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Foreward

Welcome to the 2014 *Journal of Student Research*. This volume features a variety of articles which share leading-edge, faculty-reviewed research projects conducted by students at the University of Wisconsin-Stout. Emerging research, where meaningful research is incorporated into the curriculum, is a highly valued experience for our students. With articles focusing on subjects ranging from the economic impact of "reshoring" to an analysis of the effectiveness of an education video game; from the practical problem of joining metals to ceramics in high-stress applications to the relationship of marital satisfaction and sleep patterns, the careful and imaginative work represented here shows our university's high regard for practical applications to everyday problems that our graduates will face in society and industry.

It has become evident that another value is represented in these pages: a recognition that research and dissemination is a collaborative enterprise. It goes without saying that the *JSR* and the work it presents richly benefits from faculty mentors and reviewers, as well as student support from contributions as well as by design, layout, and production of the print and online editions. We are deeply grateful for the work of all those who have been involved.

But there is another aspect of support and collaboration that should be noted. Many of the projects represented in these articles are the material fruition of programs sponsored by UW-Stout or by outside programs available to our students. Three projects received funding through UW-Stout's Research Services, while eight others were produced by students in the university's challenging and support-oriented Honors College. Eight students represented here are McNair Scholars, a Department of Education program that cultivates underrepresented students for eventual post-graduate degrees. One project was undertaken by a UW-Stout student while summering at the University of Minnesota in the Research Experience for Undergraduates (REU) program (Sponsored by the National Science Foundation). With all this significant support from within the UW-Stout community as well as from other sources, it should be no surprise that we have enjoyed a record number of submissions this year; all in all, such ample support bodes well for the JSR, for UW-Stout, and most importantly, for the future leaders, scholars, and problem-solvers that we will soon present to the world.

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Homer in Contemporary Warfare

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Abstract

This article explores the concept of honor in the Homeric expression of battle presented in the *Iliad* and in contemporary warfare. Through the use of literary analysis and contemplation of social evolution, honor is examined and applied to the Homeric model of war still present today. In the *Iliad*, Homer presents themes of honor that we still see today when examining warfare. These themes range from the concept of arête or masculine excellence, the difference between the Greek concepts of honor *(timê)* and glory *(kleos)* from contemporary understanding of honor, and the dialectic nature of war. Using these themes, Homer is able to lay the foundations for warfare that we still use as a framework for analyzing battle today. Greeks believed that honor was gained by the prestigious through wealth, power, and strength, however in the *Iliad* Homer also developed themes of personal interest, loyalty, and empathy that we associate with honor today. As this paper will demonstrate, contemporary accounts of war still represent the Homeric concept of excellence in battle, but they are imbued with cultural perspectives which give contemporary warfare a divergence. However, despite this cultural divergence, the presence of honor among men in battle represented by the Homeric narrative will likely always remain.

Key Words: honor, warfare, Homer, dialectic nature, arête

The concept of *Arête* is one of the most prevalent in the *Iliad*, particularly because it is present within its main character, Achilles. Possessing *arête* is being the best you can be or reaching your highest human potential (Fuhrer). A person who possesses *arête* would not just have bloodlust in battle; they would have qualities of strength, bravery, wit, and honor to achieve their standing. The Trojan War transformed Achilles from a petulant teenager hinged on pride and vanity into a soldier

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who was could be admired by his comrades. The metamorphosis of Achilles through the *Iliad*, provides a stunning example of the achievement of obtaining *arête* through war.

The first book of the *Iliad* initially introduces Achilles as a boy on the cusp of manhood, still susceptible to prideful indulgence and ignorant wrath. His argument with Agamemnon, born from the unequal possession of wealth evolves into battle of pride. And Achilles, with his rage burning and pride damaged, abandons the Achaeans in a fit of selfishness with the declaration,

> "By this staff I swear
> A great oath that surely someday a desperate need
> For Achilles shall come upon all the sons of Achaeans,
> Nor will you be able to help them at all, no matter
> How grieved you are, when man-killing Hector is cutting them
> Down by the dozen. Then, I say, you'll rend
> Your heart with wrath and remorse for failing to honor
> The best Achaean of all!"
> (*Iliad*, I.278-85)

Soon the Achaeans are pushed back to the sea, panicked and grief stricken. Patroclus, Achilles closest companion, is moved with grief for those dying and begs Achilles to allow him and his troops to join battle. Achilles relents, and Patroclus himself enters the battle, rallying the Greek troops and filling them with courage. But total victory was not to be, and Patroclus was not to return to Achilles. He himself is cut down by great Hector's spear, his armor stripped. Achilles is utterly distraught by the death of Patroclus, so much so that he had to be help back lest he take his own life (*Iliad*, XVII.37-38).

The death of his lover motivates him in ways that the riches offered him by Agamemnon could not. In mourning, and desperate to avenge Patroclus' death, Achilles enters the battle, and it is here where he achieves *arête*. He is no longer the petulant child presented in book one, nor is his participation in battle hinged on glory or wealth; Achilles fights for Patroclus and he allows nothing to hold him back from avenging his partner. Achilles strikes down every Trojan soldier he can reach until he meets Hector and presents bravery, speed, and a feat of strength

that he had not achieved before.

Even today in contemporary warfare, we see examples of *arête*. Though the idea of war transforming of boys to men has faded, there is a sense of hyper masculinity and excellence that prevails. The parts of battle remembered and applauded today are those stories of *aristeia*, where soldiers performed actions that seem superhuman, and those who performed these actions are the individuals that arise from the masses ("aristeia").

Not only are these actions of *aristeia* and *arête* remembered today, but they are also formally recognized. Soldiers who act above and beyond the call of duty in battle can be rewarded with medals such as the medal of honor, the distinguished service cross, the silver star, the bronze star, and more (Sterner). These awards are examples of how we take Homer's idea of *arête* and apply it to contemporary battle today. The soldiers awarded with recognition have performed their duties to their highest potential, which follows the Homeric model presented in the *Iliad*. The difference between the contemporary concept of *arête* and the Homeric concept of *arête* lies within the difference in actions. In the *Iliad*, Achilles achieves *arête* through actions motivated by love. Today, feats of *arête* are not achieved in the action of memorializing love, but to memorialize fearlessness that men present in the high stake situations of battle.

The second Homeric concept prevalent in the *Iliad* is that of *timê* (honor) and *kleos* (glory). *Kleos* is the idea of fame and eternal glory, or being immortalized by glorious deeds (Beck). It guarantees meaning to one's life and it was obtained by acts of *timê*. *Timê* was the Greek concept of honor, though it was defined differently than it is today. The Greeks defined honor as the value attributed to a person or the public acknowledgement of one's value. It was extremely subjective, because it was influenced by public performance and image (Cairns). The greater your performance in battle and the more material goods you owned, the more honors you received. Many Greek soldiers would perform outrageous acts in battle, hoping to achieve *timê* and therefore *kleos*.

In the *Iliad*, Homer often showed his heroes in situations where they had to choose between achieving *kleos* or staying with their loved ones. The contrast can be observed in the differences between brothers Hector and Priam. Andromache pleaded with Hector that he remain at home instead of fighting

the Argives, and she uses both her own fate and the fate of their child if Hector would die in battle in attempting to persuade Hector away from the fighting. But Hector in reply says:

> "But how could I face the men of Troy, or their wives
> Of the trailing gowns, if I were to skulk like a coward
> And stay away from battle? Nor does my own spirit
> Urge me to do so, since I have learned to be valiant
> Always and fight mid the foremost champions of Troy,
> To win and uphold the King my father's glory
> As well as my own."
> (*Iliad*, VI.486-92)

Unlike Hector, who understood both the honor in attaining *kleos* and the honor of defending his family and his people, Paris has no concept of *timê*. He spends much of the *Iliad* with Helen, rather than on the battle field defending the people whom his actions thrust into battle. His preference for comfort rather than glory is often scorned by the other Trojans, who perceive his acts to be dishonorable. As Hector puts it, "You are powerful enough when you want to be, but too often you let yourself go and don't seem to care." (*Iliad*, VI.576-78). This is why the soldiers of Troy respect and honor Hector, but scorn Paris. Hector's willingness to go out into battle and fight for his glory is seen as more honorable when compared to Paris' preference to play lover to Helen.

Today, social evolution and different cultural values have changed the Homeric sense of honor and glory. Instead of focusing honor around singular points of battle and masculine excellence as the Greeks did, we add more depth to the concept of *timê*, and make it something unmaterialistic. We give honor to connotations such as selflessness, valor, empathy, and compassion in spite of danger and destruction. However the tendency of soldiers to risk their lives in high stake situations to selflessly save others can fit into the Homeric framework that represented Greek soldiers who would perform outrageous acts in battle in attempt to achieve *kleos*.

The actions soldiers perform in contemporary battle are acts of honor that reflect values of selflessness and courage in high stake situations. For example, in 2005 Lance Cpl. Joshua R. Mooi attacked an enemy at close range to personally recover

four wounded Marines who had been injured in the kill zone. (McCall). Similarly, Cpl. Javier Alvarez led a squad of men one hundred meters through an enemy kill zone to reinforce an embattled squad. He later proceeded to risk his own life to throw away an enemy grenade that had landed amongst his men, saving many from potential injury and death. (McCall). Though the emphasis of honor has changed from glory to selflessness, there is still a reverence and respect that soldiers gain through performing acts of honor and bravery in battle.

The third Homeric concept examined is the nature of battle. Perhaps the best description of war, both in Homer's *Iliad* and in contemporary society is dialectical in nature. There is a ferocity in war that makes the actions performed by soldiers brutal and terrifying. No one can deny that the bloody sacrifices made and the crushing destruction that affects both soldiers and citizens alike is a terrible thing. However as Homer describes in the *Iliad*, there is a primal beauty among men who fight and give their lives for a higher cause. There is a beauty in the bond between soldiers, and though the relationship within today's military personal is often not romantic as Achilles and Patroclus' was, there is still a sense of camaraderie that binds soldiers who served together for life.

This dialectical nature is perhaps the cornerstone for Homer's *Iliad*. The characters are placed in obscene circumstances, and the descriptions of battle are gruesome and yet readers have since the 8th century found themselves fascinated with not just the story, but the relationships and actions that Homer creates. We find ourselves smiling at the truce between Diomedes and Glaucus, we can relate to the familiar affection between Hector, Andromache, and Astyanax, and we find ourselves mourning with Achilles after Patroclus' death. Homer created a sense of humanity in the *Iliad* that allows us to see both the horrors of battle and the honor among the soldiers.

Similarly in battle today, we abhor the death and destruction that follows war. Those directly involved bear scars, both physical and psychological. When soldiers return from war, they are often plagued with night terrors, post-traumatic stress disorder, depression, injury, and loss. The vast binary between warfare and civilian life often causes soldiers to remember the horrors of war that soldiers and civilians directly involved in battle have to carry with them for their entire lives, but we who have never

seen battle cannot comprehend. Soldiers never forget battle. Yet beyond the trauma of war, there is a sense of light. Families and citizens who have never met band together to support troops overseas, soldiers voluntarily sacrifice everything to protect the people they love, and amidst it all there is a sense of hope for a better future. While war is terrible, it teaches us about not only the resilience of humanity, but also about the connection between brothers, the fierce protection for those we love, and above all, the honor that humanity can still possess even in our darkest hours.

The themes used by Homer in the *Iliad* are able to lay the foundations for warfare that we still use as a framework for analyzing battle today. By observing the events that lead to the attaining of *arête*, investigating the cultural alteration of the Greek themes *timê* and *kleos*, and understanding the dialectical nature of war one cannot deny the connections between the two models. And though there is a cultural divergence between the two models, it is undeniable that the honor presented by Homer in the *Iliad* is still prevalent among the soldiers who fight today.

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Stress and Educational Expectations: A Study of Future Orientation

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Abstract

This research explores the extent to which the type of secondary education a student receives impacts their perceived stress level when it comes to thinking about college. Drawing from pace-of-life literature in educational and work-sphere studies, this research also explores whether the pace-of-life in educational institutions contributes to this perceived mental stress. This is a qualitative research project consisting of interviews with public school and alternative school (charter or home) students. Particular focus is given toward school norms on future-oriented pressures and whether the school provides leniency to lower performing students. Three theories were used for synthesis: structural strain theory, social learning theory, and fear appeal theory. This article argues that parents are most influential on a student's perceived stress level in relation to future goals. The information collected from this study can inform school and parenting resources, and it indicates opportunities for future studies.

Key Words: pace-of-life, stress, education, adolescents

Introduction

This article was motivated by the question of whether stress is detrimental or whether it is, in fact, necessary for optimal motivation and perseverance in students. In other words, does stress make us successful? While there is certainly anecdotal evidence of this many can describe from their own lives, there is also research that shows there are both good (for motivational purposes) and bad (stress which negatively effects mental and physical health) types of stress, and some people may have more bad stress than good stress. Stress can lead to various mental and physical ailments (Gamble, 2013). This research sought to

better understand why students experience stress in regards to their personal time orientation (if someone bases actions and thoughts on perceptions of past, present, or future events). The secondary school a student attended is hypothesized as an important influence on a student's perceived stress level. Specifically, this study asks: Does the type of school and its norms for time orientation affect a student's perceived stress level when considering future goals like attending college? In order to help answer this question, structural strain theory (Merton, 1968), fear appeal theory (Williams, 2010), and social learning theory (Bandura, 1971) are used in conjunction with qualitative interview data.

Literature Review

It seems quite common for U.S citizens to feel a lack of time for leisure or exercise in their busy schedules. U.S. citizens work an average of seven hours a day and allocate five hours of leisure time (U.S. Department of Labor, 2011). U.S. society can become consumed by work and productivity that encourages future-orientation, and the stress related to such norms can affect individuals' physical health and mental health (Zimbardo and Stephenson, 2010 and Leveine and Norenzayan, 1999). Levine (1999) found that future-oriented and fast-paced cultures had more risk of heart disease and death. According to Garhammer's (2002) study, the pressure to do a lot of things at once does inflict health problems like sleep deprivation and tiredness. Lack of sleep can contribute to decreased mental and physical health, such as heart disease, diabetes, stroke, and cancer (Gamble, 2013). Despite these potential negative consequences, U.S. society often prioritizes future-orientation.

