals are those that are derived from oxygen. Overproduction of these oxygen radicals may cause a threat to the organism. When reactive oxygen species production exceeds the capacity for antioxidation, it can lead to cell damage and/ or cell death caused by toxicity. For instance, when cells are exposed to abnormal environments, they may generate dangerous amounts of damaging reactive oxygen species (Bowen, Free Radicals and Reactive Oxygen, colostate.edu). The body normally regulates the oxygen radicals, but if this system malfunctions having oxygen radicals in abundance may harm the cells around them. Many drugs that are used to cure infections and diseases today have oxidizing effects on cells which may lead to the production of oxygen radicals.

Certain oxygen radicals; however are not completely harmful. Phagocytic cells generate free radicals to kill invading pathogens. Despite the benefits of oxygen radicals, due to their high reactivity they damage the cells around them starting with the cell membrane (Marnett 2002). This causes the membrane-proteins to become dysfunctional.

The presence of an unhealthy amount of oxygen radical poses a threat to an organism. Light emitted due to a chemical reaction within a cell is

called chemiluminescence. Chemiluminescence is emitted by cells as a result of of reactive oxygen species breaking down inside the cell. Due to this, we can determine the amount of oxygen radicals in a cell by measuring the amount of chemiluminescence it emits. This is due to the process of degeneration within the cells of the organism. The purpose of this experiment is to show that plants emit chemiluminescence and that chemiluminescence levels can be altered in the presence of an oxidizing/reducing agent. Thus, chemiluminescence may be an indirect measure of the levels of oxygen radicals. Hypothesis: If the amounts of chemiluminescence produced by the organism are high, then high levels of oxygen radicals will be present. Plants that are treated in an oxidizing solution will show the highest amount of chemiluminescence.

A study done by Mariola Marchlewicz and others published in Elsevir entitled "Detection of lead-induced oxidative stress in the rat epididymis by chemiluminescence" examined the relationship between chronic Pb exposure and level of reactive oxygen species (ROS) in reproductive system tissues of sexually mature male Wistar rats. Results showed that "Chemiluminescence (CL) emitted by the Pb-treated tissues was significantly higher when compared to the light emission by tissues isolated from the animals of control group." (Marchlewicz 2004) This indicates that chemiluminescence levels were measured to determine the levels of reactive oxygen species in the reproductive system of male Wistar rats. According to this study, higher levels of chemiluminescence were found in the Pb-treated tissues in the presence of antioxidants (reactive oxygen species).

"Spontaneous Chemiluminescence of Soybean Embryonic Axes during Imbibition" by Alberto Boveris and his partners from *Plant Physiology* conducted an experiment in which they tested the spontaneous chemiluminescence of isolated soybean embryonic axes "upon water imbibition" (Boyeris 1984). It states that in their results that there was a "marked increases (5-fold and 12-fold, respectively) of lipoxygenase activity between 2 and 30 hours of imbibition" (Boveris 1984). This shows how chemiluminescence is used to detect many substances within cells. Some of these substances may be harmful, so early detection can benefit the organism. Moreover, the article states, "Chemiluminescence may afford a noninvasive assay for lipoxygenase activity in intact plant tissues" (Boyeris 1984). Lipo-oxygenase tightly control the reaction with molecular oxygen and others that form mixed products and permit the release of free radicals (Brash 1999). There may be a correlation between the production of free radicals and lipoxygenase activity, which as seen in the journal article, may be detected by the levels of chemiluminescence in an organism.

"Chemiluminescence of soybean saponins in the presence of active oxygen species" by Yumiko Yoshiki and others, published in Elsevir, states "Natural active oxygen scavengers (Y; catalytic compounds) exhibit chemiluminescence (CL) in the presence of an X (active oxygen compounds) and a Z (receptive compounds)" (Yoshiki 1996). This shows that organisms that perform cellular respiration naturally emit chemiluminescence as a result of their oxygen compounds. Some of these oxygen compounds may be reactive oxygen species. It also states From the CL obtained with phenolic compounds, it is suggested that the active oxygen compounds were scavenged by Y (catalytic compounds) and Z (receptive compounds)" (Yoshiki 1996). This shows the relationship between the enzymes and compounds related to oxygen compounds and the emission of chemiluminescence (CL).

II. Materials

The materials that were used in this experiment were eighteen *Phaseolus vulgaris* seeds, distilled water, a vitamin E solution (which acted as the reducing agent) and a hydrogen peroxide solution (which acted as the oxidizing solution). Using reducing and oxidizing solutions caused the production of reactive oxygen species to either slow down, or speed up. Pieces of plastic were used to crush the plants. Luminol solution and a stopwatch were used to measure the light intensity resulting from the chemiluminescence reaction (Agarwal).

III. METHODS

Eighteen seedlings were grown for one week. They were separated into two groups of nine. The first group of nine seedlings was called group A and the second group of nine seedlings was called group B. Group A was grown in a normal environment while; group B was grown in a highly polluted environment. Both groups were grown in the dark so that outside light factors do not interfere with the natural chemiluminescence of the plants. Both groups were given equal amounts of water and soil. After one week of growth, groups A and B were taken out of the soil and washed thoroughly with distilled water. Then, group A was separated into three sets with three seedlings in each of the sets. The first set was called set 1a. Set 1a was soaked in 10mL of a 100 IU Vitamin E solution in a petri dish labeled set 1a. The second set was called set 2a which was soaked in a petri dish labeled 2a with 10mL of hydrogen peroxide. The third set was called set 3a. Set 3a served as a control group and was soaked in 10ml of distilled water in a petri dish labeled 3a. Group B was separated into three sets each with three seedlings. The first set was called set 1b and was soaked in 10mL of a 100 IU Vitamin E solution in a petri dish labeled set 1b.

The second set was called set 2b. Set 2b was soaked in a petri dish labeled 2b with 10mL of hydrogen peroxide. The third set was called set 3b. It was soaked in 10ml of distilled water in a petri dish labeled 3b. These amounts were used because previous research has shown that these amounts exhibited the best results. All seedlings from both group A and group B were soaked for 15 minutes so that the plants could absorb the solutions that they were soaked in. After the 15 minutes the plants from groups A and B were crushed between two pieces of plastic. Following this, each individual plant was crushed it was wiped dry and placed into a clean petri dish. Then, 5ml of Luminol solution was added to the petri dish while all lights were turned off in order to observe and record the chemiluminescence of the plants by measuring the duration of the light reaction using a stopwatch in seconds. The whole procedure was repeated two more times; using a new batch of eighteen seedlings each time the experiment was conducted. The data from each of these trials were averaged by adding the durations collected, in seconds, and dividing by 3 (the number of trials). This was repeated for the data collected from sets 1a, 2a, 3a, 1b, 2b,and 3b The average light duration from the chemiluminescence of each set was measured and graphed on a bar graph to compare the data to the control group (set 3a). Photos were taken of the experimental data.

Table 1. The Amount of ROS vs. Average Duration of Light Reaction

Petri Dish Set	Average Duration of Light Reaction (seconds)
Hydrogen Peroxide w/o Pollution	4.67
Vitamin E w/o Pollution	3.18
Water without Pollution (control)	3.53
Hydrogen Peroxide with Pollution	4.58
Vitamin E with Pollution	3.29
Water with Pollution	3.56

IV. DISCUSSION AND CONCLUSION

The plants that were soaked in hydrogen peroxide, had a light reaction that lasted the longest. Whereas, the plants that were soaked in water had a light reaction whose duration was the shortest. This proves the original hypothesis that plants that are treated with oxidizing solutions (in this case, hydrogen peroxide), which have the highest number of reactive oxygen species, will have the highest amount of chemiluminescence emitted from them. According to the results that were gathered, in both the groups that were and were not exposed to pollution, the plants that were treated with hydrogen peroxide showed the highest levels of chemiluminescence. The plants that were treated with hydrogen peroxide that were not exposed to pollution (set 1a) produced a light reaction that lasted on average 4.67 seconds. Moreover, the plants that were treated with hydrogen peroxide that were exposed to pollution (set 1b) produced a light reaction that lasted 4.58 seconds on average. On the contrary, the plants that were treated with the reducing agent (Vitamin E) showed a light reaction that had duration of 3.18 seconds in the group that was not exposed to

pollution, and 3.29 seconds in the group that was exposed to pollution. With all in consideration, it may be concluded that the higher the amount of reactive oxygen species in an organism, the more chemiluminescence it emits.

Possible sources of error may have included human error when reading the time on the stopwatch and inaccuracy when transferring liquid solutions to the petri dish. Moreover, since after the plants had been soaked in the solutions, they needed to be wiped clean some of the excess solution that may have remained on that plants could have affected the duration of the chemiluminescence. Also, background light during the growth of the plant may also have affected its chemiluminescence since the plants may have absorbed some light from the environment. The amount of solution that the plants absorbed while they were soaking in the petri dishes may have also varied. Overproduction of reactive oxygen species has been known to promote cell damage and damage. Some further research would be to determine the effects of reactive oxygen species on the amount of cell death/damage. One form of chemiluminescence is bioluminescence. Bioluminescence is the production and emission of light by living organisms, mainly marine vertebrates and invertebrates and bacteria. A study that could be done in the future can be to determine if there is a correlation between the bioluminescence of bacteria or marine vertebrates.

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The Effects of Acidic and Basic Rain on Bridge Stability

Jillian Panagakos, Melinda Harbhajan

Abstract – The acids and bases in the water cycle can settle on a bridge through condensation or evaporation. Acidic rain and basic rain are corrosive and have detrimental effects on building materials. Since the water cycle is continuous, acidic or basic rain would have a lasting effect on the strength of a bridge. Four bridges were created and three were suspended over hydrochloric acid, sodium hydroxide, and distilled water. For a week, each bridge was isolated under an aquarium tank. The fourth bridge was not tested with any liquid. The efficiency of each bridge was calculated by dividing the supported mass by the mass of the bridge. It was hypothesized that the bridges suspended above the hydrochloric acid and the sodium hydroxide would result in being less efficient than the bridge suspended over distilled water. The hypothesis was negated; The bridges suspended above the acid and base proved to be more efficient. The experiment is significant because the effects of acidic and basic rain should be considered when designing an effective bridge.

Keywords – truss bridges, acidic and basic rain, bridge stability and structure

I. INTRODUCTION

A bridge's structure must meet a set of requirements by the American Association of State Highway and Transportation Officials [1]. There are several variables that affect the design of a bridge, such as the dimensions of the cross section and the positioning of cables. Precautions that are taken when bridges are engineered are the management of stress, properly locating cables, knowledge of capacity and limits of deflection and force eccentricity, and widths of cracks and fatigue [1]. The truss bridge is one of the oldest and most efficient types of bridge, with a geometric structure and can be made from metal, wood, or other materials [2]. The material used to make a truss is positioned further from the center-line of the bridge, strengthening the structure. A truss does not require much structural material, making it lighter than the other components of a bridge [2]. Bridges with trusses have limited bending potential due to the location of the truss and the central axis of the bridge [2]. There is more compression strain, rather than tension strain, found in wires, allowing to support more weight than a simple bridge [3].

Although bridges are built to tolerate rigorous conditions, there are still factors that reduce their strength. High levels of SO_2 and NO_x can be found in the urban environments with bridges. The acidity of these substances can damage a bridge's structure [4], such as the corrosion and tarnishing of metals and electrical components, the discoloration of paints and organic coatings, the cracking or weakening of rubber or plastics, and the flaking of bricks [5]. The materials used to build a bridge can be negatively affected by acidic rain, which has a pH less than 5. Steel proves to be the strongest material because it can withstand acidic rain longer than the other two metals [6]. All of these factors weaken the strength of the bridge and deteriorate its structure.

Acids have a pH value less than 7, and bases have a pH value greater than 7. There are some strong bases such as sodium hydroxide, potassium hydroxide, and barium hydroxide [7]. Strong bases behave like strong acids because they can be corrosive, while weaker bases are less reactive. A strong base, like sodium hydroxide, has a pH value of 13 [8]. Rain that is basic can have the same impact on bridges as acidic rain. However, acidic rain is more likely to be found.

The effects of acidic and basic rain are implemented through the water cycle. An experiment was conducted to test the effects of acidic and basic rain on bridge strength. It was hypothesized that the bridges suspended over the hydrochloric acid and sodium hydroxide would

result in being less efficient than the bridge suspended over distilled water, because acids and bases have the ability to corrode bridge materials, therefore reducing its strength. The experiment is significant because the effects of acidic and basic rain may now be considered when attempting to design an effective bridge.