Future-orientation includes making goals and finding the means to accomplish those goals. A central aspect of the U.S. educational system is to prepare children for the future; it is up to the school to set expectations of students. These expectations are usually future-oriented; they want students to graduate and often to pursue higher education. Blustein et al (2010) reported that urban students saw the need to attend college as vital if they want more options in life. According to a student in the study, high school is merely a basic tool for college, and college perpetuates a career. In prioritizing future-orientation, schools may encourage participation in extracurricular activities, high

grade point averages (GPA), and/or Advanced Placement (AP) classes. Future-oriented expectations from schools can carry on into young adulthood prior to people entering the "real world."

The fast-paced and future-oriented lifestyle of U.S. society may hinder student's academic well–being, and therefore make fast-paced schooling tactics counterproductive (Brown et al., 2011). People can only do so much in a day, and The Slow Movement suggests that humans should balance their time (Garhammer, 2002). Unlike the U.S., some countries in Europe live a present-oriented and slower paced lifestyle, referred to as The Slow Movement. Carlo Petrini started The Slow Movement in Rome as a revolt against globalization and fast-food industries. Resisting the effect of globalization, participants in The Slow Movement began to eat longer meals (Parker, 2008). The Slow Movement can show teachers how to slow down the rapid pace set by technology and globalization, while still giving the students an enriching education through reflection (Badley & Badley, 2011). The learning and coping skills students obtain will influence future work behaviors and future orientation.

Brown, Nobiling, & Birch (2011) found there was a relationship between the amount of homework students have and their parent's busyness. Parents may impact children's time orientation and behaviors in schools, as well as time management. A student may repeatedly see their caretaker's behaviors and mimic them. However, modeling doesn't mean a behavior will remain static.

Garhammer (2002) examined whether a very busy and stressful life leads to a happy life. Generally, people with many commitments can enjoy life, if they have access to leisure activities and have access to stress coping resources (Garhammer, 2002). Students may experience less bad stress and perform better in schools if there is less pressure on future-orientation, or if the schools provide proper coping resources. We need to understand better variation in future-orientation and/or coping resources among schools and associated influences (e.g. parents) with those schools in order to explain the extent to which bad stress and student performance improves. This study attempts to do so by examining how students are influenced by schools and caregivers in relation to time orientation, coping resources given, and stress.

Methods

Participants

This study includes nine open-ended, in depth interviews. Seven participants were undergraduate students from a mid-sized Midwestern university chosen through convenience sampling. Six participants were female and Caucasian, but represented various ages (18 – 27 years old) and came from different types of schools. Three university students previously attended a charter or home school. Four of university students attended public schools. In addition, two students at the secondary school level were interviewed, one went to a charter school and the other went to a public school.

Procedure

Participants read and signed an informed consent form. If participants were minors, a parental or guardian's signature was required before the interview. Each consent form had every IRB requirement explained to them. The participants were asked a series of questions related to stress, school, parents, and time orientation in relation to the student's goals. The researcher jotted notes during each in-person interview. If it was an online interview, the researcher collected typed messages. There were two online interviews. A Microsoft Excel codebook was created for the data analysis.

Participants were numerically labeled by their grade level, the interview number, and a series of random numbers. The undergraduate participants' responses were inductively categorized into different codes: pressures, school's ideal expectations for students, school's realistic expectations for students, college resource availability, college fairs, high school curriculum, handholding (if the school offered alternative schools or academic leniency for lower performing students), and undergraduate student's advice. The two high school level participants were inductively coded separately because they had a different set of interview questions: future plans, discussion of potential futures, amount of college resources, influence of parents' work on students, parents' effect on students, role models, students' time management, students' perception of their school, students' future concerns, and institutional stress. Undergraduate students reflected on their past and how it affected them now. The high school students' questions were

present and future-oriented; however, some students clarified answers by using past examples.

Results

Future Orientation – Advanced Placement Classes and Future Preparation

Those who attended both public and charter schools discussed the availability of AP or other classes which gave students the opportunity to earn college credits before college. The purposes of these classes was to receive college credits in a more cost effective way, place students ahead of others by lessening college credits, and influence a student's GPA before college. For the purpose of this research article, AP classes (and others like them) mark future orientation. Some students reported adequately being prepared for college or "the real world" due to the rigor; however it was not fitting for all students. Regina, a female student who came from a charter school in a high socioeconomic county reported: "I personally think [my charter school] pushed too many lowerclassmen into AP classes that were hard even for upperclassmen; therefore there was an obvious difference in the quality of work of the lowerclassmen students and the upperclassmen students in AP classes."

The quote above exemplifies how that particular school pushed students at different levels to take the AP classes. Since the AP classes indicate future-orientation by the schools, it is to be assumed that this particular school favored future-orientation. When the participant mentioned the "quality of work" from lower classmen, they indicate it to be lower. There are many speculations as to why, but one reason could be that students are trying to balance their schedules between the AP classes and extracurricular activities and do not possess the same developmental level of cognition as upperclassmen. AP classes alone are time consuming due to the amount of outside work, potentially contributing to bad stress or poor achievement.

While some students reported that AP classes can be time consuming, other students reported that some of their AP classes were easy. Some students like the one above, regarded AP classes as a push from schools in regard to college achievement. Participants who cited AP, College Level Examination Program (CLEP), or other college credit granting

programs, sometimes also mentioned how their schools offered "hand-holding." "Hand-holding" refers to schools allowing lower performing students to graduate on time (normally four years). Examples of this include: sending lower performing students or students who exhibit maladaptive behaviors to alternative schools, or allowing grading leniency in classes. One participant pseudo-named Natasha, came from a well-funded public school. She mentioned that if a student did not perform well, the school would provide alternative schools or dismiss late work to ensure graduation: "I knew a guy who did well in school, but he just kinda lost interest in it. He stopped attending classes so he would get detentions and got suspended. After a while, he just got transferred to an alternative school [where] he could graduate."

The student from Natasha's experience may have seen present-orientation as more beneficial for him, rather than the school's future-oriented goals. The alternative school reported above is an indication of compromise in time orientation: an alternative school (that is not a charter school) is used for problematic students or under-performing students, therefore curriculum may be less demanding. This compromise is shown through the slower oriented push for graduation (an item of future-orientation) and the attendance of such students.

Charter schools' modes of teaching are often different than public high schools, regardless of the amount of funding they receive. Charter schools sometimes give more autonomy related to deadlines and topics. Charter schools may also require students to complete more coursework and may use project-based curriculum. Regina attended a well-funded charter school and outlines her school structure below:

> The entire structure of the school acts as an academic bridge between high school and university. Homework is not checked daily (as it isn't in college), research is self-directed (similar to university theses), and many subjects are chosen according to the student's personal interests. University is obviously something they hope for all the students but I felt less focused on getting into a specific university and more focused on cultivating a global perspective.

Additionally, Regina was thankful for the amount of coursework and requirements their charter school required:

> All of us had different life goals and I believe [my charter school] helped us become better versions of ourselves. We had a lot more academic flexibility and we could explore our interests while still maintaining that high school "safety net."… The atmosphere is inspiring and the academic structure nurtured my potential.

However, a participant pseudo-named Sasha, attended a less well-funded charter school expressed concerns towards graduation because of the extra credits her charter school required. She also did not enjoy the autonomic pedagogy:

> In the charter school you need 32 credits to graduate (3,200 hours of work). In the traditional school it's 28 both are way more high in standards than the usual school...I would gladly go back to traditional high school; I hate it here very much. It's super easy to slack and get behind on your credits and the math here is duncical. They say when you're down at the project based learning you get more freedom but, it feels like a Nazi camp. (Sorry, but it's how I feel.)

As illustrated by the previous quotes, the amount of funding a school receives effects students' perceptions of the schools. It affects stress and resources for coping with stressors. Better-funded charter schools have more college visits and guidance counselors. Participants from less-funded charter schools never discussed guidance counselors, and seldom had as many visits from other colleges. Sasha claimed: "My school does not have a lot of those opportunities. When we do have them I enjoy them a lot, it helps me get more insight on what college and adult life will be like." Without the aid of active guidance counselors or other coping resources, students may have more bad stress from the future-oriented expectations instilled from institutions such as parent(s)/guardian(s) and schools.

Institutional Expectations

Charter schools appear to have higher expectations of their students than public schools do. According to individuals

interviewed, charter schools have more graduation requirements than traditional schools. According to Regina her well-funded charter school required more than regular public school:

> Our school's academic requirements exceed those of the regular high school as we are expected to take four years of math, science, English, and one (or more) of the 30 foreign languages we are offered. Although one of the pillars of [my charter school] is field experience, I don't think they tried hard enough to get us (or encourage us to find) out of school internships.

Sasha, who attends a less-funded charter school, explained similar expectations:

> I find myself stressing out about it a lot. In the charter school you need 32 credits to graduate (3,200 hours of works) In the traditional school it's 28 both are way more high in standards than the usual school (the average high school student needs 22 credits to graduate). My parents are generally laid back so they don't really, I'm more hard on myself.

This higher credit load can contribute to higher levels of bad stress, on top of other commitments. Both of these cases have reported feeling bad stress related to school, academics, and expectations. On top of the extra credits, participants also talked about extracurricular activities. Extracurricular activities act as a means for student socialization, but the activities are also seen as positive in regards to applying to college and/or work. However, Sasha, who attended a lower-funded charter school, wished she had more free time. The lack of free time may inhibit a student's work ethic in school:

> [In relation to multiple activities] I do feel like they are taking over all of my free time… if I don't go to practice or miss something they [other students] are usually angry with me. I do wish I had more free time to do other things but I chose to do them. I never really have enough time to draw so I sometimes draw instead of doing math.

If time management is imbalanced, academics and other facets of student life may suffer, and bad stress increase. The pressure to juggle many tasks is not specific to school settings – it can also originate in the home.

Regina attended a charter school that was located in a high SES county. They reported "chronic depression" and heightened stress when discussing internalized stress from her parents. Her mother and father attended universities and appeared to be affluent, judging by their academic background:

> "Both my parents went to Northwestern University. My mother became a lawyer and my father a business consultant and between them, there are 4+ degrees. When I realized I didn't have the academics to get into Northwestern, I was disappointed in myself."

This statement helps illustrate how influential parents can be on their children related to future-orientation and bad stress. Sasha attended a charter school but had grown up in a different economic situation but their parental situation has influenced her differently than the latter:

> My biological father is in prison and my step dad has medical problems so he
> doesn't work. My mom on the other hand is an amazing woman. She didn't finish high school. She was working two jobs for as long as I can remember and, if not two jobs, she would work over-time. She tells me all the time to finish high school and go to college because she wishes she had.

From these quotes, both parents and schools can influence how participants perceive future-orientation and the bad stress related to it.

Internalization of Stress

Participants reported being pressured to attain future goals from school, parents, and themselves. Regina and Sasha were from different charter schools, but claimed that most of their stress was due to pressure they put on themselves. However, their expectations were also influenced by schools and parents. Regina offered her insight on expectations:

> …I felt my parents expected my top-notch grades to continue and so I pushed myself more in my academics than in any other aspect of my life. Technically, my parents never pushed me in high school, but they didn't need to because they planted that "perfectionism" seed when I was a kid. I'm afraid it still hasn't left me.

Sasha briefly mentioned both teachers and caretaker(s) as a means for future-oriented internalization:

> Teachers are constantly on your tail because we are the future of the United States, and they don't want us to fail. As for parent's they tell me 'to do anything that makes me happy and successful'. My parents didn't make all of the right decisions when it came to their future, so seeing me succeed would make them more than happy…She [participant's mother] tells me all the time to finish high school and go to college because she wishes she had. I have big dreams and high expectations for my future so, I won't accept anything less.

The above remark illustrates the time orientation pressure from schools and parents. Sasha stated that her future goals were influenced by both her school and her mother. Both institutions recognize that in order for students to be successful in the future, the students should attend universities. In both accounts, each student indicated internalization but from different degrees.

Parents and schools can influence internalization of time as well. Two participants who attended different charter schools expressed discrepancies in time orientation. Sasha claimed to be present-oriented, but indicated future-orientation in their responses too:

> I don't worry about the future. I know I am a go to kind of [person] so when I make my mind up that I'm going to do something; I am going to do it. I try to look a couple years ahead but, I find it difficult when I don't really know what I want to do with my future. I think sticking to the now is good; but it wouldn't kill you to look into the future. Your decisions you make now affect your future. So personally, I think a little

> bit of both [living in the now and future planning] make you live efficiently.

Regina's parents also did not push her in her charter school studies. She indicated future-orientation in her responses, especially in relation to the value of education, "Like most things in life, it's a[s] productive and valuable as you make it. Don't squander your time!"

Charter school participants were not the only people who expressed influences from their parents. Public high school students discussed how their parents and high schools influenced stress toward future goals. Regina recounted her experience with institutions such as her school and parents:

> My school just tried to get people to graduate. If people went to college, that was great. Even going to a community college was a step. Half my class either went to college or worked at a blue–collar job. When it came to family, my parents have a turkey family farm. They told me I had the option of working at that farm or I could go to college. My parents wanted me to live more comfortably than them, but also wanted me to be happy with what I did. I obviously chose college.

Regina is not the only participant who cited their parents giving them the option of autonomous decision- making in relation to future goals. Other participants who attended charter and public schools which were well-funded or lesser-funded cited similar parental perspectives. It was the participants who attended schools in a well-funded county that described worry about grades or attending specific universities.

Participants with single-parented households, or households where there was one parent or guardian working to support the household, expressed less stress in interviews in regards to recalling goals in secondary schools or current future goals. Participants whose parents/guardians both held prestigious jobs reported feeling more stressed to do well in regards to future goals, like the charter school student previously mentioned. Participants from both charter and public high schools remarked that in their secondary school years they felt pushed by themselves, and not necessarily pushed to go to college or do

well for college by parents or schools. However, parents and schools influence internalization of time orientation.

Discussion

Initially, the study hypothesized whether the type of school influenced bad stress associated with future orientation The evidence does not support this hypothesis, however, the funding level of the school can affect the amount of stress coping resources students have access to. Schools that are properly funded can provide proper coping resources for students struggling with bad stress related to future orientation.

If a student performs poorly, the school will still try to mold students to be future-oriented. However, schools are not the only institutions related to bad stress and future orientation. Caregivers can also influence the internalization of both factors. Future orientation is classified as a norm in this article and the coping resources a school provides can influence deviance. Structural strain theory (Merton, 1968) states that if cultural goals cannot be met through socially approved resources and means, deviance in the form of withdrawal from their activity may arise from individuals who cannot reach the goals, or they may reach the prescribed goals in other ways. In other words, there is tremendous incentive for one to follow cultural goals to avoid deviant stigmatization. Many interviewed participants attended college partially due to peer expectations and because it was a norm. One undergraduate student, pseudo-named Miranda, attended a well-funded public school stated that she had the option to attend college, but she also faced financial stress in order to obtain a higher education. Though this appeared to affect her stress level, she found socially acceptable ways (working hard, using federal loans, etc.) to obtain the cultural goal. U.S. society is future-oriented and fast-paced and in order to receive "The American Dream", one must receive a higher-paying job. To get such a job, one must graduate high school and strive for college. Students who are not future-oriented may not have the ability to attend college. Present-orientation may provide a more balanced and low stress life, but according to findings here would be labeled deviant.

In order to avoid deviance, schools try to prepare students for the future through AP classes, expectations for graduation, and college preparation. In spite of future-orientation, in order

to provide avenues for poor performing students to avoid bad stress, deviant labeling, and stigmatization, many schools are instead pushing them toward poor preparation. While still dependent on the level of funding, there was not variation between public and charter school students regarding tutoring or counseling resources. Instead, these resources were given out to the higher performing students or their parents who sought it across both types of schools, contributing to bad stress in other students. Interviewed students noted other students who did not seek those resources were placed in an alternative school, meant for problematic or lower academic performing students, ensuring their eventual graduation and the school's future-oriented goals. According to these findings, public schools and some charter schools practice "handholding" (providing alternative schools or free passes to lower performing students to ensure a certain threshold of graduating students), which can help reduce bad stress of students. The "handholding" allows for students to excel in the present, but it does not provide them with the skills for college. The lack of available resources in less well-funded schools for all students not requesting them meant that many students likely fail at successful future planning, despite the schools' future-orientation.

For higher performing students, participants noted that stress levels were high because of the amount of homework assigned in their AP courses. One of the motivational factors of students was to save money or time for college. Fear appeal theory (Williams, 2010) can help explain such motivation. Fear appeal theory is characterized by a person's motivation to avoid something that might decrease their well-being. Regardless of the type of school, higher performing students were worried about living up to peer, parent, or self- expectations and reported experiencing high levels of bad stress. Specifically, students felt they should pursue a future-oriented goal such as college out of fear they would let down parents or themselves. Students with highly educated and successful parents often feared not getting into colleges similar to their parents'. Students whose parents did not have prestigious of careers noted healthier, positive stress and were less likely to cite past fear of getting into college. These parents used real-life examples (sometimes their own lives) as a possible alternative to college. Participants who attended higher-funded schools

appeared to have more bad stress from their parents and internalization of earlier parental expectations or attitudes in regards to future goals. This is further explained by Social Learning Theory (Bandura, 1971), which suggests that children model behaviors they see in others. Participants reported (directly or indirectly) being influenced by parents. For example, Regina was heavily disappointed that she could not attend the same university her parents attended, and exhibited transference of "perfectionism" through future-orientation. If participants mimic or internalize parental behavior, this could greatly influence stress, and ways of coping with stress.

Conclusion

The original research question was whether the type of school had an effect on a student's future-orientation and perceived bad stress level. Both schools and parents are influential; however the type of school matters less than its funding level. Both schools and parents influence future-orientation, perceived bad stress levels, and methods of coping with it. Students are pushed by parents to meet cultural goals, including future-oriented goals, but to avoid deviant labeling many are not prepared to meet such expectations yet are allowed to out of concern for future-orientation. Other higher performing students experience the fear of letting parents or themselves down by not obtaining future goals, thus increasing bad stress. Those from well-funded schools have mechanisms for coping with such bad stress, regardless of public or alternative schools, but lesser-funded schools do not provide those resources.

More research is needed to explore those school programs that serve as mechanisms for reducing bad stress stemming from future-orientation. Future research could also be conducted on parenting styles and their effects on time orientation and bad stress. For measurements of health, which was a focus of previous studies but not in this paper, future studies should consider longitudinal analysis of future-oriented and present-oriented students and their physical health.

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Adolescent Hmong Marriage & Risk of Depression

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Abstract

Hmong women who marry before the age of eighteen are more likely to develop depression later in life, compared to Hmong women who marry after the age of eighteen (Bartz & Nye, 1970; Gangoli, McCarry, & Razak, 2009; Vang & Bogenschutz, 2011). Hmong are understudied and need more representation, which is why this research is crucial. The participants were between the ages of 20-30 years old, and included Hmong women from the Wausau, Wisconsin area. These participants are broken into three categories: married before they turned eighteen, after eighteen, or had never been married. They were recruited via snowball sampling, and individually interviewed using the Beck Depression Inventory and interview questions. After collecting the data and comparing the results, the researcher could not conclude that getting married young had a direct relationship with depression. However, someone who married before adulthood (before 18 years old) is more susceptible to depression relative to someone who married after 18 years old, or had never been married.

Keywords: Hmong women, adolescent marriage, teen marriage, depression, beck depression inventory

Background of Hmong

Hmong are an indigenous group whose roots can be traced back to China. During the Vietnam War, Hmong assisted the United States (U.S.) in helping bring down the communist government in the Lao People's Democratic Republic, also known as The Secret War (Hamilton-Merritt, 1993; Quincy, 1995). Hmong leader General Vang Pao was assured if the U.S. lost the war then Hmong could immigrate to the U.S. for safety. However, after the fall of Saigon, the American soldiers fled Laos, leaving

Hmong to fend for themselves and face persecution alone by the Lao government. Many fled to Thailand for safety by crossing the Mekong River. Nevertheless, in 1976 the U.S. Congress recognized Hmong as former Central Intelligence Agency (CIA) employees and authorized immigration to the U.S. (Hein, 2006; Lynch 2004). According to the American Community Survey, in 2010 the Census Bureau estimated 247,595 Hmong people living in the United States, and approximately 49,240 Hmong in Wisconsin (Hoeffel, Rastogi, Kim, & Shahid, 2011).

Hmong culture supports marrying before age 18. The tradition is valued and has been promoted among those residing in the US. Traditionally, Hmong marriages may happen in numerous ways such as, elopement or mutual consent, arranged marriage, and bride capture (without the bride's consent). If the bride changes her mind and does not want to follow through with the wedding she may bring shame to her family and be ridiculed by the community (Vang & Bogenschutz, 2011). The potential for shame and ridicule pressures the girl to stay in the marriage (Gangoli et. al, 2009; Vang & Bogenschutz, 2011). In addition, sexual purity and chastity is highly encouraged; premarital pregnancy can bring great shame to the family name. Therefore, if a teenage daughter gets pregnant before marriage the parents will use forced marriage as a way to atone her shameful actions (Alvi et. al, 2005; Gangoli et. al, 2009; Vang & Bogenschutz, 2011).

Consequences and predictors of depression in teen marriages:

Studies show there is a common trend of consequences for getting married at a young age regardless of ethnicity or background. Some consequences are lower education, lower socioeconomic status with lower paying jobs, more symptomatology of depression, and higher risk for domestic abuse (Bartz & Nye, 1970; Culp & Beach, 1998; Gangoli et. al, 2008, Vang & Bogenschutz, 2011; Whitton et. al, 2007). According to Vang and Bogenschutz (2011), "45.4% of Hmong women are married, 37.9% have never been married, and lesser percentage are widowed, divorced, or separated (7)." Women who marry young are likely to drop out of high school, achieve less college attendance, and experience more poverty than young women who did not marry.

Social class placement, such as socioeconomic status, is a

negative outcome for marrying young regardless of ethnicity. Bartz and Nye (1970) mentioned that early marriages do result in lower social class placement. Early marriages may disrupt education and cause individuals to drop out of school, thus resulting in lower paying jobs (Vang & Bogenschutz, 2011; Bartz & Nye, 1970). Studies have shown that early marriages in Hmong culture do not affect the individuals academically (Hutchinson & McNall, 1994), but no further research has been done that focused on teenage marriage and the risks that could impose on Hmong women's mental health, like depression. Hmong in the United States are more likely of lower-socioeconomic status due to social, political, and historical factors. Family socioeconomic status may be the motivator for young Hmong girls to enter adolescent marriages hoping for security (Vang & Bogenschutz, 2011). Bartz and Nye (1970) supported the latter, concurring that the more a girl anticipates satisfaction from the marriage the earlier she will get married. In other words, she leaves her stifling family situation or environment in hopes of finding more satisfaction in her marriage.

There seems to be a connection with gender roles and expectations that lead women who marry young to feel a sense of helplessness and show more signs of depression (Gangoli et. al, 2009; Vang & Bogenschutz, 2001; Whitton et. al, 2007). The patriarchal nature within Hmong culture and the feelings of inadequacy as a woman contributed to feeling that sense of helplessness (Alvi et. al, 2005; Vang and Bogenschutz, 2011). Bargai and Shalev (2007) concluded that learned helplessness (LH) is a psychological trait, which, theoretically, results from repeated exposure to uncontrollable and aversive events. Additionally, LH is associated with male dominant background and cultural influences that promote female submissiveness. Bargai and Shaley (2007) concurs: "this kind of psychological trait may imply that it may not only be a result of early cultural influences, but also act as a promoting cultural agent of the multi-generational cycle of female vulnerability to victimization." Hence, studies that indicated Hmong culture is a patriarchal hierarchy, where men dominate, would explain the gender distress, helplessness, and risk of depression due to being victimized (Alvi et. al, 2005; Bargai et. al, 2007; Vang & Bogenschutz, 2011).

Another predictor of depression due to adolescent marriage

is bicultural stress. According to Vang (2011), bicultural stress is defined as having a conflict between two cultures. Bicultural stress is positively correlated with depression and less optimism among adolescents. Bicultural stress is more prominent within the Asian culture.

Method

Participants

The participants were Hmong women over the age of 18 (between ages 20 to 30 years old). Due to the challenges with the sample the initial 12 participants number were lowered to 9. There were 3 individuals who married before 18, 3 who married after 18, and 3 who never married. The participants were from Wausau, WI and were recruited via snowball sampling. According to Streeton and colleagues (2001), "Snowballing samples emerge through a process of reference from one person to the next, quickly building up and enabling the researcher to approach participants with credibility from being sponsored by a named person." [The] consent form is located in Appendix B.

Measures Beck Depression-Inventory

The Beck Depression Inventory (BDI) is a 21-item, self-report rating inventory that measures characteristic attitudes and symptoms of depression (Beck, et al., 1961). These items (e.g. I have nothing to look forward to) were selected because they were relevant to a person's mental health (Cronbach's alpha = .86). Participants were asked to rate the severity of how they feel about themselves and their situations. Severity is measured on a four-point scale (*0=I don't feel, 1= I do feel, 2= I feel a lot, 3= I'm hopeless*). The Beck Depression Inventory is a self-report rating inventory where individuals can score themselves after and see the levels of depression symptoms they fall under.

Interview

The interview questions consisted of 15 open-ended questions asking the participants about their marriage situation, gender role responsibility, support, background information, and reasons for marriage. Interview questions were determined according to participant background. Questions for the group that never married were directed towards education. Since the group that married before 18 had no higher education,

questions focused more on their marriage and responsibilities. Lastly, for the group that married after 18, the questions were a mix of education and marital responsibilities. These questions were only guidelines; researcher may have asked other questions that are more tailored to each group or individual. See Appendix A.

Procedure

The researcher met with the individual participants in a place where they felt most comfortable and safe to do the personal interview. The participants signed and read the consent forms stating that what was said will remain confidential, and if at any time they chose to leave this interview they could. The participants answered the BDI first, followed by the interview. The interview questions were used as a guideline to generate conversations instead of strictly asking the questions verbatim. The sessions were audio-recorded and later transcribed verbatim. After the interview, the researcher debriefed each individual participant, telling them about the research and how their participation is greatly appreciated and helpful to the community.

The qualitative data was analyzed by organizing the interview questions into three tables: never married, married after 18, married before 18. Because each interview was tailored differently depending on the participant, the tables were organized by questions that came up the most during these interviews. Each table had three columns: initials of participants, the interview question, and the participant's response to that question. After entering the data from the interview patterns, themes, and relationships that emerged were analyzed.

Results

Never Been Married

After reviewing the data, patterns and relationships emerged. This group had either received their degree in higher education, would graduate college soon, or was still pursuing a post-secondary degree. They are between the ages of 23 to 25 years old. The participants in this group, when asked about their future goals, reported that they want to continue on to graduate school, get a stable job, get married, then have kids. Financial stability and independence were very import to this

group. When they were asked what contributed to their stress, they all reported being home made them feel more stressed because their responsibilities increased (helping parents and younger siblings, restricted social life). Participants within this group also stated that they wanted to get married and have kids before they turned 30 years old. However, they would only get married if all of the latter listed was fulfilled first. Moreover, this group showed higher academic aspirations than the two other groups. When asked if they have ever been diagnosed with depression, all the participants reported they have not been professionally diagnosed, but have felt depression at one point in their life. The contribution to their depression was mainly past relationships with boyfriends. All the participants are currently in a relationship, and when asked if they have talked about marriage and future plans, they all reported they have, but only briefly. Lastly, when asked what their biggest fear of marriage was, they all replied they feared their partner would change (become more controlling, show less affection after marriage), and feared the cultural expectations of being a daughter-in-law. Overall, when comparing the answers and questions, this group was highly motivated to become successful first before marriage.