II. MATERIALS AND METHODS

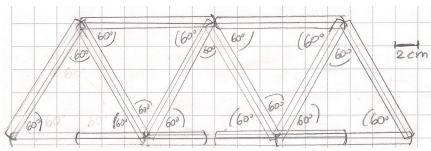

Figure 7. A blueprint displaying the horizontal view of the bridge with a scale and appropriate angle measurements

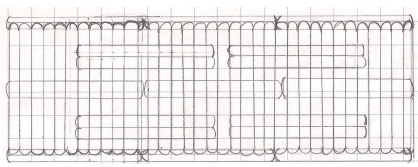

Figure 8. A blueprint displaying the underside view of the bridge with the same scale and measurements as Figure 1.

The materials used were Woodsies popsicle sticks, Elmer's glue, 2 liters of 0.5 M sodium hydroxide (NaOH), 2 liters of 0.5 M hydrochloric acid (HCl), 2 liters of distilled water, 3 pH strips, 3 1,000 mL Erlenmeyer flasks, 3 plastic containers (to each hold 2 liters of liquid), 3 empty aquarium tanks, 2 tables, string, a bucket, sand, and an electronic scale. First, four truss bridges were constructed according to the blueprints displayed in Figures 1 and 2 using Woodsies popsicle sticks and Elmer's glue. The mass of each bridge was recorded as the original mass of the bridge, and each bridge was labeled according to the liquid that they would be suspended over. The first bridge was placed between two tables with one end on each table over a gap of 26 cm. Next, string was tied around the middle of the bridge, in order to hang the empty bucket. Sand was continually poured into the bucket until the bridge broke, indicating that the bridge could support no more. The combined mass of the bucket and sand was recorded as the amount of mass that the bridge was able to support. Then, an Erlenmeyer flask was used to measure 2 liters of distilled water and was poured into a plastic container.

The same process was repeated with the hydrochloric acid and sodium hydroxide poured into one of the remaining plastic bins. The pH of each liquid was measured. The three bridges were suspended above their respective containers by laying them across the width of the plastic bin. Overturned aquarium tanks were placed over the bridge and the liquid-filled containers to simulate the environment of a bridge that spans across a body of water. After a week of isolation, the bridges were removed. To test the stability of each bridge, the same process used to measure the mass supported by the dry bridge was repeated. The efficiency of each bridge was then determined by dividing the supported mass of the bridge by the original mass of the bridge. One trial was conducted. Data was recorded in a data table, illustrated in a bar graph, and analyzed via the calculated efficiency.

III. DATA

An experiment was conducted to test the effects of acidic and basic rain on bridge strength. The results for the dry bridge, without being suspended over any liquid, were a mass of 124 g and the ability to hold 17,800 g, resulting in an efficiency of 144. The results for the bridge suspended over the distilled water were a mass of 156 g and the ability to hold 5,600 g, resulting in the efficiency of 35.9. The results for the bridge suspended over the hydrochloric acid were a mass of 129 g and the ability to hold 15,900 g, resulting in the efficiency of 123. The results for the bridge suspended over the sodium hydroxide were a mass of 135 g and the ability to hold 12,200 g, resulting in an efficiency of 90.4.

TABLE I. THE MASS, MASS SUPPORTED, AND EFFICIENCY OF EACH BRIDGE TESTED

Bridge Type	Mass (g)	Mass Supported (g)	Efficiency
Dry	124	17,800	144
Distilled	156	5,600	35.9
Acid	129	15,900	123
Base	135	12,200	90.4

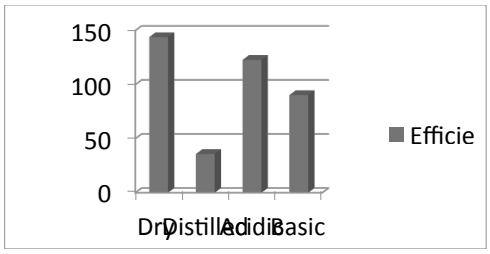

Figure 9. A bar graph that displays the differences in efficiency between each of the four bridges tested.

IV. Discussion and Conclusion

The results show that the most efficient bridge was the one suspended above hydrochloric acid, with a pH of 2, which held 123 times its weight. The bridge suspended above the sodium hydroxide, with a pH of 13, held only 90.4 times its weight, while the bridge suspended above the distilled water, with a pH of 6, held only 35.9 times its weight. The control, a bridge not tested with any liquid, held 144 times its weight.

The hypothesis that the bridges suspended above the hydrochloric acid and sodium hydroxide would be less efficient than the distilled water was negated. The results show that the bridges suspended above the acid and the base had efficiencies far greater than the bridge suspended over the distilled water. These results are significant because they show that the evaporation and settlement of an acidic or basic liquid was less detrimental to the bridge's strength than that of a neutral liquid. The hydrochloric acid and sodium hydroxide had a concentration of 0.5 M. This means that, for each liter of the solute, there exists 0.5 moles of the solvent. With the addition of these solutes into the solvent, there is a reduced amount of solvent evaporating as the hydrochloric acid and sodium hydroxide respectively are holding the water solvent in-phase. Since the acid and base had less solvent evaporating compared to the distilled water, which is a pure solvent, the popsicle sticks of those two bridges had a lower moisture content. As the moisture content in wood increases, the wood expands and the strength decreases. The bridges which absorbed less moisture suspended over the acid and base were stronger because they did not swell as much.

The main source of error for this experiment was that the bridge suspended above the distilled water was tested immediately after isolation. Bridges suspended above the acid and base were not tested until one day after their removal from underneath the aquarium tank. This extra day of drying may have lowered the moisture content and affected the strength of the popsicle sticks. The glue that held the popsicle sticks together may have also been able to dry, causing an increase in the bonding strength. Future experimentation includes the use of bridges constructed of metal instead of wood, the use of a different bridge type aside from a truss, the use of an acidic or basic rain recipe instead of just an acidic or basic liquid, or simply the use of different pH values.

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Bhante Katukurunde Nanananda's Interpretation of Nibbana: Experience Without Boundary

Arjuna Jayawardena

Abstract – This research is an attempt to interpret how the early Buddhist teachings portray Nibbana and how this portrayal might be understood as a fitting conclusion to the Buddha's quest to overcome suffering. In particular, we have tried to shed light on what is meant by *bhava-nirodha* (cessation of existence), a common description of Nibbana, and how such a dictum might avoid annihilationist interpretations without, at the same time, leaning towards an eternalist interpretation, the two extremes the Buddha seeks to avoid. In the second section, we attempt to see how the Buddha instructed his disciples to abandon the arising of the self-perspective. We have relied heavily on Bhante Katukurunde Nanananda's analysis of the *sutta-pitika* as seen in a number of his books and most notably, in his *Nibbana: The Mind Stilled* series [1].

Keywords – Nibbana, self-perspective, mindfulness, peace, and Buddhism

I. Introduction

Nanananda, formely a Pali lecturer, came under the guidance of Bhante Matara Sri Nanarama and was invited by the latter to deliver the sermons on Nibbana which would comprise the *Nibbana: The Mind Stilled* series [1]. Nanananda's interpretation is notable, first, in its disagreement with the commentarial tradition's understanding, and second, in its insistence of Nibbana being the cessation of existence while nevertheless avoiding an annihilationist point of view. The sermons also rely heavily on the early texts. For the most part, these sermons were met with much resistance for the very same reasons that they are notable
(the commentarial tradition is held in very high esteem in Sri Lanka, where these sermons were delivered).

II. Cessation of Existence and Dependent Arising

Nibbana is often defined as the cessation of existence, a claim that is met with much resistance and accused of representing a nihilistic worldview. We ordinarily perceive existence in terms of some essential being, and to conceive Nibbana as the destruction of that essence surely leads us to perceive the cessation of existence as annihilation. According to the Dhamma (the Buddha's teachings), however, we need to straighten our view in line with the way things are, namely, the law of dependent arising. According to this law, the independent existence of a thing is an unfounded presupposition in conflict with the way things are. Some think that the blissful experience of the cessation of existence is won only after death. This, however, goes against the 'here-and-now' quality of the Dhamma, according to which one need not wait for some future state in order to experience spiritual awakening. The Dhamma would have it that the cessation of existence occurs when craving, conceit, and views are made null and no longer go to concocting a prepared-but-apparent existence (or substantiality) and preparations are perceived simply as preparations, arising and passing according to their nature. Then all things are comparable to grass and twigs because they possess no inherent value.

At the center of the Buddha's teaching (Dhamma) is dependent arising [2]. Dependent arising is the 'relatedness of this to that' (*idappaccayata*) [2]. The relationship between any two consecutive links is a specific expression of that basic principle. Thus, that verse must signify what is meant by 'the relatedness of this to that'. Now this formula describes the structure of personal experience and in particular, how the concepts of (self)-existence, birth, decay, death, and dissatisfaction arise, according to the Buddha's understanding.

Buddha described dissatisfaction as dependently arising: The point of origin is the deluded belief (*avijja*) that it is possible to go against the three signs of existence, namely impermanence,

unsatisfactoriness, and not-self. Preparations (*sankharas*) are made to take the current against the stream of reality, and that pushing of the current against the mainstream, as well as the tendency to do so, is discriminative consciousness (*vinnana*). That point of resistance is name-and-form. With the whirlpool, an abyss is formed, the functioning of which is comparable to the six-sense bases (*salyatana*). How so? An abyss has been likened by the Buddha to painful feelings, feelings of emptiness and despair. The ordinary individual knows no escape from pain but sensual pleasures, and so, the six-sense bases are molded in order to quench the thirst (or craving; *tanha*) arising from painful feelings (*vedana*). This is [seemingly] done by the act of grasping (*upadana*) the surrounding flotsam and jetsam, which are comparable to the aggregates of grasping (*pancupadanakkhanda*). Consequently, the designation of a this-ness becomes possible; a show of existence (*bhava*) is put up. That is to say that a reference point and things referred to have arisen as consciousness pushes against the main stream. At this point, there are two forces opposing one another and this makes possible the designation of one thing as separate from the other. A 'this' has been born and, in line with the ever-changing nature of experience, is bound to decay and die. So here we have the Buddha's outline of life.

III. Mindfulness and Peace

When, with mindfulness, the relative designations of painful/ pleasant, internal external, and so on are seen to be ineffective, or, when the collectedness and calm of a trained mind watches how feelings, whether painful or pleasurable, arise only to pass away, then one realizes that the utter significance those feelings once held were actually branded *onto* them by a point of view, and that even that point of view was prepared –that it was the propped up separation in experience that made possible all such designations. Thus, the distinction between painful/ pleasant, internal/ external, and so on, falls away and the dualistic interplay between consciousness and its object lessens. When discrimination is undone, then one is truly alone because there are no others, and no self; there is no inside, and no outside. This consciousness is "indeed symbolic of the Arahant's singularity, wholeness, aloofness and solitude" [1]. In that consciousness, *there is no separation*. This is a "solitude born of full integration" [1]; there is no alone because there is no separation and because there is no separation there is full integration.

Nanananda teaches that if the understanding that in the case of the Awakened ones, "what remains there, now, is the great ocean, undifferentiated and unique" is gained, then that fear of nihilism and annihilation will dissipate: the cessation of the whirlpool is no different than "inheriting [the] expansive great ocean. It is where a vortex ceases that the great ocean prevails unhindered. To give up the limitations of a vortex, is to inherit the limitless ocean... It is by giving up all that one becomes worthy of all [1]. This paradox is inherent in the term 'Arahant', which literally means 'one who is worthy of gifts' and refers to the one who has no attachments –who has let go of all. Nanananda adds that when the vortex of samsara ceases, one gains a vision of the "depth, immeasurability, and boundlessness of the great ocean. This line of reflection might even enable one to get a glimpse of an unworldly beauty in this philosophy of the void, which drives an unfounded fear into the minds of the worldlings" [1]. Voidness and essencelessness, though feared often, is in the Dhamma nothing but natural and limitless freedom. The concepts of existence, concurrent with the concepts of birth, decay, and death, confine experience. Essencelessness is the beauty that tempts one to let go –to abandon grasping altogether. Grasping abandoned is the very gaining of freedom from grasping and all its consequent suffering. It is the realization that as-it-is, the norm of Nature is perfectly at ease and undisturbed.

Wisdom, in the Buddhist sense, is knowledge of emptiness and in particular, the emptiness of even consciousness. Even consciousness as

discrimination is prepared. It is out of this ignorance that the awakened ones emerge, blooming like the louts, pure in fragrance and form. For the Buddha, it is such a sublime beauty that instills in the ordinary individual a fear of the cessation of existence.