Married Before 18

The participants of this group married before they turned 18 (15-16 years old). They all had their first child at or around the age of 18, and they have at least three kids. Two participants worked full-time jobs while the other one is a stay-at-home mom. Their full-time jobs paid them under 15 dollars per hour, and they all owned houses and cars. All three participants have been married at least 8 years or more, and obtained their high school diplomas. They all had the desire to pursue higher education, but could not due to familial obligations; such as taking care of their children, providing for the family, having no babysitters, and having financial burdens. For instance, one participant said she could not pursue higher education even if she wanted to because they needed the money more. When the researcher asked their reason for marriage, participants responded they wanted to "run away" or "get away" from their family or parents. Furthermore, participants were questioned about their thoughts on adolescent marriages. At first they seemed to be neutral with the idea stating, "if two people love each other and wanted to

get married no one can stop them." However, when asked, "if your 15-year-old daughter wanted to get married because she's in love would you allow it?" they quickly replied "no." They stated their daughter would be too young, and they would not know anything about love, or how to make their own decisions. Lastly, the participants were asked if they marry young all over again, would they? Participants responded that they would not have gotten married at that age. They would have pursued higher education first, got a job, and then got married. These participants had lower academic aspirations than the other two groups. Nevertheless, it's not because they are not motivated, but their circumstance prohibited them from pursing their goals. Marrying young contributed to their lower education attainment, and lower paying jobs which also affects their mental health. This group reported feelings of "hopelessness" when filling out the BDI.

Married After 18

This last group seemed to be between the two groups listed above. There were no relationships that emerged within this group in particular. However, when comparing this group with the other two groups as a whole, relationships were formed. This group was married between the ages of 18-20 years old. Only two participants had children (2 kids & 4 kids), the third participant had no children yet. One of the participants graduated with her nursing degree and is working as a full-time registered nurse. As for the other two, they are working part-time and pursuing their degree full-time. Within this group, husbands showed more support in academia than the group who married before 18. When the researcher asked why they decided to get married, one of the participants said she felt like she was ready and saw a clear future with her husband. Another one said she was pregnant and decided it was better to get married. The third one said because of her family situations, such as not wanting to abide by her parents rules, she felt alone both financially and emotionally, and she did not get along with her parents. She also wanted independence because she did not want to follow her parents' rules. However, she did not have the financial means to be on her own, so she married to alleviate her financial problems. When asked if they would do anything differently? they all replied that they would have waited until they were older,

accomplished more, and experience life first then get married.

Beck Depression Inventory (BDI)

All the participants fell under the normal range on the Beck Depression scale. However there was one participant who married before she turned 18 and scored within the mild mood disturbance on the BDI. Those who married after the age of 18 and those who never married reported no depression symptoms. Individuals who married before the age of 18 experienced at least one or more symptoms of depression from the DSM-IV including feeling of worthlessness, depressed mood, fatigue, and loss of interest in activities (the DSM-V was not in print at this time).

Discussion

Comparing the three groups the researcher saw that when asked "if they felt there was gender inequality within their marriage" most of them did not say "yes there is gender inequality within my marriage" but they expressed that there was no choice because it was their culture and the way it has always been. There was one participant who was married before the age of 18 that expressed her frustrations of not being able to make decisions without her husband. He was traditional, dominant, and in order to avoid fights she obeyed. Two other participants expressed their frustration regarding gender inequality within their marriage as well. Moreover, the participants also expressed the unfairness they felt when Hmong community or elders dealt with marital problems between two spouses; Hmong men were often favored. Especially in cases when Hmong men commit adultery, the participants felt that the elders expected the women to forgive their husbands, continue to be patient with them, and obey them. Conversely, if a Hmong woman were to commit adultery, the participants felt that the elders and Hmong community would ostracize her and call her foul names. Therefore, all nine of the participants felt a great deal of unfairness when it came to how men and women were treated within Hmong community. For instance, one participant said, " If I have problems with my relationship . . . Hmong tends to push the women back saying that "ohh you should obey him more" and what more do they want us to obey?" However, there was one participant who felt that the elders' way of helping

the spouses with their marital problems was beneficial. As she stated,

> "In the situations where I've been in meetings where the elders, they kind of give you options . . . they pretty much want to hear your side and your story then the guy's side and his story."

There were two participants who reported equality within their marriage, but one of them reported she only received equality when they were alone. She expressed that when they are around the elders and relatives she has to "pretend" to play the "submissive" wife. This participant said she felt frustrated sometimes having to play this role of a submissive wife.

It is evident participants are experiencing the psychological trait of "learned helplessness." As Bargai and Shaley (2007) stated in their research, "learned helplessness is a trait resulted from repeated exposure to uncontrollable and aversive events." The patriarchal society these Hmong women grew up in, and the cultural obligations they have to fulfill, is a contribution to their acceptance of their roles as Hmong wives. For instance, one participant concurred with the acceptance of the patriarchal society she lived in, "I feel like I don't have any say in any kind of decisions. I just feel like it's not fair, not fair for me and why should he get to do the things he want in life and I don't . . . and I guess I just learned to accept it."

When the participants were asked about their thoughts on adolescent marriages at least five of them said they do not have the right to say what is right and wrong (they felt neutral about adolescent marriages). The other four participants immediately affirmed their disapproval of adolescent marriages, and one of the four participants even said, "I think it should be banned." All nine participants did agree that getting married at a young age came with too many responsibilities, and these teens were not ready for that kind of commitment.

The researcher also saw a connection with the participants who married before they turned 18. The reason these women married was to escape their unwanted situations in their home. According to Bartz and Nye (1970) a girl will marry early if she's around tension or an unhappy environment, and it was evident that participants felt that way. For instance, a participant stated, "I'd say more than 50% why I got married was due to my family. I wanted to get away from my family so much as my mom is

pretty abusive." Therefore, participants thought leaving an unwanted situation would bring happiness. Also, Bartz and Nye (1970) indicated that the earlier a girl starts dating, the earlier she'll marry. This was obvious with the group collectively, (they all dated at an early age) which led a few of them to marry at age fifteen and sixteen.

The results of the BDI did not validate the hypothesis that Hmong women married before age 18 would be more likely to experience depression, but the data did show some support. It is not guaranteed that a girl married before the age of 18 would experience depression later in life, but she will be more susceptible to depression. The group who married before 18 graduated with a high school diploma, and were working at jobs (or not working at all) that paid less than fifteen dollars per hour. This aligned with other studies that have been done by Vang and Bogenschutz (2011) and Bartz and Nye (1970) where early marriages resulted in disruption of education, and lower social class placement. It was apparent the three participants that were interviewed did not have higher education and had lower paying jobs. The researcher could not conclude that getting married young has a direct relationship with depression. However, the researcher predict that someone who marry before adulthood (before 18 years old) is at higher risk for depression, relative to someone who marry after 18 years old, and never been married.

Limitations & Future Research

Some limitations of this study were small sample size, environment, and the short duration of interview. Hmong participants from a small town in Wisconsin could differ immensely from Hmong participants from bigger cites and states like Minnesota or California. Another limitation was the interview process. It takes time to get comfortable with someone first before sharing such personal details. Since these participants only spent an hour with the interviewer, they were more apprehensive to open up. For future research regarding this subject, researchers should use a larger sample in order to represent the population better. Enhancing the interview questions and using other depression tools to measure would improve results for this research.

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Appendix A

Sample Interview questions (married & never been married)

1. What is your view of Hmong marriage?
2. What are some of your thoughts about how Hmong community deals with marriage?
3. How did you get married? According to Hmong custom, was it voluntary, negotiation or forced?
4. How old were you when you got married?
5. Do you have kids? How old were you when you had your first child?
6. What's your occupation status? Who supports you financially through school?
7. How is your relationship with you husband and his family?
8. Do you feel you have enough moral support from your husband, friends and family?
9. How do you feel about teen marriages? Do you support teen marriages? Why or why not?
10. Do you feel there is gender equality within your marriage?
11. If you could do this over again would you make the same decisions? Why or why not?
12. What are your goals/plans for your future?
13. Where do you see yourself in 10 years?

14. Do you have stress? What kind of stress? How do you deal with them?
15. Have you ever been diagnosed with depression? Have you ever felt depressed? How severe was it? Why did you feel depressed?
16. Are you currently in a relationship? For how long? Have you two talked about marriage? Kids?
17. What kinds of responsibilities do you have? How do you deal with them?

Appendix B
Consent to Participate In UW-Stout Approved Research

Title: Adolescent marriage & Risk of marriage

Research Sponsor:
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Description:

This research is intended to find out if a Hmong girl gets married before the age of 18 if she's more likely to develop depression later in her adult life, as compared to a Hmong girl who gets married after the age of 18. In order to test this theory we will be interviewing individual Hmong girls who are over the age of 18, but got married before they turned 18, and Hmong girls who got married after the age of 18. We will also look at girls who never got married as well to compare if teen marriage serves as a predictor for depression.

This study includes an interview section, and a survey that

participants will need to answer. During the interview session participants will be audio recorded and transcribed verbatim. Along with the interview the participant will be taking the Beck Depression Inventory survey as well.

Risks and Benefits:

The benefits of this research will be able to educate Hmong community about adolescent marriages and the consequences of it. In addition, it will also promote awareness to Hmong teens as well as Hmong elders that teen marriage can potentially affect one's educational future and life negatively.

The risks of this research may effect Hmong elder's and their traditional views on marriage. Also, this topic can be culturally sensitive to Hmong community as a whole.

Time Commitment and Payment:

The participation in this project is voluntary. Participants understand that they will not be paid for their participation. They may withdraw and discontinue participation at any time without penalty. If they decline to participate or withdraw from the study, no one will hold them responsible for completion of this study. Participants understand that this study will last at least an hour.

Confidentiality:

Your name will not be included on any documents or during the auido recording. We do not believe that you can be identified from any of this information. This informed consent will not be kept with any of the other documents completed with this project.

Right to Withdraw:

Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. Should you choose to participate and later wish to withdraw from the study, you may discontinue your participation at this time without incurring adverse consequences.

IRB Approval:

This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you

have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

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Statement of Consent:
By signing this consent form you agree to participate in the project entitled, ADOLCESENT MARRIAGE & RISK OF DEPRESSION.

_____

Signature Date

_____

Signature of parent or guardian Date
(If minors are involved)

Barium Titanate and Barium Titanate/Aluminum Oxide Ceramics for Capacitors and Transducers

Lewis E. Brigman and Jake Pedretti | Seniors
B.S. in Manufacturing Engineering

Abstract

An inexpensive solid-state powder compaction and sintering method to make barium titanate disc structures for use in capacitors and piezoelectric transducers was researched. Barium titanate powders were uniaxially pressed to 20,000 lbf into discs and sintered over 1,100 to 1,400°C for different times. The discs were characterized for density, capacitance, and output voltage characteristics under uniaxial compression. The output voltage exhibited an exponential relationship with disc thickness. The experimental relative permittivity revealed a trend with percent porosity similar to the theoretical predictions. To strengthen $BaTiO_3$ against cracking during mechanical and electrical loading, $BaTiO_3/xA_{l2}O_3$ (x = 0, 5, 10 and 15 percent by weight) composites were prepared by ball-milling, compaction, and sintering (1,250°C and 1,350°C, 1h and 4h). The density and flexural strength of sintered composites decreased and porosity content increased as the amount of Al_2O_3 increased. Because of high incidence of porosity, the composite samples did not develop their full strengthening potential. Recommendations have been made to further expand this research and achieve higher strength in $BaTiO_3/xAl_2O_3$ composites.

Keywords: powder metallurgy, piezoelectric ceramics, composites, capacitance, flexural strength, densification

Introduction

Barium titanate ($BaTiO_3$) is a ferroelectric ceramic with piezoelectric properties. It is used in multilayer capacitors in TVs, video cameras and computers. It is also used as a piezoelectric transducer in microphones and in power generation devices. The

standard method to make barium titanate for use in multilayer capacitors involves tape casting of barium titanate slurry into a thin sheet which is dried and a paste or ink containing silver-palladium powder is screen printed. The large sheets are then diced, stacked, and co-sintered. The electrical properties of barium titanate depend upon processing parameters. Unfortunately, like most ceramics, barium titanate is brittle and it develops cracks during mechanical and electrical loading that can cause device failure. The structural stability of barium titanate is important because of an increasing demand for applications requiring long lifetime and large displacements under continuous operation.

The purpose of this research is two-fold: (i) investigate the effect of fabrication conditions on electrical properties of $BaTiO_3$ synthesized using a simple and inexpensive fabrication method and (ii) develop a composite fabrication procedure to strengthen $BaTiO_3$ by co-dispersing aluminum oxide with $BaTiO_3$.

The first objective was accomplished by implementing an inexpensive solid-state powder compaction and sintering method to make barium titanate disc structures. Barium titanate powders were uniaxially pressed into discs that were subsequently sintered at different temperatures and for different times. The sintered discs were tested for capacitance and output voltage characteristics. The second objective was accomplished by synthesizing $BaTiO_3/Al_2O_3$ composites using powder blending, compaction, and sintering, followed by testing the sintered material for flexural strength.

Composites such as barium titanate/silicon carbide [1,2], barium titanate/magnesium oxide [3], and lead-zirconate titanate/aluminum oxide [4] have been developed and tested. In nearly all cases, the composites were fabricated using expensive methods such as hot pressing [1], cold isostatic pressing [5] and spark plasma sintering [5,6]. Simpler, mixed oxide uniaxial pressing methods have been researched [7] only sparingly because of variability in the quality of the synthesized composites. Nevertheless, a low-cost, mixed-oxide pressing method was used in the present study for learning and exploration even at some expense to material quality. Material testing focused on strength properties of $BaTiO_3/Al_2O_3$ composite ceramic and electrical properties of undoped $BaTiO_3$.

Experimental Procedure

Sieve Analysis

High-purity (99.9%) barium titanate powder (< 2 μm) from Sigma-Aldrich was used to fabricate test specimens for electrical measurements. Ceramic composite samples of $BaTiO_3/Al_2O_3$ were synthesized using barium titanate powders from Honeywell, Inc., and aluminum oxide powders from Reynolds Metals Co. as starting raw materials. Sieve analysis was done to determine the grain size of the powders using an ATM Sonic Sifter and U.S. Standard Series sieves (180 μm, 150 μm, 125 μm, 106 μm, and 75 μm). The sieves were individually weighed and then stacked in descending order with the 180 μm sieve at the top. Below the 75 μm sieve a rubber diaphragm was inserted to collect the residual powders. Five grams of powder was placed in the top sieve and the stack was mechanically vibrated at a frequency of 45 Hz in the Sonic Sifter for two minutes and an amplitude setting of 8. Upon conclusion of the test each sieve was weighed from which the amount of powder residing on each sieve was determined. Over 70% of the Honeywell barium titanate powders were 75 μm or less in size, and about 50% of the aluminum oxide powders were greater than 180 μm in size. While these powder sizes are very different and thus not optimal for making composites via sintering, mixed size powder fractions are expected to yield less porosity in powder blends than matching sizes (e.g., finer powders lodge in the interstices between larger powders).

Ball Milling

Ball milling was done for the purpose of homogeneously blending the barium titanate and aluminum oxide powders prior to compaction and sintering. Ball milling was done for 24 hours using zirconia milling media to obtain batches of powder mixtures of $BaTiO_3/xAl_2O_3$ with different percentages of the powder constituents (x = 0, 5, 10 and 15 percent by weight). Unblended barium titanate powders used to make samples for electrical measurements were not ball milled.

Powder Compaction

A weighed quantity (10-12 g) of powder was placed into a 3-piece die comprised of a tool steel cylindrical die, a punch and a base plate, all of which were lubricated liberally with

zinc stearate. The die was then mounted on a Carver hydraulic press and uniaxially pressurized to 20,000 lbf for 10 s. The newly pressed sample was then carefully removed and stored at room temperature until sintering. The load of 20,000 lbf was selected on the basis of a series of tests that were done to press powders using loads from 5,000 lbf through 30,000 lbf and measuring the green density of each pressed sample. The tests showed that at 20,000 lbf force, the green density began to reach a saturation value, meaning that a greater compaction load would not increase the densification. A test to qualitatively characterize the green strength of pressed samples, referred to as 'rattle test', was performed on unsintered samples. Samples were weighed before and after the rattle test to determine percent weight loss, a measure of the green strength of pressed samples. The green parts were rattled for 2 min. in a desktop tumbler designed to be rotated in a gyratory motion at a constant speed of 50 rpm. The test outcomes showed that pure (unblended) barium titanate samples lost 0.81% of the initial weight whereas a $BaTiO_3/10Al_2O_3$ sample (10% Al_2O_3) sample lost 3.37% of the weight. A coarser size and a greater hardness (low compressibility) of the Al_2O_3 powders could be responsible for a lower green strength of the $BaTiO_3/10Al_2O_3$ compacts.

Sintering

Sintering was carried out under ambient conditions in a programmable electrical resistance tube furnace rated to 1,700°C (Rapid Temp, CM Furnaces, Inc.). Samples were heated to target sintering temperature at a rate of 80°C.h-1, sintered at 1100°C, 1250°C, 1300°C, 1350°C, and 1400°C for 2, 4, or 6 hours, and allowed to furnace cool for nearly 24 hours.

The bulk density of sintered samples was determined from weight and volume measurements that were made using an analytical balance and a dial caliper. A few samples warped during sintering and were not amenable to measurements with a dial caliper. The volume of such samples was obtained using a water displacement method. Percentage porosity in each sintered sample was calculated from the relationship: % Porosity $= (p_{theo} - p_{exp})/p_{theo}$, where p_{theo} and p_{exp} are the theoretical (i.e., fully-dense) and experimental values of the density, respectively. For BaTiO3/xAl2O3 composites, the theoretical density was calculated using a powder volume fraction-averaged Rule-of-

Mixtures.

Measurement of Capacitance

Sintered discs of barium titanate were assembled with silver-copper conductive thin metal foil into sandwich-like structures to create a simple capacitor configuration. Capacitance (C) was measured using an LCR (inductance, capacitance and resistance) meter by firmly pressing probes on either side of the silver braze foil outer layers. Capacitance in vacuum (C_0) was calculated using previous measurements, permittivity of vacuum (ε_0), and area (A) and thickness (d) of the ceramic using the fundamental relationship, $C_0 = (A\varepsilon_0/d)$. Relative permittivity (ε_r) or the dielectric constant (K) was then calculated for each sintered sample using the capacitance in vacuum from $\varepsilon_r = K = (C/C_0)$.

Measurement of Output Voltage

For measurement of output voltage, the sintered barium titanate samples were again assembled into sandwich-like structures with silver-copper metal foil as inner layers and thin rubber discs as outer layers. The silver-copper foil was connected to a multimeter to record output voltage. The sandwiched samples were placed on a hydraulic press and uniaxially compressed under loads of 2,500, 5,000, 7,500, 10,000, and 12,500 lbf. Output voltage generated upon compressing the barium titanate discs was measured and recorded.

Optical Microscopy (OM) and Scanning Electron Microscopy (SEM)

Select sintered samples were mounted in epoxy and ground and polished on an automatic polishing unit using magnetic discs and diamond suspensions of three different abrasive sizes (6 um, 3, um and 1 um). Polished samples were examined on an optical microscope to observe the extent of densification during sintering. Additionally, un-polished as-sintered samples were also observed under a Tescan Vega II Scanning Electron Microscope (SEM) with the Chemistry Department at UW-Stout.

Flexural Strength

Sintered $BaTiO_3$ samples with and without Al_2O_3 doping, were tested for flexural strength (also referred to as Modulus of Rupture) using a three-point bend test. The bend test used in

this experiment followed the ASTM Standard C1161, "Standard Test Method for Flexural Strength of Advanced Ceramics at Ambient Temperatures", except for the fact that non-standard test specimens (round discs) were used. The test was conducted on a Tinius Olsen tension tester using a three-point bend test fixture to record force versus deflection data from which the load required to break the sample was obtained. The data collected from the tests were used to estimate the modulus of rupture of sintered samples. For non-standard round disc-shaped samples with a variable rectangular cross-section along the loading directions that were used for testing, an exact equation to calculate the Modulus of Rupture (MOR) was not readily available in the standard literature. Approximate values of the MOR were obtained using the following equation for rectangular samples: $MOR=(3FL)/(2DH^2)$, where F = breaking force (N), L = support span (m), H = sample thickness (m), and D = diameter (m).

Results and Discussion

Density and Microstructure

The test outcomes and observations are summarized in accompanying graphs and photomicrographs. Samples sintered at different temperatures and soak times varied in density. Figure 1(a) shows the effect of temperature on measured density (expressed as percent of the theoretical density) of undoped $BaTiO_3$.

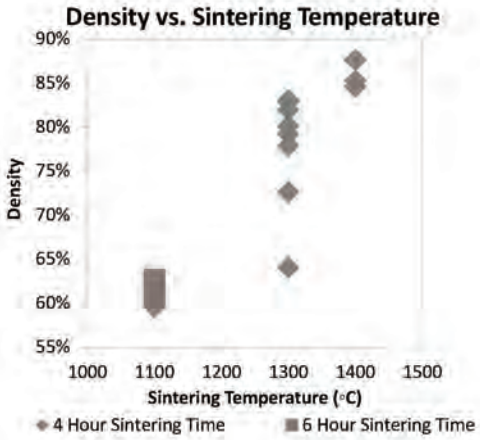

Fig. 1(a) Density versus sintering temperature data for undoped $BaTiO_3$ coupons. The two lowest density samples at 1300C each had visible surface cracks that caused their volumes to be overestimated and the density to be underestimated.

The sintered density is observed to increase with increasing sintering temperature. The two lowest density samples at 1300C each had visible surface cracks that caused the sample volume to be overestimated thus leading to a significant decrease in the density values. These two data are outliers but they were included in the figure to reflect all of the measurements that were actually made. The densest samples (88% dense) were sintered at 1,400°C for 4 hours. The samples with the lowest density (most porosity) were sintered at 1,100°C. Because of the time constraints in processing additional samples, the effect of sintering time on density was investigated only at one temperature (1,100°C). As shown in Fig. 1(a), the density data for 4h and 6h sintering times at 1,100°C yielded nearly identical density values. Our limited data suggest that sintering time is less critical than sintering temperature in part densification. This is consistent with the greater sensitivity of the diffusion processes responsible for sintering to temperature than time.

The density data for the $BaTiO_3/Al_2O_3$ composite samples for different percentage additions of the Al2O3 are shown in Fig. 1b.

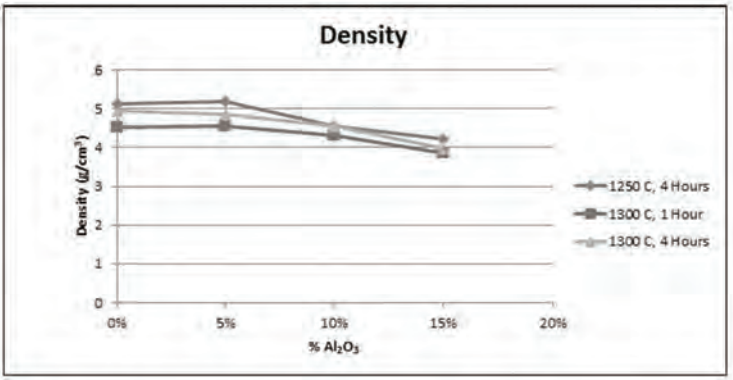

Fig. 1(b) Density versus as a function of Al_2O_3 content in $BaTiO_3/Al_2O_3$ composites prepared under different sintering conditions.

Consistent with the fact that aluminum oxide has a lower density (4,000 kg/m^3) than barium titanate (6,020 kg/m^3), the density of the composite samples decreased with the addition of aluminum oxide to $BaTiO_3$ whereas the porosity content of the samples increased with the addition of aluminum oxide. This could also

be due to the fact that the Al_2O_3 particles are much coarser with a smaller surface-to-volume ratio and inhibit sintering kinetics. Coarse powders are known to sinter slower than fine powders. Sintering temperatures in excess of 1,300°C caused warping and cracking in the composite samples with the result that 1,300°C was the highest temperature used. The warping and cracking could have resulted from the difference in the coefficients of thermal expansion (CTE) between $BaTiO_3$ (CTE: 6×10^{-6} K^{-1}) and Al_2O_3 (CTE: 8.1×10^{-6} K^{-1}).

Sintering occurs by atomic diffusion, usually in the solid state, and the diffusion rate is enhanced at elevated temperatures facilitated by sintering aids (e.g., minute quantities of additives such as MgO). No sintering aids were used either in the $BaTiO_3$ or in the Al_2O_3 powders used in the composites. The higher melting temperature of aluminum oxide (2,072°C) compared to barium titanate (1,625°C) could have led to incomplete densification of $BaTiO_3/Al_2O_3$ composites when sintered at a temperature of 1,300°C. This is because undoped $BaTiO_3$ attained 88% densification at 1,400°C and with the additions of higher melting alumina, a temperature of 1,300°C would not suffice. To achieve full densification, hot pressing and use of finer barium titanate and alumina powders may be recommended.

Figures 2 through 4 show optical and scanning electron microscopy images of undoped and Al_2O_3-doped $BaTiO_3$ sintered under different conditions.

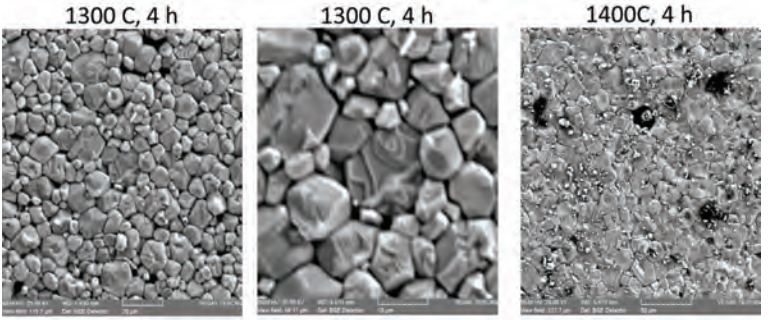

Fig. 2 SEM images of un-doped and unpolished barium titanate following sintering at (a) & (b) 1300C, 4h, and (c) 1400C, 4 h.

Undoped $BaTiO_3$ sintered at 1,300°C, 4h (Fig. 2a & b) shows partially sintered grains together with intergranular porosity dispersed throughout the sample cross-section. At a higher temperature (1,400°C, Fig. 2c), there appears to be more

complete grain fusion, diminished intergranular porosity, and large localized pores.

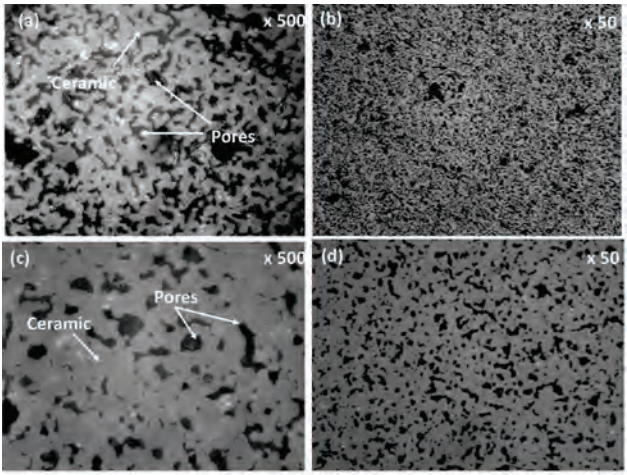

Fig. 3 Optical photomicrographs of ground and polished undoped barium titanate sintered at (a) & (b) 1200 C for 2 h, and (c) & (d) 1300 C for 2 h

The optical photomicrographs of Fig. 3 provide additional evidence for the effect of sintering temperature/time on porosity in sintered coupons; higher sintering temperatures reduce the total porosity content and increase the average pore size. Although chemical composition and phase analysis were not attempted, prior work [7] has shown that $BaTiO_3/Al_2O_3$ composites consist mostly of $BaTiO_3$ with small amounts of secondary phases such as $BaAl_2O_4$ and $Ba_4Ti_{10}Al_2O_{27}$.

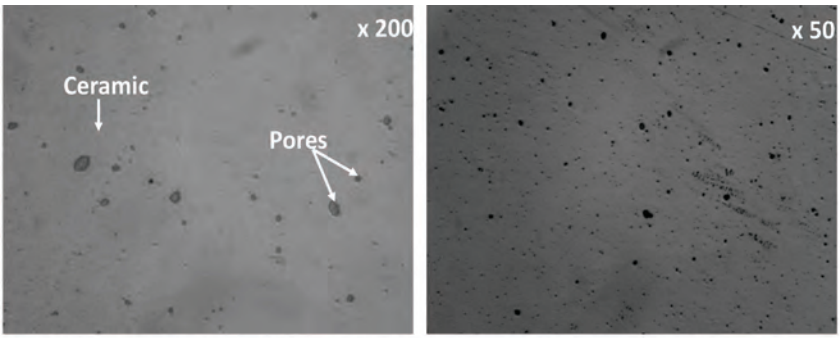

Fig. 4 Optical photomicrographs of ground and polished MgO-doped aluminum oxide (1350 C, 4 h)

No sintering aid was used in the $BaTiO_3/Al_2O_3$ blends. Based upon the theory of sintering, however, it is anticipated that a sintering aid such as MgO in the blend shall facilitate sintering and permit full densification to be achieved at a lower temperature. To test the effectiveness of MgO, a demonstration experiment on the effect of MgO on densification of Al_2O_3 was conducted. Figure 4 shows optical photomicrographs of ground and polished MgO-doped aluminum oxide (0.05% MgO) sintered under different conditions; a considerable reduction in percentage porosity even in samples sintered at 1,350°C for 4 h is noted to result from the use of MgO as a sintering aid. While a direct proof of the effectiveness of MgO to facilitate sintering of $BaTiO_3/Al_2O_3$ blends could not be demonstrated within the constraints of the project, this would be addressed in future research.