IV. Discussion and Conclusion

We have presented here a vision of Nibbana, primarily according to Nanananda's interpretation of the early Buddhist canonical texts. In it, we have shown that dependent arising attempts to portray how the subject-object dichotomy arises in experience. It portrays the interaction between consciousness and its object as something that is prepared and inherently dualistic. From this perspective, consciousness in the ordinary sense is something that is prepared specifically to discriminate. For the Buddha, this preparation is the arising of the point of view which makes possible the designation of a this-ness. From it arises all concepts, which establish in experience the sense of separation and thing-ness. The Buddha goes on to highlight this experience as being prepared and made-up. He attempts to persuade the listener to abandon this act of preparing through insight by highlighting its pivotal role in the arising of dissatisfaction. This can be seen in his instructions which ask to refrain from imagining in experience a subject or object apart from that bare experience. We then bring up various discourses, describing a form of consciousness wherein this subject-object dichotomy is absent which itself is claimed to be the end of suffering. In this consciousness, there are no objects ordinary to the world.

Nevertheless, there is still a sort of quasi-object –a knowing of Nibbana which supposedly does not involve any form of dualistic knowing. What is there is just the experience of unbifurcated experience and this itself is Nibbana. This is further described as the cessation of the sense-spheres and the end of the world. In the interpretation adopted, what is meant is the cessation of the bifurcation in experience which makes possible the measuring of the world. This is portrayed as an experience of wholeness and vivid serenity. In it, there is said to be no longing and no distress. It is in this way that we have attempted to portray what is meant by the cessation of existence.

In our interpretation, suffering is not limited to ordinary suffering or difficult experiences. It is, in its most fundamental meaning, the discomfort and dis-ease that is said to go along with a sense of separation in one's experience. For the Buddha, dissatisfaction arises only because there is a felt-sense of separation in experience that goes towards a sense of incompleteness or discontent. Thus, the cessation of this separation which is referred to as the cessation of existence is the abandoning of any sense of incompleteness and discontent.

It would be interesting to compare this interpretation with a number of other Buddhist schools which seem to advance similar positions, such as the Dzogchen school of Tibetan Buddhism. Normally, these schools are thought to be in opposition but these oppositions are usually based on an entirely different perspective of the Theravada tradition than the one presented here. It would also be of interest to understand any similarities and/or differences between this presentation of Theravada Buddhism and other spiritual traditions which advance a non-dual perspective.

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A New Ring Theory Based Algorithm and Stopping Criterion for Image Segmentation

Alisa Rahim, Rishi Nath

Abstract – Ring theory is most widely known as a branch of pure mathematics under the field of abstract algebra. Some of the uses of Ring Theory in the modern world involve cryptography, computer vision, and image segmentation. As of now, finite cyclic rings have been incorporated into performing image segmentations for the Mean Shift Iterative Algorithm. This paper analyzes the Mean Shift Iterative Algorithm and devises an improved algorithm and stopping criterion using finite cyclic rings and matrices in Ring Theory.

This perform high-quality image segmentations for images that can be used in computer vision and possibly the segmentation(s) of grayscale (d = 1), colored (d = 3), and multispectral (d ≥ 3) images.

Keywords – ring theory, Mean Shift, and Iterative Algorithm

I. INTRODUCTION

Based on the concepts of Group Theory and the field of abstract algebra, Ring Theory is a concept where a "ring" is a set of elements with two binary factors: addition and multiplication. To subtract within a ring would essentially mean to add an element to its additive inverse. Likewise, to divide would mean to multiply an element by its multiplicative inverse. A ring also satisfies the following axioms:

- The ring, under addition, is an abelian group.
- The multiplication operation is associative, and therefore closed.
- All operations satisfy the distributive law of multiplication over addition.

An example of a ring includes the set of real polynomials. The set of real polynomials can be denoted as:

$$R[x] = a_n x^n + a_{n-1}x^{n-1} + \cdots + a_1 x + a_0 | a_i \in R$$

Within this ring, you can freely add, subtract, and multiply one polynomial, essentially an element within the ring, to get another polynomial - another element. The additive identity is presented as zero. Since zero is a constant polynomial, it is also considered to be an element in the ring of real polynomials. The multiplicative identity is presented as one. Since multiplication is always commutative among all polynomials, the ring of real polynomials is deduced as a commutative ring with an identity element.

Some rings are finite, meaning that the amount and type of elements may be limited. Some rings may not have the additive identity zero or the multiplicative identity one. Upon adding, subtracting, or multiplying two even numbers, the result is always another even number. The value of 1 does not fall within the set of even numbers. Therefore, the set of even integers does not have the multiplicative identity of one - and is only a commutative ring.

The term "elements" is used rather than "numbers" because rings can be used to generalize complex concepts in mathematics; such concepts include integers, polynomials with coefficients, and matrices.

Image segmentation is the practice of breaking a picture up into pixels and assigning each pixel a value based on a given class. The purpose of image segmentation is to partition images into more meaningful, easy to examine, sections. The segmentation of images is primarily applied to image editing/compression, as well as the recognition of certain objects or another relevant aspects of a taken image. The Mean Shift Iterative Algorithm uses finite cyclic rings to detect specific features of an image (i.e. eyes of a face,

abnormalities in an MRI scan of a heart, tumors in a brain) and the probability of there being a specific part of an image. A finite cyclic ring is any ring where the elements derive from a single element (hence, they are limited in regards to what elements may be present within the ring and, when brought back within range of said ring, the elements repeat in a cycle).

Ali Asghar Heidari defines the stopping criterion of a segmentation algorithm as ”a condition that forces [an]algorithm to terminate the process. It can be any meaningful condition that [you] wish, such as: number of iterations, quality of solutions, statistical values, an external or internal condition, a [possible] random termination key, etc.”

A primary factor in determining the stopping criteria for a segmentation algorithm is the entropy, or number of consistent microscopic configurations, of an image. The number of consistent microscopic configurations is significant to constructing a stopping criterion for an algorithm for image segmentation because while images may interchangeably be weakly and strongly equivalents, images that are strongly equivalent are not weakly equivalent. Images are defined in a finite cyclic ring when the Mean Shift Iterative Algorithm is used for image segmentation. However, an established stopping criterion for the Mean Shift Iterative Algorithm has not been formulated thus far; instead, the entropy formula has been in place as the stopping criterion for Mean Shift for stability purposes.

II. Related Work

Ring Theory is used in many fields of computer science, including image seg- mentation. Yasel Garces et al. discusses the significance of rings in segmentation in his paper, ”Application of the Ring Theory in the Segmentation of Digital Images”. In his paper, the following is remarked regarding Ring Theory: ”However, in the field of images the range of properties of this function could be increased if the images are defined in Zn rings. The inclusion of the ring theory to the spatial analysis is achieved considering images as a matrix in which the elements belong to the cyclic ring Zn.” Garces indicates the presence of rings in image segmentation through stat- ing that finite cyclic rings can be used to represent matrices in the sense that both have a limited set of elements, and these elements repeat in a cycle when brought back to range (i.e. added or subtracted to bring the elements within the range of the ring or modulus in use). The following is also remarked in Garces’ publication: ”The ring theory for the Mean Shift Iterative Algorithm was employed by defining images in a ring Zn. A good performance of this algorithm was achieved. Therefore, the use of the ring theory could be a good structure when one desires to compare images, due to that the digital images present cyclical properties associated with the pixel values. This property will allow to increase or to diminish the difference among pixels values, and will make possible to find the edges in the analyzed images.” In his work, Garces proves the Mean Shift Iterative Algorithm to be an efficient method of image segmentation as a result of the cyclical aspects that come with the integra- tion of a finite cyclic ring. Finally, Garces et al. iterates the following about entropy being incorporated as the stopping criterion for the Mean Shift Iterative Algorithm: ”Within a totally uniform region, entropy reaches the minimum value. Theoretically speaking, the probability of occurrence of the gray-level value, within a uniform re- gion is always one. In practice, when one works with real images the entropy value does not reach, in general, the zero value. This is due to the existent noise in the im- age. Therefore, if we consider entropy as a measure of the disorder within a system, it could be used as a good stopping criterion for an iterative process, by using MSHi.” As of now, the entropy function has been set to also serve as the stopping criterion for Mean Shift. The reasoning behind this is that the image after segmentation will hold a certain stability in comparison to the image before.

When discussing Ring Theory in image zoning, Professor D. Aruna of the Cha- lapathi Institute of Engineering and Technology notes the following: ”Entropy is an essential function in information theory and this has had a special uses

for images data, e.g., restoring images, detecting contours, segmenting images and many other applications [12,15]. However, in the field of images the range of properties of this function could be increased if the images are defined in rings. The inclusion of the ring theory to the spatial analysis is achieved considering images as a matrix in which the elements belong to the cyclic ring n. From this point of view, the images present cyclical properties associated to gray level values. ” (D. Aruna) Here, Aruna elaborates on the significance of entropy within the process of image segmentation, as well as the use of cyclic rings (see definition in Introduction). However, there is no present discussion of a stopping criterion being used for Mean Shift; therefore, entropy substitutes as the stopping criterion for MSHi. Aruna additionally remarks the following: ”Also, it is defined the quotient space of strongly equivalent images and some properties of entropy are proved. The experimental results, comparisons and discussion are presented. Taking in consideration the good properties that, in general, the NED definition has, one sees logical to take this new similarity index as the new stopping criterion of MSHi.” (D. Aruna) Within this section, it is mentioned that the Natural Entropy Distance can also be used as the stopping criterion for the Mean Shift Iterative Algorithm since the two factors hold similar properties.

One of the many important theoretical aspects of the Mean Shift Iterative Algo- rithm is entropy. Yasel Garces Suarez quotes the following in his publication entitled ”Stopping Criterion for the Mean Shift Iterative Algorithm”: ”Entropy is an essen- tial function in information theory and this has had a special uses for images data, e.g., restoring images, detecting contours, segmenting images and many other ap- plications [12, 15]. However, in the field of images the range of properties of this function could be increased if the images are defined in rings. The inclusion of the ring theory to the spatial analysis is achieved considering images as a matrix in which the elements belong to the cyclic ring Zn. From this point of view, the images present cyclical properties associated to gray level values. It is natural to think that two im- ages are close if their subtraction is close to zero. The problem of this idea is that, in general, when the rest have negative values many authors consider to truncate this elements. This consideration in general not describe the difference between two images, and in some cases is possible to lost important information. For this reason is necessary to define a structure such that the operations between two images are intern.” Within this work, Garces indicates a primary flaw in segmentation research.

III. Theoretical Aspects

The algorithm of which will be analyzed has previously been stated to be the Mean Shift Iterative Algorithm. For any given point x, we denote the Mean Shift Iterative Algorithm as follows:

$$f(x) = \frac{1}{nh^d} \sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right)$$

Where n represents the amount of points in a picture x_i, and i=1, …, n represents the picture as a whole with an unknown density.

The entropy function for the Mean Shift Iterative Algorithm is as follows:

$$E(A) = -\sum_{x=0}^{2^B-1} p_x log_2 p_x$$

Where B represents the total number of pixels generated by image A, while p(x) represents the probability of the presence of a grayscale value.

The function for the natural entropy distance for MSHi is denoted as such:

$$E(A_k + (-a_{k-1})) \leq \varepsilon$$

Where ε and k are parameters of which will be used to stop the interactions and count thereof. Two images, A and B, are weakly equivalent if E(A) = E(B) In this example, S is used to represent the scalar image. Images A and B are strongly equivalent if A= S+B if images A and B $\in G_{k\times m}(Z_n)(+,\cdot)$.

For the sake of the research at hand, rings were used to summarize pixel values given to images when performing an image segmentation. In

gray-scale images, pixels are given a value from 0 to 1. These values indicate the presence of the shades along the gray scale. For instance, a pixel with a value of 0.1 will have a lighter presence, while a pixel with a value of 9.8 will have a drastically darker appearance. The pixels as a group all satisfy the axioms of a finite, commutative ring. These axioms are as such:

- The number of elements within a ring is finite, or limited in terms of included values.
- When adding two elements in the ring, the sum is another element in the ring.

IV. Criteria for a New Clustering Algorithm

The improved Mean Shift Iterative Algorithm will be outlined as such:

- The input will be a set of data points represented by x^k where k serves as the index starting at 1. We use the value of 1 because while every ring has the additive identity of zero, not all rings contain the multiplicative identity of 1. Starting the ring with the element of 1 ensures that the ring being used has both the additive and multiplicative identities. To minimize errors in segmentation, we want to include any and all possible elements for the course of this research.
- The output will result in a clustered set of points represented by X_{IMS}.