Capacitance and Piezoelectric Output Voltage

Figures 5 and 6 show the results of electrical measurements conducted on un-doped $BaTiO_3$. The output voltage generated across two opposite faces of sintered $BaTiO_3$ discs of different thicknesses is shown in Fig. 5.

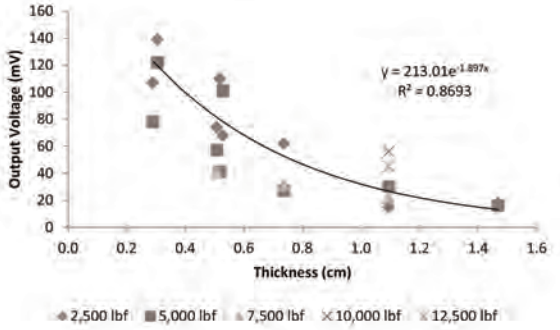

Fig. 5 Output voltage generated upon compressing sintered $BaTiO_3$ discs under different loads as a function of the disc thickness. Note that only a few samples survived the two highest loads (10,000 and 12,500 lbf), thus leaving an inconsistent number of samples for output voltage measurements.

Of central importance to understanding the outcomes of Fig. 5 is the overall trend in the voltage versus thickness data rather than the relative behaviors of individual samples. As is evident from Fig. 5, there are several different types of data points being used at inconsistent thicknesses. The problem was caused due to fewer samples surviving large loads. Of the samples tested at

10,000 and 12,500 lbf, a large number shattered, leaving only a few surviving samples that could be tested.

On an average, thin discs generated greater voltage than thick discs when loaded under the same pressure. The thickness of the sample and the output voltage exhibited a roughly exponential relationship. The actual magnitude of the voltage output was, however, inferior to an industrial piezoelectric sample of tape-cast lead-zirconate-titanate (PZT) ceramic that was obtained from APC International, Ltd. This is believed to be due to the limitations inherent in the fabrication technique used in the present research. It in envisioned that the method used in the research could be refined to approach the properties of the commercially available piezoelectric ceramics.

The effect of percentage porosity on relative permittivity of sintered $BaTiO_3$ discs is shown in Fig. 6. Samples containing high percentages of porosity yielded small values of the dielectric constant. A theoretical model [8] for the effect of porosity on dielectric constant was invoked to predict the dielectric constant as a function of percentage porosity in sintered samples. According to this model, the dielectric constant (K) varies with fraction porosity (v_p) according to [8] ww$\varepsilon_r = K = K_m(9\text{-}14v_p)/(9+v_p)$ where K_m is the measured relative permittivity of the individual sintered sample.

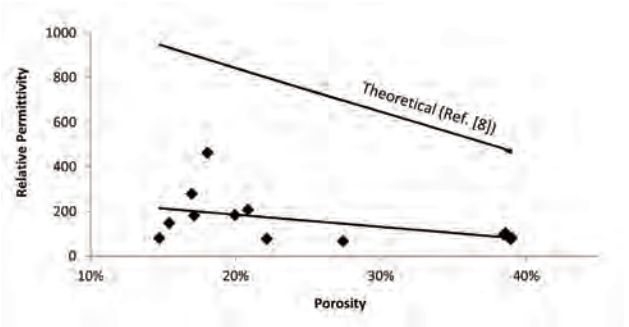

Fig. 6 Relative permittivity (dielectric constant) versus percentage porosity in sintered $BaTiO_3$ discs.

The experimentally measured values of the dielectric constant are much less than the theoretical values predicted by the above equation (Fig. 6). A possible reason for the degradation is dielectric aging, which is time-dependent loss of capacitance

in a ceramic after it is cooled through its Curie Point (125ε for $BaTiO_3$). The loss follows a logarithmic law with time and can continue indefinitely.

Besides testing the output voltage generated with sintered $BaTiO_3$ samples fabricated in the study, select industrial samples of another piezoelectric material, lead zirconate titanate (PZT), were tested for output voltage characteristics. Small (1 cm x 1 cm x 0.2 cm) PZT samples donated by APC International, Ltd., were tested under the same loading conditions as the $BaTiO_3$ samples. Unfortunately, the PZT samples could not sustain such large loads (2,500 - 12,500 lbf), and shattered when tested for output voltage characteristics. As a result, PZT samples had to be tested under a different set of loading conditions, thus making a comparison with the $BaTiO_3$ samples impossible. A simple setup was designed and built to test the output voltage generated by PZT samples under small impact loads. A metal tube with a hole drilled in at 3 ft. from one of the ends was held vertically in a fixture. A ball bearing that fitted inside the tube was held vertically with a dowel pin at 3 ft. A force dynamometer was positioned directly under the tube to record the impact force. Five sample drops of the ball bearing from 3 ft. height were used to find the average impact force. Following impact force measurements, the ball bearing was dropped on individual PZT samples and output voltage waveform was observed on an oscilloscope screen. Strong spikes in voltage signal were observed upon impact on PZT. No such voltage spikes occurred when the $BaTiO_3$ samples were tested under identical conditions. This suggested that sintered $BaTiO_3$ samples fabricated in the study were more rugged but less sensitive than the industrial PZT samples, and needed much larger loads (2,500 - 12,500 lbf) to reveal their piezoelectric behavior.

Flexural Strength

The flexural strength was found by calculating the modulus of rupture (MOR) using the results of the three-point bend test. Typical load versus strain curves for sintered $BaTiO_3$ and $BaTiO_3$/Al_2O_3 composites and test configuration are shown in Fig. 7.

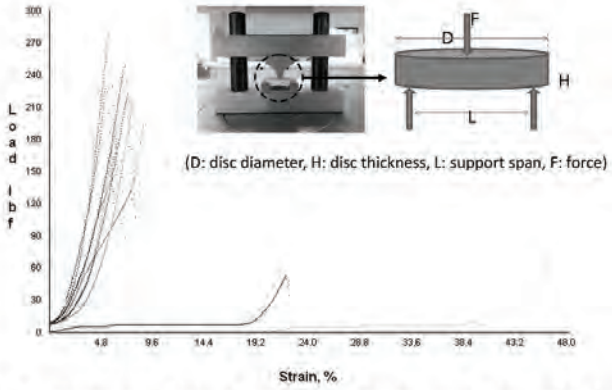

Fig. 7 Representative normal load versus percent strain curves for sintered $BaTiO_3$ and $BaTiO_3/Al_2O_3$ composites from the three-point bend test.

The average modulus of rupture for the tested samples is shown in Fig. 8 as a function of the percentage of Al2O3 (results on un-doped $BaTiO_3$ correspond to 0% Al_2O_3).

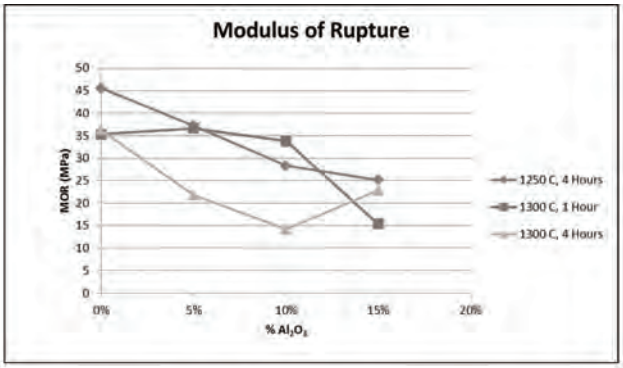

Fig. 8 Modulus of Rupture (MOR) of $BaTiO_3/Al_2O_3$ composites as a function of Al_2O_3 content under different sintering conditions.

In general, the MOR decreased with the addition of Al_2O_3 to $BaTiO_3$ because of incomplete sintering and higher resultant porosity that impaired the mechanical strength. This was independently confirmed via a rattle test that measures weight loss in samples in a rotating tumbler. The rattle test showed the un-doped $BaTiO_3$ sample lost 0.81% of the total weight whereas the $BaTiO_3/Al_2O_3$ composite sample with 10% Al_2O_3 lost 3.37% of the total weight.

Conclusions/Future Work

Powder-based processing and electrical and mechanical characterization of a piezoelectric ceramic, $BaTiO_3$, with and without Al_2O_3 dopant were investigated. Powders were uniaxially pressed into discs and sintered at various temperatures and for different times. The discs were characterized for density and assembled with conductive metal foil into ceramic capacitors and piezoelectric transducers and tested for capacitance and output voltage characteristics. When discs were compressed uniaxially an output voltage was generated which exhibited an exponential relationship with disc thickness. The experimental values of relative permittivity revealed a trend with percent porosity similar to the theoretical predictions although the values were substantially lower than predictions.

Barium titanate is brittle and it develops cracks during mechanical and electrical loading. In order to strengthen $BaTiO_3$, composites of $BaTiO_3$ containing different percentages (5, 10 and 15 percent by weight) of Al_2O_3 were prepared by ball-milling, compaction, and sintering. The effect of Al_2O_3 addition and sintering temperature on density, porosity, and flexural strength was evaluated. The density and flexural strength of sintered $BaTiO_3/Al_2O_3$ composites decreased and porosity increased as the Al_2O_3 content in the composite increased. Because of high incidence of porosity, the composite samples did not develop their full strength.

There are a number of improvements that can be made to improve the research study to achieve higher strength in $BaTiO_3/Al_2O_3$ composites. These include use of higher sintering temperatures, finer aluminum oxide powders, and judiciously selected sintering aids to increase the densification, reduce the porosity, and enhance the fracture strength. Additional research could discover relationships between measured grain size and sintering parameters, and between electrical or mechanical properties and sintering parameters.

Acknowledgement: LB extends his grateful thanks to Dr. John Kirk, Chemistry Department, for allowing and coordinating use of the Scanning Electron Microscope (SEM). LB wishes to thank Jake Hillstead for spending many hours using the SEM for this research project. LB also would like to thank Dr. Cheng Liu, Engineering and Technology Department, for his advice and

instruction on capacitance and electrical measurements.

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Characterization of Vacuum Brazed Advanced Ceramic and Composite Joints

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Abstract

The microstructure and hardness of nineteen vacuum brazed joints of zirconium diboride and silicon nitride made using a variety of braze alloys were evaluated. Samples were cut and mounted in epoxy, ground and polished, tested for Knoop hardness, and examined for joint microstructure using optical microscopy. Select multilayer joints were examined in depth for microstructure and composition using scanning electron microscopy and energy dispersive spectroscopy. Directly bonded zirconium diboride (ZrB_2) led to better quality joints than directly bonded silicon nitride (Si_3N_4). The larger thermal expansion coefficient of Si_3N_4 than ZrB_2 led to greater expansion mismatch and a higher propensity for cracking in Si_3N_4 joints. The incidence of cracking in Si_3N_4 joints decreased with the use of tungsten, molybdenum and tantalum interlayers. The joints made using Ti-containing braze alloys exhibited Ti enrichment of the interface. The hardness distribution mimicked the stacking sequence of the interlayers.

Introduction

Because of their high hardness and brittle nature, ceramics are rarely machined into finished parts. Ceramic parts are either cast to net-shape or assembled from simpler units by joining. Ceramics also need to be joined to metallic alloys in applications involving implantable electronics (e.g., neuro-stimulators), seals for vacuum tubes, microwave reflectors, spark plugs, nozzles and cutting tools. Because of the very different physical and chemical natures of metals and ceramics, joining ceramics and metals is technically more difficult than brazing, soldering or welding of like materials. In the following paragraphs, we first review the current state of research on joining of ZrB_2 and Si_3N_4 ceramics

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and then explain the purpose of the current research project.

Zirconium Diboride

The transition metal diboride ZrB_2 (density: 6,090 $kg.m^{-3}$) has a melting temperature greater than 3,000 K and has been identified as a promising material for applications in extreme environments such as ultra-high temperatures (2173-2773 K) on sharp leading edge of space vehicles reentering the Earth's atmosphere. Additives such as SiC and carbon improve the thermal and mechanical properties, and oxidation resistance. Zirconium diboride is considered as a family of ultra-high temperature ceramics (UHTC) that have been developed and characterized for physical, mechanical, thermal, and thermomechanical properties [Paul et al, 2012; Gasch et al, 2005; Zhu et al, 2008; Bellosi and Babini, 2007; Sciti et al, 2006; Monteverde et al, 2002]. Studies on joining of diboride-based ceramics are, however, scarce. Some researchers (Muolo et al, 2003) have used Ag-Zr brazes (liquidus temperature, TL ~1323 K) whereas others [Singh and Asthana, 2007, 2009 & 2010; Asthana and Singh, 2009] have used Ni-base metallic glass, AgCuTi and Pd-base brazes to join ZrB_2-based ceramics. Still other investigators [Valenza et al, 2012; Passerone et al, 2006 and 2007; Voytovich et al, 2007] have characterized the wettability and chemical interaction of diboride ceramics with Ag, Cu, Au and Ni.

Silicon Nitride

Like ZrB_2, silicon nitride ceramics have excellent high-temperature strength, thermal stability, and resistance to creep, thermal shock, wear, and oxidation. These materials are used in engine components, turbochargers, bearings, and cutting tools. In such applications, relatively complex part designs are needed. As Si_3N_4 is less amenable to machining, robust joining techniques play a critical enabling role (e.g., in hybrid gas turbines with ceramic blade and metallic disk). Among prominent applications of multilayer Si_3N_4-to-metal joints, turbo-charger rotors with Si_3N_4 blades joined to a steel shaft with laminated interlayers via active metal brazing is probably the most well-known product. It has a soft metal/low expansion and hard metal/soft metal interlayer structure (e.g., laminate interlayer of Fe/W).