The steps to use this method of image segmentation are the following:

- Select one data point $x_k^i \in X_k$ whose movement may result in the loss of energy or values.
- Move x_k^i according to $x_i^{k+2} = x_k^i + IMS_x^k x_i^{k+2} = x_k^i + IMS_x^k$
- If E(X_k) satisfies the stopping criterion, then stop. Otherwise, set k = k + 2 and repeat.

Definition 1

While every ring has the additive identity of zero, not every ring has the multiplicative identity of one.

Additionally, we move the selected data point x_k^i according to x_i^{k+2}

Rather than x_i^{k+1} since the ring of matrices is commutative.

Remark 1

In any commutative ring, any element can be added, subtracted, or multiplied and the result will be another element within the ring.

Definition 2

Image segmentation is the process of partitioning an image into multiple portions as a means of simplifying the process of finding a region of interest for further analysis within that image.

Remark 2

Rings can be used to generalize complex concepts in mathematics, including integers, polynomials, and matrices. **Remark 3**

By partitioning an image for segmentation, the values produced represent an array or a matrix of gray-scale presences.

V. Stopping Criterion

The stopping criterion for the improved Mean Shift will be denoted as such: If the value of x, any given pixel value within an image, is greater than Mhx, then the stopping criterion is denoted as KB(x) = K(x). Likewise, if the value of x is greater than Mhx, then the stopping criterion is denoted as zero.

$$K_B(x) = K(x) \text{ if } x < Mh_x \text{ and } 0 \text{ if } x > Mh_x$$

where M is a positive constant satisfying that Mhx can cover a large portion or the entire space. At any early stage of improved iterations where a clear configuration of clusters has not been formed, the kernel KB is similar to a broad kernel.

Definition 3

A kernel in image segmentation refers to a broad section of an image that can be categorized under

a certain set of values. For instance, a predominantly light section of an image can be classified as a kernel, as each pixel within this area shares the similar characteristic of low (from zero to one) pixel values on a given gray scale.

Remark 4

The number of iterations depends on the construction of the ring and the number of times a certain stopping criterion must be entered in order for the function to come to a complete stop.

Remark 5

Since an iterative method computes successive approximations to the solution of a linear system, a practical test is needed to determine when to stop the iteration. Likewise, since the Mean Shift Iterative Algorithm is capable of performing multiple segmentations on an image (depending on the region of interest), a stopping criterion is defined as the function or coding sequence that can be entered into the segmentation algorithm for the process of an iteration to come to a complete stop.

Remark 6

In the original Mean Shift Iterative Algorithm, the entropy formula takes the place of the stopping criterion for the purpose of maintaining stability along the course of the segmentation of an image. By constructing a new stopping criterion along with an improved version of the Mean Shift Iterative Algorithm, we allow the function to come to a complete stop rather than remaining stable while continuing to perform iterations.

VI. Conclusion

The improved Mean Shift Iterative Algorithm compares to the original Mean Shift Iterative Algorithm in the sense that the stopping criteria differs for each respective method of segmentation. When using the Mean Shift Iterative Algorithm, the functions for the entropy and stopping criterion show no difference, therefore lacking efficiency in commanding the segmentation to stop altogether. In the improved version of the Mean Shift Iterative Algorithm, the stopping criterion is set as an individual function. The reason for this is that we want the function to stop entirely as opposed to maintaining stability. Therefore, if the function using the improved Mean Shift algorithm is able to stop entirely, we will know that the improved Mean Shift algorithm works in a more efficient manner than the original Mean Shift algorithm.

The improved Mean Shift Iterative Algorithm can be used for the segmentation of grayscale, colored, and multispectral images by substituting the d values in the original Mean Shift Iterative Algorithm for 1, 3, and a value greater than 3, respectively. In doing so, a set of pixel values arises. Therefore, a ring can be constructed from said elements. By using this ring, the number of iterations can be measured in order to force the improved Mean Shift Iterative Algorithm by following the newly formed stopping criterion for the IMS.

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Overview of Soviet Language Policies: A Holistic Evaluation of the Legacies of Soviet Language Policies Concerning the Central Asian Republics

Eric Jiefei Deng

Abstract – The impact of the Soviet legacy on the linguistic situation in Central Asia is almost universally agreed upon but this paper seeks to find new insights on how the extent and ramifications of this legacy are evaluated and quantified by bringing up the Soviet impact on the titular languages of the republics themselves. This paper does not seek to place qualitative evaluations of "good" or "bad" on the Soviet linguistic legacy but to just describe the reasoning, histories, and origins of the current situation. This is paired along with an analysis of how the current situation is viewed.

Keywords – linguistics, Soviet Union, USSR, language policies, and reform

I. Introduction

Following the collapse of the USSR and the birth of newly independent republics in Central Asia, some of the first decisions made by these nascent nations involved how they would reconcile their post-Soviet reality with their nationalistic aspirations. One of the major focal points for policy concerning this conflict was the question of language. The Central Asian republics were almost all distinguished from the other new post- Soviet states of the Baltics, Eastern Europe, and the Caucasus by the fact that individual standardized literary languages had involved more Soviet interference and guidance than the titular languages of the likes of Estonia, Lithuania, Georgia, Armenia, or even Azerbaijan [1]. This unique situation has led to much literature on the linguistic situations of the Central Asian states since their independence because of the fact that these finally truly independent and autonomous states were entering the uncharted territory of creating their own pathways concerning language and identity.

II. Overview of Soviet Language Policies

Before one can delve into the legacy of Soviet Era linguistic policies in the Central Asian republics one needs to outline the general trends and policies implemented by the USSR towards its Central Asian populations. With the establishment of Bolshevik power within the former Imperial Russian state, the various policies enacted since then within the Soviet Union point towards the establishment of a general policy trend of the division and delaminating of distinct Soviet nationalities [2] for the purpose of standardizing their rule [3]. This policy of divide and rule was paired with a general trend of Russification policies that intensified as the Soviet Era progressed [3]

Soviet motivations for its proactive involvement in the linguistic development of the region originated in the reality that illiteracy was endemic in the Central Asian region. The 1897 Imperial Russian census revealed that the literacy rate across the empire was a dismal 28.4%, at that time the lowest of any European state [3] The same census revealed that "among the Kazakhs, Kirghiz, Tajiks, Turkmen, and Uzbeks the rates were 1.0%, 0.6%, 3.9%, 0.7%, and 1.9%, respectively." [3] It must also be noted that rates of female literacy among the various Central Asian populations were even lower on the account of their social position within their respective societies. This state of affairs stayed much in place after the establishment of the USSR [4].

Literacy was seen as central to the Bolshevik's communist goals concerning the USSR in its

entirety. Literacy was central to the Marxist-Leninist vision across the state, "...although perhaps there was some general concern for the well-being of the people, the primary motivation for eradicating illiteracy was avowedly political as mass illiteracy hindered the building of socialism. It was of vital importance for the success of the cultural revolution that illiteracy should be eradicated." [3] Lenin's personal disavowal of what he termed as "Great Russian Chauvinism" [3] meant that literacy for the state's ethnic minorities was to be done in their mother tongues. In order to achieve these goals active measures were taken by Russian linguists in order to set policies that would ease the introduction of mass literacy on the Central Asian population. This included the favoring of vernaculars over literary standards such as Chagatai, seen as too removed from the speech of the general population to be effective in easy mass literacy [3]. This also entailed the abolishment of the Perso-Arabic script as a writing system for the regions languages. Concerning the Turkic languages this stemmed from the fact that the Perso-Arabic script was lacking in symbols for the vowel rich Turkic languages while over abundant in consonants that were redundant in Turkic pronunciation. This led to a level of ambiguity and etymological spelling based on Arabic and Persian that would hinder the quick implementation of mass literacy.11 This viewpoint however was not solely present in the USSR as a parallel and similar push for writing system reform was underway in the new Turkish Republic under Atatürk [3]

The changing writing systems shifted first toward the Latin alphabet, with necessary modifications for the Central Asian languages, as the Soviets were wary of upsetting the local populations with seeming to try to "russify" the languages with the Cyrillic alphabet. Latin was seen as a neutral writing system and again was bolstered in legitimacy by the Turkish writing system reform in Turkey. [3]

Despite this sensitivity, however, this would mark the trend of divisionary policies towards the peoples of Central Asia. The implementation of a non-Perso-Arabic script meant the severing of local populations from their literary traditions and connection with neighboring Muslim regions. This move also rendered more religiously attached elites semi-illiterate and in need of learning the new writing system. [3]

The move to give each language grouping its own new literary standard also divided the languages of different groups of peoples. The traditional nomadic-settled dichotomy of Central Asia [2] was replaced with a new system of nationalities. The dialect continuum of Kazakh and Kyrgyz nomads was changed into one of a distinct Kazakh language and a distinct Kyrgyz language. This also redefined linguistic identities by placing all members of a defined nationality under the same standard dialect [5] A "Kazakh" speaker and a "Kyrgyz" speaker neighboring each other often spoke dialects that were more similar to each other than their assigned standards, yet were now bound by their new linguistic standards [6]. Such attention was paid to language in the formation of nationalities because of the idea that nationality was inherently connected to language, something Stalin would emphasize when he defined a nation as:

> "...a stable and historically constituted human community founded on its community of language, territory, economic life, and spiritual makeup, the last contained in the idea of community of national culture...Of these characteristics, language is a nation's most obvious and important attribute. There is no such thing as a nation without a common linguistic basis" [3]

This choice reveals the long-term motivations of the Soviets. With the concept of *sliyaniye*, the ultimate fusions of all peoples into one as Marxist ideology privileged class divisions over nationalistic, it would have made sense for the Soviets to implement a unified Turkic literary standard. This concept already existed in the

Soviet lands from the Jadidist Crimean Tatar Ismail Bey Gaspirali with his unified Turkic language published in the *Terjuman* publication [3] The ultimate non-relevance of nationalistic divisions could have led to unified Turkic literary language in the USSR but this was eschewed because of fears of Pan-Turkism among the Central Asian populations [3]. Much like how the Perso-Arabic script was abandoned in order to isolate the Central Asian populations from Pan-Islamism, the divisions among the Turkic Central Asian languages helped the Soviets prevent Pan-Turkic tendencies. Later reforms changing the Latin script written languages to Cyrillic systems during the Stalin era would solidify this fact. The Cyrillic script was adopted to isolate the Turkic language speakers from Turkey while also easing the learning of Russian and incorporation of Russian vocabulary. The Cyrillic alphabet was no better or worse than the Latin at representing the sounds of Turkic languages [2]. If the sole goal was mass literacy this move would have been counter intuitive, resources would have to be diverted to teaching the masses an entirely new system but the fact was *sliyaniye* would be achieved in the USSR with the Russian language uniting the people.

In terms of language the Soviets ruled over the Central Asian populations by using Russian loanwords to fill perceived gaps in the lexicon of the standardized Central Asian languages. Arabic and Persian loanwords were also replaced by Russian words and new terminology was created from a Russian lexicon instead of Persian or Turkic roots. This can be quantified in the fact that in the Uzbek language, from 1923 to 1940, went from a 37% Perso-Arabic lexicon to 25% while at the same time seeing an increase of Russian words from 2% to 15.24%.

In all these language reforms and policies, it must be noted that they originated from Moscow and its mandates instead of the mass request of local populations. These moves to standardize each newly created distinct language grouping can be seen as a wider policy of "double assimilation" as outlined by Hirsch. By accepting the Soviet classification system of these nationalities, the populations of Central Asia not only defined themselves by these parameters but also integrated into the Soviet state's apparatus. If one was Turkmen, Kazak, Kyrgyz etc. and adopted this new nationalistic language of the Soviets one also became a Soviet and privy to all the associated benefits and responsibilities. [2]

In later years the arc of russification extended beyond just the growing influence of Russian on the Central Asian tongues but a policy of *Dva Potoka*, or two streams. The teaching of Russian was mandatory and Russian was to be the "second native" language of all Soviet minorities and the language of interethnic communication. This, paired with the socio-economic benefits and prestige of the Russian language led to many urban cosmopolitan Central Asians to grow up knowing better Russian than their "mother tongues." This was the linguistic situation during the dissolution of the USSR.