Among the filler metals used to join Si_3N_4 ceramics, Ag-Cu

eutectic alloys containing Ti have been most widely used. Other common fillers include Ag-Cu-In and Ag-Cu-Sn containing Ti. Besides Ti, active elements such as Hf, Zr, Nb and Ta also have been evaluated for joining Si_3N_4 ceramics. Additionally, braze alloys such as Pd-Ni-Ti, Au-Pd-Ti, and Cu-Pt-Ti/Nb as well as non-reactive brazes Pd-Ni and Au-Pd-Ni in conjunction with pre-metallized Si_3N_4 also have been used. Silicon nitride has been successfully joined to steel, aluminides, W, Ti, Nb, Inconel, Cu-clad-Mo and other metals and alloys using either direct bonding or with the aid of multilayers [Blugan et al, 2004; Brochu et al, 2004; Hadian and Drew, 1996; Liu et al, 2006; Zhang et al, 2008].

Silicon nitride is acknowledged to be one of the most difficult ceramics to join to metallic materials in spite of its useful properties. The difficulty arises mainly from the relatively small coefficient of thermal expansion (CTE) of silicon nitride (~$3x10^{-6}$ K^{-1}), even compared with other engineering ceramics. High-temperature alloys such as Inconel have appreciably larger CTE ($CTE_{Inconel-625}$: ~$16x10^{-6}$ K^{-1}). The expansion mismatch generates large residual stresses during temperature excursions often leading to the fracture of the ceramic. Judiciously selected metal interlayers in the bond region reduce the strain energy and fracture propensity in the ceramic. For example, strain energy in directly bonded Si_3N_4/Inconel-600 joints is estimated to be 38 mJ, and with a 0.3 mm thick Ni interlayer, the strain energy drops to 15 mJ [Park et al, 2002]. Multilayer Si_3N_4/steel joints have been brazed using AgCuTi brazes in conjunction with Ni and Ni-W interlayers with some success.

Research Objectives

This research had three interrelated objectives: i) examine the effectiveness of three hitherto unexplored interlayers (tungsten, molybdenum and tantalum) with favorable thermal expansion and elastic modulus to bond Si_3N_4 to metal substrates, ii) demonstrate direct bonding of some new and emerging ZrB_2 based composites to metals and alloys, and iii) evaluate the effectiveness of multiple commercial brazes, not commonly used to join Si_3N_4 and ZrB_2 based materials to bond titanium, nickel-base super alloys, and copper-clad-molybdenum.

Vacuum brazed joints obtained from the NASA Glenn Research Center were used in the study. The joints were made using a range of active braze alloys with melting temperatures

as high as 1,510 K. Because of the high joining temperatures, chemical interactions of molten braze alloys with the ceramic and metallic substrates were expected to significantly alter the joint structure and mechanical properties such as hardness. This research evaluated bond integrity, microstructure and micro-hardness of nineteen Si_3N_4 and ZrB_2 based ceramic joints with metallic substrates including some new and promising materials (e.g., ZrB_2 based composites) that are still under development in aerospace industry. Although the study did not focus on a specific product such as turbochargers, exhaust valves, and leading edge of aircraft wings where use of such ceramics is promising, the research outcomes offered insights into engineering development of a simple and environment-friendly joining technology applicable to such components.

Experimental Procedure

Joining Procedure

The joints were created using vacuum brazing (vacuum pressure ~10^{-6} torr) in the Ceramics Branch at the NASA Glenn Research Center. The substrates and braze foils were ultrasonically cleaned in acetone and the braze and metal interlayers were sandwiched by the substrates. A load of ~1-2 N (~3.5-7.2 kPa pressure) was applied during brazing. The assembly was heated in a furnace to about 15-20° above braze liquidus and soaked for 30 min., followed by slow cooling to room temperature.

A total of 19 joints listed in Table 1 were characterized. Commercial braze alloys that were used along with their composition and liquidus and solidus temperatures are listed in Table 2.

Table 1. Ceramic/Metal Brazed Joints for Testing

Sample ID (ref. #)	Braze Alloy(s)	Joined Materials	Joint configuration
120307-3 **(2)**	Copper-ABA	Si_3N_4 to Ti	Si_3N_4/Cu/Cu-ABA/Cu/Ti
062307-A5 **(18)**	Palco	Si_3N_4 to Cu-clad-Mo	Si_3N_4/Palco/Cu-clad-Mo
012408-1 **(11)**	Copper-ABA	Si_3N_4 to Si_3N_4 (NT-154)	Si_3N_4/Cu-ABA/Si_3N_4
012408-5 **(14)**	Copper-ABA	Si_3N_4 to Waspaloy	Si_3N_4/Cu-ABA/Waspaloy
071409-AS800 **(19)**	Copper-ABA	Si_3N_4 to Si_3N_4 (AS800)	Si_3N_4/Cu-ABA/Si_3N_4
062307-A2**(7)**	Palco	ZS to ZS	ZS/Palco/ZS
071406-10 **(12)**	Ticusil	ZSC to Cu-clad-Mo	ZSC/Ticusil/Cu-clad-Mo
061907-9 **(6)**	Palni	ZSS to Cu-clad-Mo	ZSS/Palni/Cu-clad-Mo
062307-A3 **(5)**	Palco	ZS to Cu-clad-Mo	ZS/Palco/Cu-clad-Mo
061407-2 **(17)**	Palco	ZS to Ti	ZS/Palco/Ti
062807-1 **(1)**	Cusil-ABA	ZS to Cu-clad-Mo	ZS/Cusil-ABA/Cu-clad-Mo
061907-3 **(9)**	Palni	ZS to Cu-clad-Mo	ZS/Palni/Cu-clad-Mo
091107-1 **(13)**	Ti 375	ZS to ZS	ZS/Ti 375/ZS
061407-7 **(3)**	Palco	ZSC to Cu-clad-Mo	ZSC/Palco/Cu-clad-Mo
061407-11 **(15)**	Palco	ZSS to Cu-clad-Mo	ZSS/Palco/Cu-clad-Mo
091207-1 **(4)**	Ti-120	ZS to Ti	ZS/Ti-120/Ti
060708-F **(10)**	Copper-ABA	Si_3N_4 to Inconel-625	Si_3N_4/Cu-ABA/W/Cu-ABA/Ta/Cu-ABA/Inconel-625
060708-G **(16)**	Copper-ABA	Si_3N_4 to Inconel-625	Si_3N_4/Cu-ABA/Ni/Cu-ABA/W/Cu-ABA/W/Ni/MBF-20/Inconel-625
062008-7 **(8)**	Copper-ABA	Si_3N_4 to Inconel-625	Si_3N_4/Cu-ABA/W/Cu-ABA/Mo/Cu-ABA/Inconel-625

Table 2. Commercial Braze Alloys used in Ceramic/Metal Joints

Braze	Composition (%)	T_L, K	T_S, K
Copper-ABA[a]	Cu-3Si-2Al-2.25Ti	1297	1231
MBF-20[b]	Ni-6.48Cr-3.13Fe-4.38Si-3.13B	1297	1242
Ticusil[a]	Ag-26.7Cu-4.5Ti	1173	1053
Cusil-ABA[a]	Ag-35.3Cu-1.75Ti	1088	1053
Palco	Pd-35Co	1492	1492
Palni	Pd-40Ni	1511	1511
Ti-375	Ti-37.5Zr-15Cu-10Ni	1116	1112
Ti-120	Ti-12Zr-22Cu-12Ni-1.5Be-0.8V	1088	1023

[a] Morgan Advanced Ceramics; [b] Honeywell, T_L: liquidus temperature, T_S: solidus temperature

St. Gobain Si_3N_4 (NT-154) containing 4 wt% Y_2O_3 as a sintering aid was used for silicon nitride joints and three ZrB_2-based ceramics, called ultra-high-temperature ceramics (UHTC) were used to create joints. The three ZrB_2-based ceramics, named ZSS, ZSC and ZS, have the following compositions:

(i) ZSS (ZrB_2 + 20 v/o SiC_p + 35 v/o SiC_f), contains SCS-9a fiber and particulate SiC,
(ii) ZSC (ZrB_2 + 14 v/o SiC_p + 30 v/o C_p), contains particulate SiC and carbon, and
(iii) ZS (ZrB_2 + 20 v/o SiCp), contains particulate SiC.

These ceramics were fabricated by hot-press diffusion bonding. The ZSC and ZS achieved full-densification but the hot-pressed ZSS had ~30% residual porosity (determined from weight and volume measurements) and micro-cracking due presumably to residual stresses resulting from the mismatch of coefficient of thermal expansion (CTE) between the SCS-9a fibers (CTE~4.3×10^{-6}/K) and the matrix.

The metallic substrates (Table 1) used in bonding were obtained either from Inco Specialty Metals or from Good Fellow. The interlayer metals included foils of W (20 μm), Ta (50 μm), and Mo (20 μm) and were used to create multilayer joints with Si_3N_4. The CTE and yield strength of the selected substrate and interlayer materials are given in Table 3.

Table 3 Representative Physical and Mechanical Properties

Material	E, GPa	YS, MPa	UTS, MPa	CTE, $\times10^{-6}K^{-1}$	K, W/m.K
Silicon nitride	310	-	830	3.3	30
Inconel 625	207	450-550	870-930	13.1	10
Ta	186	170	241-482	6.5	58
W	411	550	690-3447	4.5	173
Mo	329	500	--	4.8	138
Cu-ABA	96	278	520	19.5	38

Metallurgical Preparation

Samples were first mounted in epoxy to allow for easier handling when grinding and polishing. The polishing step allows for a mirror/micro finish of samples, which in turn allows for a clear view at high magnifications. The grinding and polishing procedure consisted of the following steps:

i) Grind on 240C grit paper (speed: 100 rpm, duration: 10 min., load: 25 lb., lubricant: water)
ii) Grind on Cameo Platinum II Disc (150 rpm, 10 min., 25 lb. load, lubricant: water)
iii) Polish on Cameo Silver Disc (100 rpm, 10 min., abrasive: 6μm diamond paste, lubricant: isopropyl alcohol mixture)
iv) Polish on Cameo White Disc (100 rpm, 10 min., abrasive: 3μm diamond paste, lubricant: isopropyl alcohol mixture)
v) Polish on Cameo Grey Disc (100 rpm, 10 min., abrasive: 1μm diamond paste, lubricant: isopropyl alcohol mixture)
vi) Final polish on Cameo Grey Disc (100 rpm, 10 min., abrasive: colloidal silica, no lubricant).

Microhardness testing

For micro-hardness testing, a Buehler Micromet-2001 tester with Knoop indenter was used with a 500 gram load. This allowed for enough of an indentation of the harder ceramics and did not overly scar the softer metals. The hardness tester was calibrated prior to testing to ensure reliability using the calibration materials provided with the tester. Samples were securely mounted in the fixture, an appropriate testing location was found using the microscope attached to the tester, the indentation was made, and the indentation size was measured and converted to the Knoop hardness number. Multiple hardness scans were made to check the reproducibility of the measurement.

Microscopy

The microstructures of all polished joints were examined and recorded at various magnifications (x50 to x500) using an optical microscope. Selected samples were characterized for microstructure and composition using Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) at the NASA Glenn Research Center.

Results and Discussion

ZrB_2-base Ceramic Joints

The microstructures of some ZrB_2 ceramics joined to themselves and to Cu-clad-Mo and titanium are shown in Figs. 1 and 2, respectively.

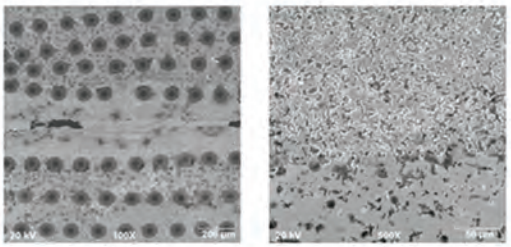

Fig. 1(a) Fig. 1(b)

Fig. 1 ZrB_2-based ceramics joined to themselves: (a) ZSS/Palco/ZSS, and (b) ZSC/Palco/ZSC.

Fig. 2(a) Fig. 2(b)

Fig. 2 ZrB_2-based ceramics joined to metals: (a) ZSS/Cu-clad-Mo, and (b) ZSC/Ti.

The very fine, dark and dispersed platelets are SiCp and the continuous light-gray phase is the ZrB_2. The evenly distributed round features are SiC fiber cross sections in the ZSS material. The ZrB_2-based ceramic (ZSS, ZSC and ZS) joints that were characterized in the study are listed in Table 1. Overall, the joints made using ZS, ZSC, and ZSS with Palco braze and copper-clad-molybdenum were defect-free. Joints 4 and 17 (Table 1), both ZS joined to titanium, exhibited large cracks in the ZS. This may due to the large differences in their moduli of elasticity (116 GPa for Ti, 421 GPa for ZS) and thermal expansion [Park et al, 2002]. ZS to ZS joints made using Palco and Ti-375 brazes (7 and 13, Table 1) turned out quite well, but in sample 7 (Palco braze), small vertical cracks appear perpendicular to the joint in the reaction

zones. No such cracks formed in sample 13 (Ti-375 braze) due presumably to the fact that Ti-375 is a lower temperature braze and less reactive than Palco. No reaction zone formed in sample 13. The joints made using Palco and Palni exhibited considerably thicker interaction zones than joints made using other brazes.

Interestingly, unlike joints made using Cu-clad-Mo in which Cu cladding acted as a stress absorbing interlayer (ductility of Cu: 55%), in self-joined ZSC with Palco braze, hairline cracks and penetration of Pd into ZSC, were noted. In self-joined ZSS using Palco, the pre-existing microcracks and pores facilitated braze penetration that led to presence of Pd in interaction zone away from the braze matrix and formation of a prominent but somewhat diffuse interaction zone. Unlike Palco braze, the Palni braze led to poor bonding and cracking. The lower ductility and higher yield strength (ductility: 23%, yield strength: 772 MPa) of Palni than Palco (ductility: 43%, yield strength: 341 MPa) inhibited effective stress relief and led to unsound joints even though joints made using Palni could be used in applications that require higher operating temperatures.