III. Persistence of the Russian Language in Independent Central Asian States

Because of the universal presence of the Russian language in the independent Central Asian republics and the dominant influence the Russian language has had on the titular languages of the Central Asian republics, the prevalence of Russian language is often used as a marker on the strength of the Soviet linguistic legacy on a now independent Central Asian republic. Such utilization of the Russian language as a measurement of Soviet linguistic legacy is almost universally used, with the conclusion that the Soviet linguistic legacy is still strong in the Central Asian republic when compared to other post-Soviet states. Baktygul M. Ismailova and Ayşe Pamir Dietrich both use such a mechanism in their analysis of the post-Soviet linguistic situation of Central Asia while Ferdinand Siarl and Flora Komlosi do as well in their survey of the overwhelming Russian language prevalence in

urban Bishkek and its implications for the Kyrgyz state [8].

This is an obvious measure of the Soviet legacy as many of the Russification processes pursued in the Soviet era are still evident in the Central Asian republics to different degrees [9]. Russian is seen as an integral lingua franca for international and interethnic communication among the Central Asian states. Kazakhstan, with its 48% Russian population, as well as Kyrgyzstan, have kept Russian as official languages on par with their titular languages. The necessity of Russian in relation to socio-economic is still evident and Russian is still the standard language in many scientific and academic fields [9]. Specifically noted in the Siarl and Komlosi survey of Bishkek, Russian is seen, heard, and spoken more than Kyrgyz with Kyrgyz youth apathetic to the usage of their titular language. Local elites are still overwhelmingly Russophone across the region. In Kyrgyzstan, Ferdinand and Siarl stated that Russian language was so dominant in Bishkek that:

> "...Kyrgyz could be considered an endangered language in the city of Bishkek. Although most parents still use it as their main tool to talk to each other, there is an endemic tendency not to transmit it to their children, maybe due to the feeling of superiority of Russian among the Kyrgyz, who consider that language a tool of international communication and of social progress... when there is no legal rule about it, most businesses choose to communicate with customers in Russian. This voluntary Russian-immersion situation is also evident in the streets and parks of Bishkek" [8].

The prestige of Russian from the Soviet era is still lasting. Kazakhstan is home to a noteworthy portion of Kazakhs who are more proficient in Russian than their titular language with many in high ranking public positions at home and abroad in embassies, consulates, and the like.

Russian is perceived as more useful than the titular languages and the prevalence of Russian loanwords is still ever constant. The Soviet linguistic policies of isolating Soviet populations from related peoples abroad is most obvious in Tajiki, where Russian loanwords for items like *kartoshka* limit comprehensibility between Tajiks and Persian speakers in Afghanistan and Iran. Russian discourse markers are common in daily speech out of habit or the belief that a native equivalent is nonexistent. The Russian language naming system of patronymics and case endings is still present and distinct among the Central Asian populations. 40 and many foreign words are still integrated into the titular languages via Russian, nouns like "Hamlet" or "Harry Potter" are rendered as "Gamlet" and "Gerry Potter" because of Russian transcription practices even though the English "h", which doesn't have an exact equivalent in Russian, exists in all the Central Asian languages [4].

Such views on the dominance of Russian should not be taken to ignore the nationalism of the peoples of Central Asia, which is not entirely correlated to the usage of the Russian language. In his ideas on the situation of post-colonial African literature, English medium Nigerian author Chinua Achebe speaks about how the usage of a colonial language does not impede on the expression of local ideas [10]. In a similar vein, a post-soviet Kazakh, Kyrgyz, Uzbek or Tajik author writing about his/her life as a Kazakh, Kyrgyz, Uzbek or Tajik is expressing his or her own viewpoint even if the medium of language is Russian. In the same vein a Kazakh youth who says *"Davai Brat!"* is not automatically Russian the way speaking Russian would have made him Soviet. In this academic dichotomy of Russian language vs titular language, Russian is used as a unit of measurement for the Soviet linguistic legacy. However, while the influence of Russian is present in Central Asia, it would be incomplete to evaluate the entirety of the Soviet linguistic legacy solely through such a mechanism focused on Russian language use.

IV. Language Policy Shifts in Favor of TItular Languages

It would be incomplete to ignore the de-russification policies of the Central Asian republics post-USSR in an evaluation of the Soviet linguistic legacy in Central Asia. Many scholars point to these policies as a major shift in the linguistic trajectory of the region with many, such as Baktygul, pointing to these shifts in certain republics as a break with the Soviet legacy. In general, it is held by this lens that the independent Central Asian republics are actively moving away and distinguishing themselves from the Soviet legacy through purposeful language reforms in the field of society, policy, and especially education. Novel policies divorcing the states from the Soviet legacy are being implemented against Russian and, according to this lens, therefor severing the Soviet linguistic legacy.

This can be seen in the naming of their respective titular languages by all the Central Asian republics upon independence as official languages and the attempt at dethroning Russian from its former position in the Soviet republics. While in Kazakhstan and Kyrgyzstan these were only attempts, they found success in Uzbekistan, Turkmenistan and briefly in Tajikistan [5].

A focus on writing system shifts can outline the various attempts of the newly independent Soviet Central Asian republics at redefining themselves outside of Soviet lines. Caucasian Azerbaijan adopted a Latin alphabet based almost entirely on the Turkish alphabet as it wanted to align itself with the Turkish Republic [11]. Uzbekistan similarly chose to Latinize its writing system with its own novel system in a nationalist move shifting its identity away from the Soviet past [9]. Isolationist Turkmenistan originally shifted from its Soviet Cyrillic script to a “Latin” alphabet from 1993 to 1999 that included unique characters such as “$,¢” for “Ш,ш” as the eccentric Saparmyrat Ataýewiç Nyýazow wanted a writing system for the digital age–in this case a writing system that required no “exotic” diacritics and used only symbols available to the basic Latin alphabet keyboard. This was an attempt at defining Turkmenistan as a digital, modern, and forward-thinking country. Such thinking is not only reserved for the eccentrics however, the original Kazakh new Latin alphabet only used apostrophes instead of diacritics when necessary for different sounds as one of the stated motivations for the Latinization of Kazakh was to integrate it with the digital age–the old Cyrillic alphabet was claimed to have too many symbols and took up too many keys on a keyboard [12]. Language policies concerning writing systems in post-Soviet Central Asia have been used to redefine the various republics from their Soviet pasts. Other shifts away from Russian have been used to define the post-Soviet linguistic legacy (or lack thereof) of the Central Asian states. Rising fluency and use of titular languages in all the republics are pointed to as a divorce from the Soviet era trajectories of decline. The rise in prestige of English across Central Asia and Kazakh in Kazakhstan are also shifts from the former dominance of Russian [13]. Uzbekistan and Turkmenistan are notable for their most stringent de-russification policies. Uzbekistan gave Russians 8 years to learn Uzbek [9] while Turkmenistan’s 1990 Single Language Law closed all Russian medium schools. During its early days Tajikistan also had a projected shift back to the Perso-Arabic script like its Iranian and Afghani cousins and made Tajiki the language of interethnic communication over Russian in 1989. The rise in the usage of non-Russian declined family names is also on the rise in the region. The usage of Uzbek as the language of interethnic communication in Uzbekistan must also be noted along with the active effort to replace Russian loanwords with new words derived from Persian or Turkic roots [9].

This point of view defines the strength of the Soviet legacy through the position of the Russian language in society and because of the policy shift in the post-Soviet states towards privileging the titular languages over Russian they conclude on the weakening of the Soviet linguistic legacy because of the weakening of the Russian language’s position.

This analysis should be taken with a grain of salt, however, as to varying degrees these post-Soviet de-russification policies have been stalled or are unsuccessful. Local opposition from Russian speaking groups prevented the demotion of Russian in Kazakhstan and Kyrgyzstan [5]. The status of Russian as the language of interethnic communication is very much in place and can be exemplified by the fact that while Russians are 12% of the Kyrgyzstani population and Uzbeks are 16%, Russian is an official language and Uzbek is not. Kazakhstan's post-independence plans of having the Russian population "master Kazakh by 2006" [9] have completely failed. Uzbek's usage as an interethnic lingua franca in Uzbekistan actually started during the Soviet era and Tajikistan's original plans to shift to the Persian alphabet and remove Russian from official use had been cancelled by 2000. Textbook shortages in the republic would hinder attempts at major drastic language planning, while the fact that Russian troops man the Tajik-Afghan border mean the Russian language will stay central to the nation for the foreseeable future.

The increase of English fluency, whether through Gülenist schools or the rise in the prestige of English, does not mean the dethroning of Russian as nations such as Kazakhstan see the importance of a trilingual education policy– Kazakh, Russian, and English. While there definitely is a shift in will and ideology concerning the titular languages of the Central Asian republics, it would be far too optimistic to claim this as the beginning of the end of the Soviet linguistic legacy, for even through the metric of Russian language use all these de-russification policies have more or less fallen short of their goals.

V. Titular Languages as Embodiments of the Soviet Legacy

One of the problems with the above evaluations of the Soviet linguistic legacy in the Central Asian states is the fact that the metric used for the analysis of the Soviet linguistic legacy is solely defined by the usage of Russian or Cyrillic. This problem is evident in the previous two points of view as it relies on the dichotomy of the Russian language and the titular language to analyze the Soviet linguistic legacy in each independent state.

The proposal of this paper is to evaluate the Soviet linguistic legacy through the persistence of the Soviet designed mechanics of each of the languages themselves, instead of the simple presence or lack thereof of the Russian language. It is only through the inclusion of the situation involving the results of Soviet policies on the titular languages themselves in the present day that we can have a fuller image of the extent of the Soviet linguistic legacy in Central Asia.

Statements about current language policies in relation to Russian ignore the extensive Soviet involvement in the development of these titular literary standards that the Central Asian republics are currently promoting.

The standardization choices of each of the titular languages were ones focused on Soviet objectives, as was briefly outlined previously. These choices during the creation of the current standard languages were made often at the expense of the local reality and were often solely motivated by the Soviet Union's concerns for controlling the Central Asian populations. This can be most explicitly seen in the development of the Uzbek standard language under the Soviets. The original dialect chosen to be the standard for the Uzbek language was based on the speech of Turkistan, in modern day Kazakhstan [14]. This variety was similar to the neighboring Turkic languages and all other Turkic languages in that it phonologically contained vowel harmony. In 1934, however, the dialect base for Standard Uzbek was chosen to be Tashkent Uzbek [14]. Unlike Bukharan Uzbek or Samarqand Uzbek, the other major varieties of Uzbek, Tashkent Uzbek lacked vowel harmony (or according to some sources had very weak and irregular vowel harmony) due to heavy historical persianization of its phonology. In this way the Uzbek standard language suddenly lost 4 vowels in its alphabet and was standardized under a pronunciation that was not only not representative of the majority of the dialects of Uzbek but entirely removed from the phonological rules of

all other Turkic languages. This was a major drastic shift as in the original 1929 standardized version of Uzbek, vowel harmony was named the "iron law", only for it to be proclaimed as "dying law" in 1934 [14].

This shift was undertaken by the Soviet language planners because of the fact that many Uzbek intellectuals saw their tongues as direct descendants of the Chagatai literary language. IN order to sever this connection, the Soviet language planners divorced Standard Uzbek from the phonological principles of Chagatai and, by extension, every other Turkic language. This Standard Uzbek that has no vowel harmony is still the Standard Uzbek in modern independent Uzbekistan. While not as intrusive as in the Uzbek case, it was top-down Soviet decisions that established the make-up and character of each of the titular post-Soviet Central Asian languages. The Soviet linguistic legacy cannot be solely analyzed through the lens of Russian language use in the former Soviet republics because the titular national languages of the republics themselves find their current forms as a result of Soviet language policies. The retention of these linguistic decisions that often affect the very basic nature of the standard language itself must be considered when evaluating the Soviet linguistic legacy.

Continuing this focus on the titular languages themselves while evaluating the Soviet linguistic legacy, one can see a wealth of Soviet influence in the post- independence language policies of the Central Asian states. The focus on language as a proactive tool for the shaping of society in the modern republics mirrors the Soviet focus on language policy as an extension of social policy. One can see proactive language planning as a policy legacy of the USSR in the Central Asian states. The methods used by the independent states to reform their languages are the same or similar to Soviet linguistic policies.

The changing of writing systems was used again and again by the Soviets to strategically isolate and align populations. The shift of the Perso-Arabic script was meant to isolate Central Asia form neighboring Muslim peoples and Pan-Islam. The poor fit of the alphabet to Turkic languages was a major factor but Tajiki also shifted to a Latin, and then Cyrillic, script even though the Persian dialect that was Tajiki was a much better fit for the Persian alphabet [4]. This choice can be explained by the desire to isolate the Tajiks from their sibling in neighboring Afghanistan and further away Iran. When the languages used the Latin alphabet, chosen because it was seen as neutral from "great Russian chauvinism", the script was very different from the Turkish Latin alphabet that was being promoted in Turkey. The order of the Latin letters was also made to follow the Cyrillic order. These were done to isolate and control the Central Asian populations [4]. Even among the Turkic Latin alphabets, artificial differences were created between the languages by using different letters for the same sound [4]. This continued in the later Cyrillic alphabets, where spelling was purposefully differentiated between the titular languages in order to emphasize differences [4].

This emphasizing of differences and strategic choices in writing system representation is mirrored in the modern day among the Central Asian republics. Following the fall of the Soviet Union, the Republic of Turkey saw an opportunity to extend its influence in the newly independent Turkic states and developed the Common Turkic Alphabet based on the Turkish alphabet and including letters for every sound in the Turkic language family. This system was not adopted by any Central Asian republic that had Latinized its alphabet, each opting to create their own systems and orthographies in order to emphasize their national distinctness. This reality of the decision to adopt Latin alphabets with disparate spelling conventions and letters representing the same sounds can even be seen in even among the Central Asian titular languages themselves in their Latin forms. For example, the sound represented by the Turkmen "Ğ" is "G'" in Uzbek and "Ǵ" in Kazakh. This technique is an exact copy of Soviet era policies and such policy legacies concerning the titular languages should be included in evaluations of the Soviet linguistic legacy in Central Asia.

Beyond the nature and policies of the titular languages, the Soviet linguistic legacy can also be seen in the politics of language in the modern Central Asian states. As a result of Soviet national myth building combined with modern nationalistic myth building many ancient Persian-medium and Chagatai-medium literary figures are claimed by the republics as their own and the other republics'. This rivalry can be seen between Uzbekistan and Tajikistan, where often the figure would be buried in Uzbekistan but have written in Persian/Tajiki, which both claim literary figures like Omar Khayyan, Rudaki, and Avicenna. Because of the Soviet creation of a Standard Uzbek that lacked vowel harmony, some Uzbek historians now claim that the Chagatai language of writers like Ali Shir Nava'I was lacking in vowel harmony as well. Because many of the major cities in Uzbekistan are majority Persian speaking, and therefore Tajik, the Uzbek government has mimicked Soviet policies of linguistic planning in order to homogenize its population. This is exemplified by the closure of Samarkand University by Uzbek authorities because the medium of instruction there was Tajik. The shared linguistic heritage of the region in both Persian and Chagatai has been artificially delineated by the modern language and national boundaries of the Central Asian states. This ignoring of the common nature of this literary heritage and application of boundaries that originate with Soviet linguistic policy is being carried out by these independent states but can be seen as a policy legacy of the Soviet era.

The Soviet linguistic legacy is strong in Central Asia not only because of the persistent presence of Russian in daily life, but also because the standard languages of the different republics themselves are products of the Soviet linguistic legacy. To ignore the impacts of the Soviet linguistic policy on the titular languages and the policies and politics concerning them by only focusing on the Russian language in Central Asia does a great disservice to the fascinating complexities of the region.

VI. Conclusion

The Soviet policies leading to the Russification of the Central Asian republics should not be the only legacy of Soviet linguistic policy used to measure the impact of the Soviet linguistic legacy on Central Asia for Soviet linguistic policy, as shown in this paper, extended far beyond the promotion of the Russian language but to the framework of the current titular official languages as well. The Soviet Union did not just create Russophones in Central Asia, but the distinct nationalities as they are currently defined in Central Asia as well [3].

The language policies of the Central Asian states in the post-Soviet era might be nationalistic in motivation but are ultimately Soviet in application and policy. It would be inaccurate in this paper's viewpoint to say that Turkmenistan, for example, has strayed further from the Soviet linguistic legacy because it has been the most linguistically de-Russified when its very standard language is the result of Soviet decisions and its current writing system was created on reasons that mirror proactive Soviet language planning.

The true linguistic legacy of the Soviet Union in Central Asia is not the usage of Russian nor the creation of policies to counteract Russian language use, as often applied to other post-Soviet spaces like the Baltics or the Caucasus, but how Soviet policies meant to divide and rule the peoples of Central Asia are very much alive and well and carried on in new and old forms by the independent Central Asian republics.

The delineation of language and identity carried out by the Soviets is very much maintained by the current independent republics. The standard languages of the republics that are taught in school were standardized under Soviet direction. These are parts of history that must be included when one evaluates the Soviet linguistic legacy in Central Asia.

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Assessment of Lake Water Quality and Quantity Using Satellite Remote Sensing

Noel Cercizi

Abstract – Assessment of both water quality and quantity pose a great challenge to those studying the effects of anthropogenic activities on bodies of water. Eutrophication created by the increased concentration of nutrients including nitrates and phosphates has been known to contribute to the development of both toxic algal blooms, which serve as limiting factors in the ecosystems of the water, rendering it useless for consumption.[1,2] Another common development is the buildup of suspended sediments (SS/TSS), contributing to the anoxic conditions characterizing environmental hypoxia.[3] Because current methods for the assessment of the presence of such issues rely upon tedious and costly methods, a timely and cost-efficient method is desirable for application to the practice.[4] This research relies upon analysis of the inherent optical properties of chlorophyll and sedimentation present within the bodies of water in question, achieved through analysis of the reflectance values of the red and blue bands from Landsat satellite images of five bodies of water. [5] The analysis, performed using Geographic Information System ArcMap, allows for determination of the values that attest to changes in surface area, turbidity, and eutrophication. The trends in the data hold consistency with the natural occurrences surrounding the bodies of water associated with the three parameters outlined above, supporting usage of remote sensing for qualitative and quantitative analysis of water.

Keywords – water quality, quantity satellite remote sensing.

I. INTRODUCTION

Lakes are popular hosts of environmental problems as a result of anthropogenic activities. For the majority of these lakes, causes of these problems often involve sediment loading or nutrient enrichment, also known as eutrophication.[1] Eutrophication is also the cause of algal bloom in water. Both eutrophication and algal bloom are a natural phenomenon, but human activities may accelerate them, which can cause harm in terrestrial ecosystems. In fact, eutrophication and harmful algal blooms are the leading source of impairment of water quality in many lakes around the world.[2] Specifically, human-derived sources due to industrialization, urbanization, or agricultural wastes due to the amount of excess nutrient that these sources then load onto their local freshwater bodies. Anthropogenic activities change the amount of Nitrogen and Phosphate - both of which are nutrients essential to algal growth - present in water. For instance, sewage, agricultural, and household discharges often contain large quantities of P minerals.[3] Harmful algal blooms may cause anoxic conditions, which is the depletion of oxygen in water. Such conditions are especially dominated by cyanobacteria, which is a blue alga that produces cyanotoxins and makes lake water toxic, causing wildlife deaths and seafood poisoning in humans.[4]

Traditional methods to measure water quality parameters like algal blooms involves field surveying techniques while measuring suspended solids involves the filtration technique. Unlike the other methods, studies show that satellite remote sensing is more cost-effective, economic, and ideal for acquiring spatial data from lakes with large surface areas[7] like the ones that will be investigated. For the purpose of this study, there are two other water quality parameters measured, besides the quantity factor with surface area. One is the chlorophyll, which will indicate the severity of algal bloom, and the other is total suspended solids, as a measure of water turbidity. The Inherent Optical Property (IOP) - which refers to absorption and scattering properties of underwater contents - of chlorophyll and suspended solids were used to determine algal and sediment presence. And because of the optical properties of

chlorophyll and suspended solids in water, one can use commercially available optical instruments to measure their respective concentrations.[7] This can be applied to satellite data because of the way in which satellite sensors collects the intensity of light reflected. And since satellites measure reflectance values in different intervals of the electromagnetic spectrum, the focus will be placed on reflectance values on certain intervals - also known as band values - in this paper. In summary, a lower reflectance value of blue band correlates to a higher concentration of sediments. As a lower reflectance value of the red band would suggest a higher presence of chlorophyll.

In this study, three lakes across the world are analyzed, and each is chosen for the significance of their impact on local livelihood. The three bodies of water are the Aral Sea in Kazakhstan, the Wular Lake in Kashmir, and Lake Taihu, or Lake Tai in China.

II. METHODS

United States Geological Survey satellite images were to collect the data related to the measures of surface area, turbidity, and eutrophication. The satellite images were acquired from the United States Geological Survey's Earth Explorer Database. The GIS software was utilized in order to determine the surface area and mean red and blue band values for each of the bodies of water.[6] The satellite images that were selected were without any cloud coverage over the bodies of water, as the functions that were utilized in determining the presence of chlorophyll and sedimentation relied upon the properties of reflectance of light.[6] The mean red band values of each image would analyze the levels of chlorophyll present in the lake, while the mean blue band values would represent the presence of Total Suspended Solids (TSS). The selected images were then downloaded with the " LandsatLook Images with Geographic Reference" option in order to be able to have the images automatically oriented geographically upon downloading, taking advantage of the automatic georeferencing done by ArcMap. Following the creation of a mosaic image, a new shapefile was created and categorized as a polygon, to permit usage of the editing tool that allows users to outline figures. The shapefile was edited to create features known as "profiles."

The "Freeform" tool was utilized in creating the profiles over the bodies of water, as it is designed to function as a tracer. This ability permitted the creation of accurate profiles that covered the bodies of water. The profiles were created with the intention to analyze to mean values for the red and blue bands of the lakes. In order to receive the intended values from only the areas that were covered by a profile, the "Clip" tool found under the Raster Library was utilized. This tool allows users to make a copy of the areas that are underneath the created profiles. Clipping the shapefile to the mosaiced image creates the copies of the profiles, that appear as a new layer on ArcMap. ArcMap automatically computes the data values that are associated with the new layer and attaches them to the newly created layer. To calculate the surface area, the attribute tables were opened. The area is not automatically calculated, but can be computed using the software. An attribute was added to attribute file: "Surface Area, adding the values of the surface areas of the shapefiles created. For each clipped layer, the properties feature was utilized to access the statistical analysis section, locating the values listed as "mean." The values were listed as Band 1, Band 2 , and Band 3. Each pixel that forms an image derives its color from the values of intensity of three different bands: Red, Green, and Blue. Band 1 and Band 3 were the bands that were observed as they represent the values of the bands that attest to the degrees of turbidity and eutrophication: the conditions in question..

III. Results and Discussion

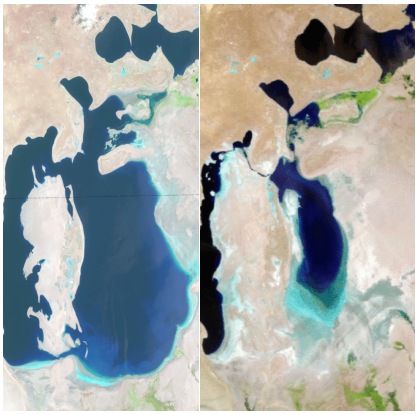


Figure 1. The Aral Sea in 1999 and 2017 respectively

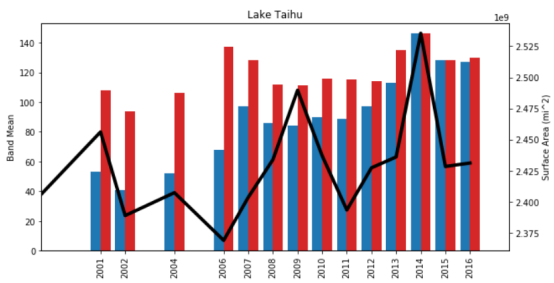


Figure 2. Graph of Aral Sea with all three parameters. Blue representing blue band values, red representing red band values, and black line shows the trend for surface area

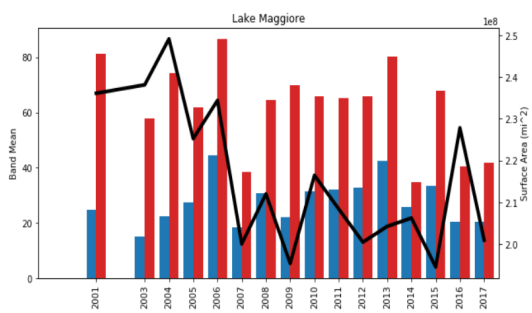
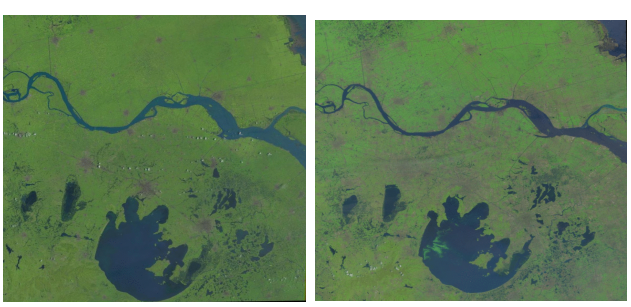


Figure 3. Graph of Lake Maggiore with all three parameters. Blue representing blue band values, red representing red band values, and black line shows the trend for surface area



Figures 4 and 5. Images of Lake Taihu in 2001 and 2016, maintaining non uniformity about it in its color, with the northern region of the lake suffering from greater nutrient concentration, creating a faint green tint, and then having maintained a more consistent and clear body of wate in 2016, attesting to the decrease in pollution

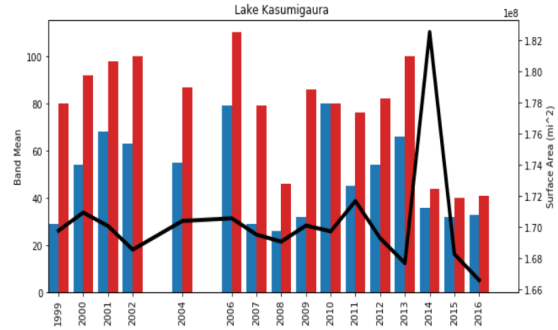


Figure 6. Graph of Lake Kasumigaura with all three parameters. Blue representing blue band values, red representing red band values *and black line shows the trend for surface are*

IV. Conclusion

From observing the images of the Aral Sea, there is an apparent decrease in surface area from the almost two decade period that was examined. This is greatly reflected in the rapid decrease in value of the surface area as represented on the graph. In addition, there is a trend present in the values of the red and blue bands where the values are present: the values of the red bands are significantly higher than the values for the blue band means, though this disparity does seem to decrease in the more recent years. The decrease in the red band value from the year 1999 to the 2017 reflects the presence of organisms that absorb more red light, representative of the occurrence of algal blooms that are caused by the phenomenon of eutrophication. The minor increase in blue bands may allow us to determine a decrease in the presence of total suspended solids present within the lake.

For the Wular Lake, the values for the blue bands are consistently significantly higher than the values for the red bands, slowly decreasing in recent years until meeting values similar to those of the red bands. The Wular Lake shows to have maintained a consistency with the values of the red bands as they do not display a significant gap, showing a stability of the values representing the presence of chlorophyll in the lake. There was a significant decrease in the values for the blue bands, representing an overall increase in the quantity of total suspended solids in the lake. The surface area for the lake remained rather stagnant

with the exception of 2014, during which floodwaters increased the surface area of the lake. It otherwise did not exhibit any significant change during the years that were utilized in the data extracted.[8]

With both of its red and blue band values observed to have an increasing trend, Lake Taihu is the only lake in which its case with pollution is gradually getting better over the course of the 15-year period. The increase in band values is more notable as the mean of the reflectance value in the blue wavelength is nearly three times at 2016 than it was 2001. This suggests a significant decrease in the presence of TSS. The increase in both band values also suggests a decrease in chlorophyll presence in the lake. The surface area of Lake Taihu has remained relatively stagnant over the 15-year period.

It is relevant here to mention that not all of these lakes were expected to have large fluctuations in all three quality as well as quantity parameters to begin with. For instance, during the lake selections phase, it is expected for lakes like the Aral Sea to show a more obvious trend in decreasing surface area for the past few years, because it is more notoriously known globally for its problem with the shrinking size. Other lakes, like Lake Tai and Wular Lake, are not expected to have as much of a decrease in surface area, though it is expected to have more problems in terms of its water quality, as they are often subject to case studies involving the extents of their harmful algal bloom or excessive sedimentation.

Looking at the red band values of these graphs, there seems to be an observable trend in all the lakes except for the Aral Sea. Which makes sense because the Aral Sea is the only lake out of all the five that is technically located in the middle of a desert in Central Asia, and it seems to be the most remote from live plants and vegetation. The rest of these lakes are most located in scenic areas where there are mountains full of trees some of them are located in a more subtropical climate. In the Wular Lake, for example, there is the most apparent trend of a decrease in red band means, which is correlated to an increase in chlorophyll concentration. This is an indicator that the algal growth in Wular Lake is certainly still an ongoing problem. Lake Tai, however, seems to be in the minority as there is an upward trend in the red band value, indicating a decrease in algal growth. This is evidently consistent with its local government's conservation efforts to control local industrial pollutions. The blue band values seem to be fluctuating from year to year. The only cases with an obvious trend may have been present is in the case of Wular Lake. There is a relatively strong trend of decreasing blue band values, which indicates an increase in suspended sediments. This fits context as reportedly, the lake still suffers from pollutions from fertilizers and animal manure from plantations nearby. Another trend in blue band is observed in Lake Tai, as there is a slight increase in blue band values, meaning there has been a decrease amount of sediments.

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Neuroprotection in Temperature and Oxygen Stressed Turtles

Shivanie Saith and Sarah L. Milton

Abstract – This study is designed to detect the expression levels of heat shock protein 72 in the forebrain, midbrain, hindbrain, and ventricles of *T. scripta*, when subjected to anoxia and warm and cold temperatures for various periods of time.

Keywords – Neuroprotection, temperature, oxygen stress, turtles, and *Trachemys scripta*

I. Introduction

The freshwater turtle, *Trachemys scripta*, has a unique ability to survive without oxygen for prolonged periods of time. Unlike a vast majority of vertebrates that die after a few minutes of being deprived of molecular oxygen (anoxia), anoxia-tolerant vertebrates can survive from hours to weeks (Stecyk et al., 2007). Anoxia followed by reoxygenation produces a rapid transient increase in reactive oxygen species (ROS) that destroys cells and its contents (Hashimoto et al. 2003). The mammalian brain is susceptible to ROS; however *T. scripta* may employ protective mechanisms to survive anoxia, thus preventing ROS damage. Not only is brain function protected, but heart function is, too. One protective mechanism is the over expression of heat shock proteins (HSPs). HSPs are overexpressed when cells are stressed, acting as a molecular chaperone.

II. Materials and Methods

The brains and hearts of *T. scripta* were exposed to anoxia at 21°C, normoxia at 5°C, and anoxia at 5°C, with normoxia at 21°C as the control group. Exposure times ranged from 1.5 hours to 2 weeks. Each sample, weighing at least 200mg, was homogenized and the proteins were extracted. Protein assays were performed on the extracts to determine the respective concentrations. Western blots were done to detect the presence of heat shock protein 72. Results are expressed as ±SD.

III. Data

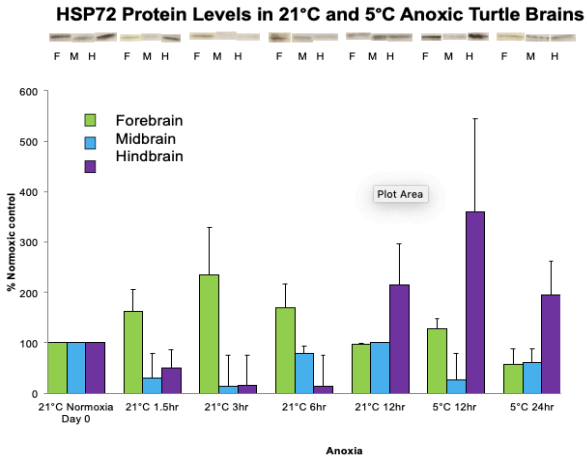

Figure 10. Representative Western blot (A) and densitometric analysis (B) of HSP72. Western blot is in the same order as graph. N= 3- 4 animals per treatment. F= forebrain, M= midbrain, H= hindbrain.

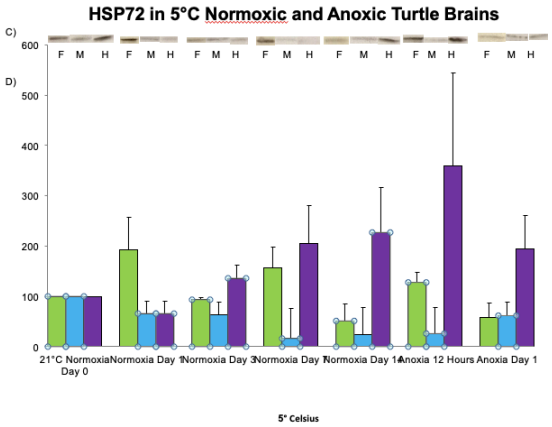

Figure 11. Representative West ern blot (C) and densitometric analysis (D) of HSP72. Western blot is in the same order as graph. N= 3- 4 animals per treatment. F= forebrain, M= midbrain, H= hindbrain.

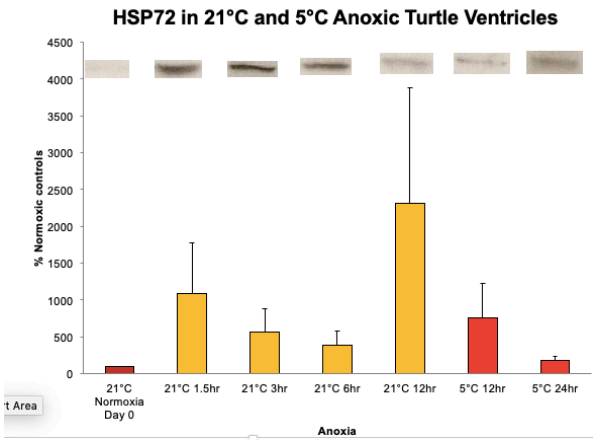

Figure 12. Representative Western blot (E) and densitometric analysis (F) of HSP72. Western blot is in the same order as graph. N= 3- 4 animals per treatment.

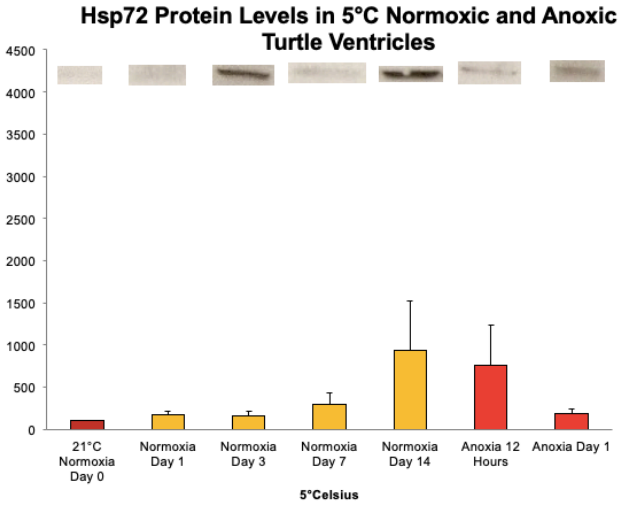

Figure 13. Representative Western blot (G) and densitometric analysis (H) of HSP72. Western blot is in the same order as graph. N= 3- 4 animals per treatment.

IV. DISCUSSION AND CONCLUSION

Previous studies have shown that HSP72 is induced early in anoxia, increasing for 8 hours but then falling to normoxic levels by 12 hours of anoxia showing that HSP72 may play a key role in the initial transition to the anoxic state (Milton and Prentice 2007). This study examined the brain in sections, rather than the previous whole brain.

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Study on the Bio-Fluid in the Microfluidic Channels Using Numerical and Computer Programming

Aaron Zhao

Abstract – In this paper, optimizing microfluidic technologies through a multiple channel network using numerical and computer programming were suggested. This paper studied the micro-fluid flow in organ-on-a-chip microfluidic systems, and considered factors such as flow pattern, optimal flow rate, flow uniformity. For the purposes of this paper, micro-fluidic channels with a circular cross section were chosen due to its low fabrication complexity. Computer code was developed to investigate how the flow rate Q would change based on a variety of factors through both an Iteration Analysis (Continuity Equation and Modified Bernoulli Equation) and the Hardy-Cross Method (An alternate iterative method). Ultimately, we found that flow rate Q had a quadratic relationship to Length/Diameter of the channel in both iterative methods.

Keywords – Flow rate, micro-fluidic channels, Continuity Equation, Modified Bernoulli Equation, Hardy-Cross Method

I. Introduction

The recent application of microfluidics in research involves examining cell growth and development in dynamic microenvironments [4]. The advantages of the microfluidic technology include miniaturization, parallelization, and integration. This research quantitatively studies the micro-fluid flow in organ-on-a-chip (OOC) microfluidic systems.

Defining necessary specifications builds the foundation in designing the structure of microfluidic channels. During this process, factors such as sample size, flow pattern, optimal flow rate, flow uniformity, and fabrication complexity must be considered.

Similar to a tubular network of blood vessels, a microfluidic channel that separates the flow into multiple channels is proposed. The goal of this particular system is to address the constraints on the microfluidic system.

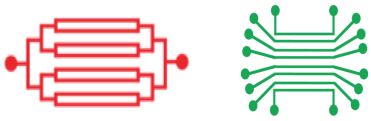
Micro-fabrication provides a significant toolbox which helps process and manufacture the microfluidic channel. However, microfluidic systems are often costly due to the complexities that result from inconsistent channel depths and dimensions. This necessitates using sophisticated technology and establishing fabrication procedures. In order to fabricate the microfluidic channel, the proposed geometry must include and develop uniform cell deposition in proper devices.

The design of the proposed microfluidic channels has circular cross sections because of its low fabrication complexity and simple manufacturing procedure. With a Reynolds number less than 2000 the laminar flow requirement of such microfluidic channels is satisfied [1].

In this study, the channel diameter D is constant at nano-scaled dimensions of 4E-9m and 3E-9m. In addition, the cross-section of the channels will be circular: a few nanometers in diameter, and a few millimeters long. Multiple channels may be used in a device by either joining them (parallel) or having many disconnected ones (independent).

Building Blocks of Microfluidic Circuits

As in electronics, fluidic devices may be idealized to be fluidic circuits made of various independent components and elements as they are shown below [2, 4]:



(a) Multiple channels [2]

(b) Channels with parallel/wound and parallel/straight [5]

Figure 1. Schematic diagram of basic channel system

These channels can be manufactured with a variety of surface features (ridged etc.) and can be coated with various chemicals.

II. Applications Iteration Analysis of Biofluid in Micro Channel in OOC System

A. Continuity Equation and Modified Bernoulli Equation

Consider the micro channel system shown in Figure 2.

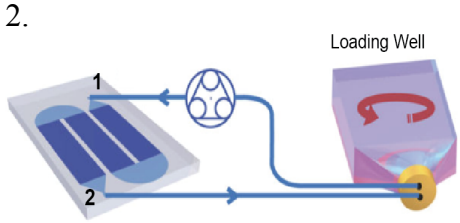


Figure 2. Schematic diagram of a channel system

The energy equation between 1 and 2 in the system is

$$\left(\frac{p}{\gamma}+\frac{V^2}{2g}+z\right)_1-\Sigma h_L=\left(\frac{p}{\gamma}+\frac{V^2}{2g}+z\right)_2 \qquad (1)$$

The head loss in the channel due to viscous or turbulent effects is given by the Darcy-Weisbach equation which is:

$$h_f=\frac{V^2}{2g}\frac{L}{D}f \qquad (2)$$

where

L = channel length (known)
D = channel diameter (known)
f = friction factor

Q is the volume flow rate and υ is the kinematic viscosity . The expression for V that was used in Equation (5) is

$$V=\frac{Q}{A}=\frac{4Q}{\pi D^2} \qquad (3)$$

Substituting Equation (6) into Equation (8) and solving for Q^2 gives

$$Q^2=\frac{g\pi^2D^4(z_2-z_1)}{8\left(\frac{L}{D}f+K_{entrance}+K_{valve}\right)} \qquad (4)$$

Unknown value in the channel flow problem is usually the flow rate Q. Or it could be the channel diameter D. In this case an iteration scheme may be used to solve the problem. This is because velocity V is related to flow rate Q and friction factor f is related to the Re, which is related to flow rate Q. So, Equation (9) is an implicit function of Q. The following iteration scheme may be used to solve for Q.

1. Assume a value for friction factor f , say f_1= 0.05. (Experiment data shows that the f ranges from 0.005 to 0.1).
2. Solve Equation (9) for Q.
3. Solve Equation (5) for Re.
4. Solve Equation (4) for friction factor f, and assign it as f_2.
5. If the difference $|f_2-f_1|<\varepsilon$ say $\varepsilon=1.0*10^{-5}$ where epsilon is tolerance, or difference between f_2 and f_1 then the flow rate Q is the correct value otherwise set $f_1=f_2$and repeat process until condition of item 5 is satisfied.

We now create an algorithm using MATLAB program to determine the flow rate, Q, and the friction factor f by the iteration method described above.

Use the following values for the problem.

L =0.008, D=0.000004, z1=0.0001, z2=0, g=9.8 m/s^2, and nu=1.15e-06 m^2/s

Output Data

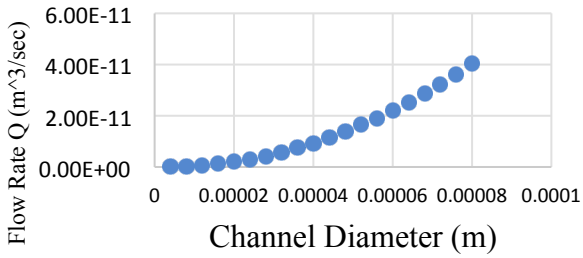


Figure 3. Channel Diameter (m) vs Flow Rate Q (m^3/sec)

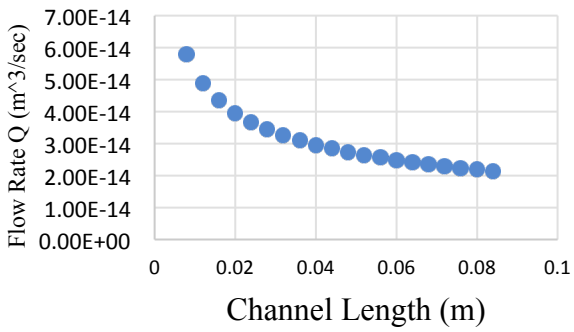


Figure 4. Channel Length (m) vs Flow Rate Q (m^3/sec)

B. The Hardy-Cross Method

Geometrical complexity of the microfluidic channel

The Hardy-Cross method is another iterative method that can be used to find flow rates in OOC network and head losses throughout a 2-D channel network. A loop is defined by a closed path and

Schematic Diagram of a 2 Dimensional Rectangular Micro-channel

The fluid flow is assumed to be laminar, steady state and incompressible with constant properties while dissipation, pressure work and body forces are neglected. In this tree-like channel, fluid flows first from the inlet to the bifurcation of the inlet, then flows further downstream to where additional bifurcation occurs. The fluid flows through three sub-channels, which are then merged into two outlets as it is shown in the Figure 5.

The following definitions are used in describing the Hardy-Cross Method. (see Figure 6).

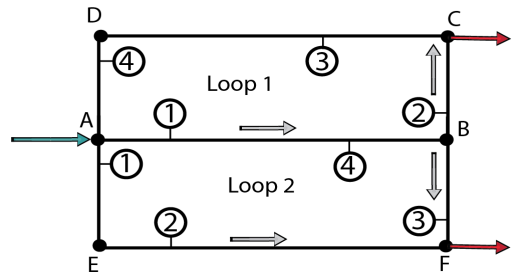


Figure 5. Loop rule - Two loops of OOC network

$$Q_{11} > 0, \quad Q_{24} < 0, \quad Q_{11} = -Q_{24}, \quad Q_{22} > 0$$

A two dimensional microfluidic system with the length of L and the width of W is considered as shown in Figure 5. The length is longer than the width of the channel (W< L).

Loop Rules

1. The flow rate Q is positive if the flow is in the counterclockwise direction around the loop.

2. The head loss h_f is considered positive if the flow is in the counterclockwise direction around the loop.

3. The two loops with a common channel can be a positive Q in one loop and a negative Q in the other loop.

Loop Number, Channel number, Channel Length (m), Channel diameter (cm) are assumed as follows :

Table 1. Channel lengths and diameters

	1	0.00004	0.000000004
1	2	0.00001	0.000000004
	3	0.00004	0.000000003
	4	0.00001	0.000000003
	1	0.00001	0 .000000003
2	2	0.00004	0. 000000004
	3	0.00001	0. 000000003
	4	0.00004	0. 000000004

Loop Number, Channel number and Initial guess Q (m3/s) are set as follows:

Table 2. Initial guess Q for the channel system

	1	0.15
1	2	0.05
	3	-0.05
	4	-0.05
	1	0.10
2	2	0.10
	3	-0.10
	4	-0.15

Output Data

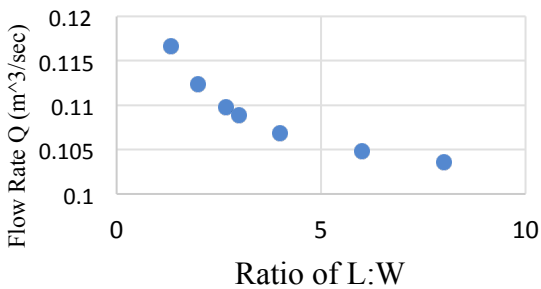


Figure 6. Ratio of L:W vs Flow Rate Q for Channel (1,1) Starting D

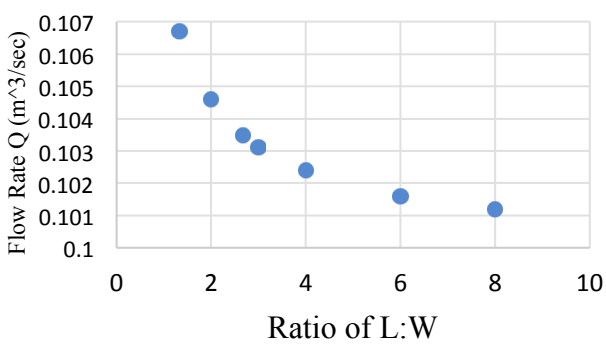


Figure 7. Ratio of L:W vs Flow Rate of Q for Channel (2,4) Invert Starting D

General Trends for (2,3): Q values increase as Ratio of L:W increases regardless of D value. As we move from a starting D to an invert starting D, the Q values in general increase by an average of 8.5E-4.The average difference in values shown here are identical to the one found in channel (2,1);(2,2) but instead of decreasing it is increasing.

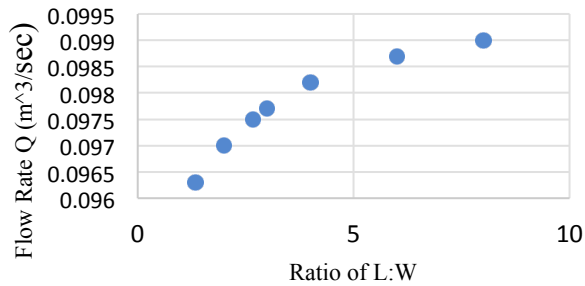


Figure 8. Ratio of L:W vs Flow Rate of Q for Channel (2,3) Invert Starting D

III. Conclusion

Through two separate iterative methods that accounted for viscous and turbulent effects that lead to head loss throughout a two-dimensional channel network. Computer code was then developed to investigate how the flow rate Q would change based on a variety of factors.

First, an Iteration Analysis using the Continuity Equation and Modified Bernoulli Equation was done and found that flow rate Q (m^3/sec) exhibited quadratic growth to channel diameter(m) and quadratic decay with channel length(m).

Then, an alternate iterative method, the Hardy-Cross Method, was performed and found that flow rate Q(m^3/sec) also exhibited quadratic properties in relation to ratio of length to width of channel (m). This relationship was much more nuanced as it considered varying length to width ratios as well as varying channel diameters in the entire loop. Channels (1,1), (1,2), (2,1), (2,2) and (2,4) all saw a decrease of flow rate Q as ratio of length to width increased regardless of channel diameter values. Channels (1,3), (1,4) and (2,3) all saw an increase in flow rate Q as ratio of length to width increased regardless of channel diameter values.

Ultimately, microfluidic channels can be made more efficient using this proposed system or separating flow into multiple channels. Flow rate may be increased and decreased based on channel length, width and diameter. Further studies may

may be focused on variations in channels such as uneven and ridged surfaces, chemically coated surfaces, or multi-layer photolithographically manufactured surfaces.

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3. Equations: Default settings should be used, with Arabic numbers flush right in parenthesis.
4. All margins of the 2 columns should be 1 inch.
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7. References should be listed at the end of the paper (after endnotes and appendices). This section should have a first-level heading "REFERENCES" and followed by a single line space. Entries should appear in alphabetical order by the first author's last name.
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The End