It is conceivable that dissolution of Si and Zr from ZS, ZSS and ZSC in molten braze could saturate the melt with solutes resulting in the formation of intermetallic phases upon cooling and solidification. In addition, silicides and complex ternary compounds could form via chemical reaction in the interfacial zone. A detailed analysis of the chemical reactions kinetics and thermodynamics in these complex multi-component systems may not be feasible. Simple thermodynamic considerations could be invoked to suggest possibilities. For example, chemical reactions between ZrB_2 or SiC and Ni, Pd, and Co in braze could form borides (Ni_2B, Ni_3B, CoB, Pd_5B), silicides ($CoSi_2$, Ni_2Si, PdSi) and carbides (Ni_3C, CoC, PdC). The free energies of reactions between ZrB_2 or SiC and Ni and Co show that Ni could react with SiC to form Ni_2Si. In contrast, the reaction of ZrB_2 with Ni or Co to form Ni_2B, Ni_3B, and CoB is thermodynamically unfavorable. Similarly, formation of $CoSi_2$ and Ni_3C from the reaction of SiC with Ni or Co is unlikely.

Silicon Nitride Joints

Figures 3 and 4 show representative Knoop hardness profiles for two joint configurations: Si_3N_4/W/Mo/Inconel (Fig. 3) and Si_3N_4/W/Ta/Inconel (Fig. 4)

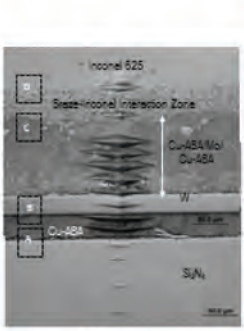

Fig. 3(a)

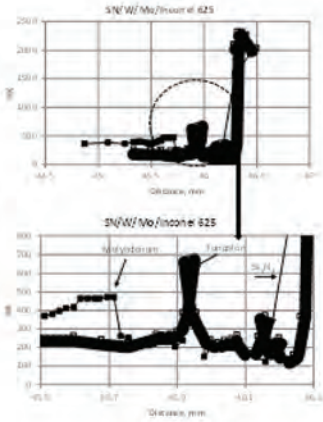

Fig. 3(b)

Fig. 3 (a) Overall view of a multilayer Si_3N_4/Inconel joint with interlayers of W and Mo. Regions marked as A, B, C and D were examined in depth using SEM and EDS, and (b) Knoop hardness distribution across the joint.

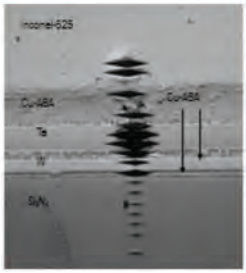

Fig. 4(a)

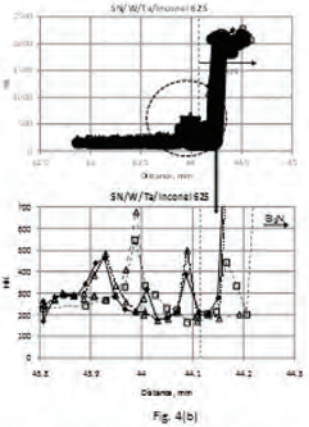

Fig. 4(b)

Fig. 4 (a) Overall view of a multilayer Si_3N_4/Inconel joint with interlayers of W and Ta, and (b) Knoop hardness distribution across the joint.

These figures also show magnified hardness profiles in the multilayer regions. The baseline hardness of Inconel-625 in all joints is 300-400 HK200, and the hardness of Si_3N_4 substrate is in excess of 2000 HK_{200}. Periodic increase and decrease of hardness across the refractory metal interlayers is noted. The hardness peaks around the minima in the figures represent the interlayers and follow the expected trend in material hardness of stacked layers (e.g., HK_{200} of W is greater than HK_{200} of Mo). It is conceivable that modification of braze metallurgy from the dissolution and redistribution of alloying elements together with

the residual stress effects could modulate the hardness values of the braze and refractory metal interlayers compared to their values in a pristine state.

Figures 3(a) and 4(a) also showed the physical location of the various interlayers in joints. Each interlayer is well-bonded to its neighbors and does not exhibit warping or cracking generally confirming that the joints are microstructurally sound. The Si_3N_4/W/Mo/Inconel-625 multilayer joint was selected for a more complete evaluation of the interfaces. Figures 5 through 8 show the microstructure and elemental compositions across the various interfaces in this joint.

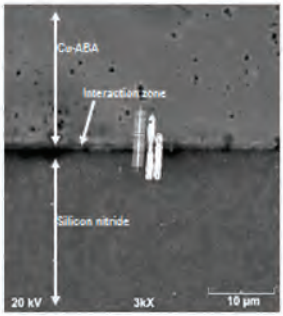

Fig. 5(a)

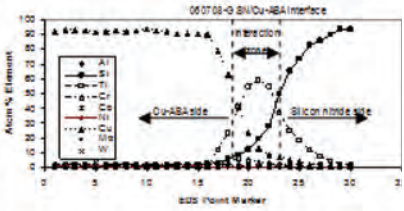

Fig. 5(b)

Fig. 5 (a) Region 'A' (Fig. 3a) in a Si_3N_4/W/Mo/Inconel 625 joint, and (b) elemental distribution across the interface between Si_3N_4 and braze layer.

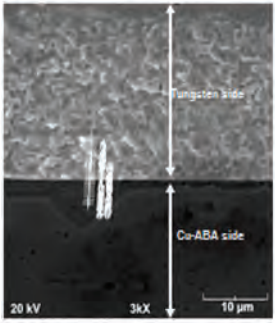

Fig. 6(a)

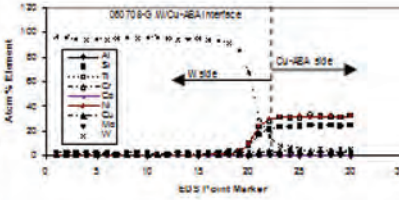

Fig. 6(b)

Fig. 6 (a) Region 'B' (Fig. 3a) in a Si_3N_4/W/Mo/Inconel 625 joint, and (b) elemental distribution across the interface between tungsten and braze layer.

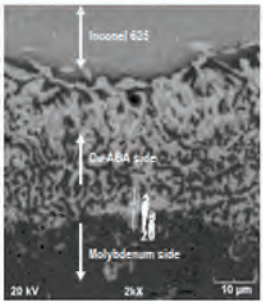

Fig. 7(a)

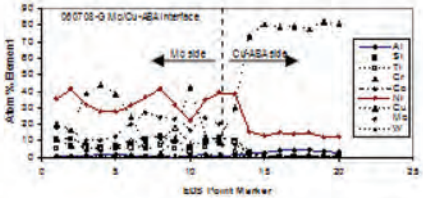

Fig. 7(b)

Fig. 7 (a) Region 'C' (Fig. 3a) in a Si_3N_4/W/Mo/Inconel 625 joint, and (b) elemental distribution across the interface between molybdenum and braze layer.

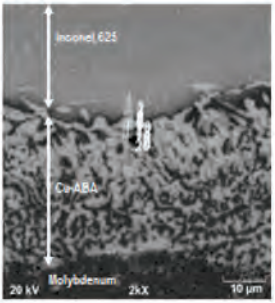

Fig. 8(a)

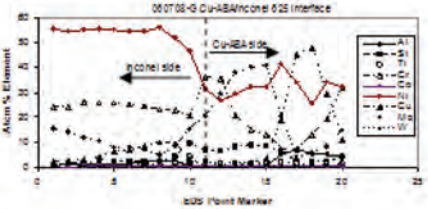

Fig. 8(b)

Fig. 8 (a) Region 'D' (Fig. 3a) in a Si_3N_4/W/Mo/Inconel 625 joint, and (b) elemental distribution across the interface between Inconel and braze layer.

Titanium segregation was observed at the Si_3N_4/braze interface in all joints that were made using Ti-containing braze alloys. The metal interlayers appear to be well-bonded to the adjoining braze layers. While there is no evidence of interfacial de-cohesion in the joints, a single hairline crack, visible to the unaided eye, and parallel to the joint had formed in the Si_3N_4 substrate approximately 2 mm from the seam. Upon removal from the brazing furnace, the joints were visibly crack-free; however, it could not be ascertained if the hairline crack had developed in the subsurface regions due to residual stresses during brazing or if it had formed during sectioning of epoxy-mounted joined assemblies prior to metallurgical polishing. The EDS analysis revealed small quantities of Cr from Inconel at the $S_{i3}N_4$/braze interface in joints made using Inconel. It is evident that Cr has diffused across the different interlayers

within the joint resulting in a concentration gradient with the Cr concentration progressively decreasing from the Inconel side to the Si_3N_4 side. Indeed, in directly brazed Si_3N_4/Inconel 625 joints without interlayers, Cr could react with Si_3N_4 to form chromium nitrides (CrN and Cr_2N) and chromium silicides ($CrSi_2$, Cr_3Si, and Cr_5Si_3), and Ni from Inconel could form nickel silicide (NiSi, Ni_2Si, $NiSi_2$, $Ni_{16}Ti_6Si_7$) could also form at the interface.

In designing the Si_3N_4/W/Ta/Inconel and Si_3N_4/W/Mo/Inconel joints, the goal was to create a CTE gradient across the joints. For example, the CTE (in ppm/K) variation from the Si_3N_4 side to Inconel side is 3.3/4.5/6.5/13.1 for Si_3N_4/W/Ta/Inconel joint, and 3.3/4.5/4.8/13.1 for the Si_3N_4/W/Mo/Inconel joint. A graded CTE variation is expected to mitigate residual stress buildup from joining. A trade-off exists between relief of CTE-mismatch induced residual stress in the ceramic and plastic deformation in the metal interlayer. The yield strength of a metal is, therefore, also important in reducing the strain energy (and fracture tendency) in the ceramic. Unfortunately, interlayer materials with small CTE generally have high yield strength. Hardness will vary considerably across the joints, not only because of different materials being joined but also because of un-known reaction zones between materials being created.

To better understand occurrences in microstructure such as voids, cracks, and abnormal bonds, a residual stress analysis was performed using Equation 1 listed below.

$$\sigma = E_M E_C / E_M + E_C (T_b - 30)(a_M - a_C)$$

Where E_M = elastic modulus of metal; E_C = elastic modulus of ceramic; T_b = brazing temperature, a_M = thermal expansion coefficient of metal; and = a_C thermal expansion coefficient of ceramic. The results of the theoretical calculations are shown in Fig. 9

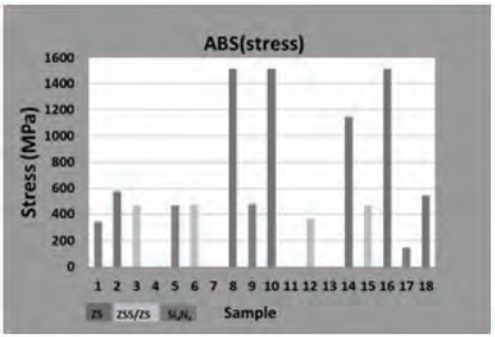

Fig. 9 Theoretical projections of residual stress in joints from the mismatch of coefficient of thermal Expansion of joined substrates.

Silicon Nitride has a very low expansion coefficient, which causes the residual stress in the samples to be much higher than in ZrB_2-based ceramic joints. The zirconium diboride-based ceramics exhibit much lower residual stresses, due in large part to their higher coefficients of thermal expansion (over twice that of silicon nitride). This allows the zirconium diboride samples to more consistently match the alloys' expansions that they are bonded to, giving less prevalence of major cracking.

Conclusions

Joint microstructure and micro-hardness were characterized in a number of vacuum brazed ceramic/metal joints made using a wide variety of braze alloys and combinations of technical ceramic and ceramic/metal joints made using silicon nitride, zirconium diboride, titanium, Inconel 625, and copper-clad-molybdenum with and without stress absorbing interlayers of tungsten, molybdenum, and tantalum. Directly bonded zirconium diboride-to-metal joints exhibited better integrity and less interfacial defects than directly bonded silicon nitride-to-metal joints with the latter exhibiting a greater propensity for cracking because of residual stresses arising out of a large mismatch of thermal expansion coefficients of bonded materials. Residual stress management with the aid of stress absorbing metal interlayers yielded better quality silicon nitride-to-metal joints. Further research shall be needed to optimize interlayer thickness and interlayer ordering in order to create perfectly bonded joints. The interfaces in joints that were made using Ti-containing brazes exhibited Ti enrichment. The distribution of

micro-hardness in multilayer joints was broadly consistent with the stacking sequence of metal interlayers; however, diffusion layers and reaction products that formed during joint formation at elevated temperatures yielded hardness values that could not be matched with the expected hardness because such layers and interfacial compounds were not identified in the present study.

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Differences in Executive Function and Creativity between Bilinguals and Monolinguals

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Abstract

Previous research has suggested a bilingual advantage in executive function (EF) and creativity compared to monolinguals. It is theorized that bilinguals' EF advantage stems from their constant practice of selecting one language while inhibiting the other language in conversation, thus strengthening their EF, which may facilitate more complex problem solving such as creative tasks. Eighty-three participants recruited from the university community participated in the two-part study. Both computer and pencil-and-paper tasks were used to assess the five proposed components of EF, as well as creative performance. Contrary to our initial hypotheses, preliminary findings indicate a monolingual instead of bilingual advantage on EF and creativity. Our findings are consistent with the lack of bilingual advantage recently reported in other studies. These results suggest that the language effect may not be as robust as once thought, or that other factors need to be taken into account when evaluating findings across studies.
Keywords: executive function, creativity, bilingualism, language.

Introduction

The understanding of bilingualism's effects on cognition is a relatively uncharted area of cognitive science that has been gaining interest in recent decades. The effect of bilingualism on cognition has not been clear cut. Some of the earliest research suggested it may have detrimental effects on cognition and intelligence (Tucker & d' Anglejan, as cited by Salvatierra & Rosselli, 2010).More recent research started compiling evidence that bilingualism provides advantages in a variety of domains,

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such as executive function (EF) and creativity (Bialystok, Craik, Klein, & Viswanathanan, 2004; Bialystok & Craik 2010). It has been found that while bilinguals enjoy some cognitive benefits, they have also shown deficits in verbal tasks requiring rapid lexical access and retrieval, such as verbal-fluency tasks (Bialystok & Craik 2010). Beyond the immediate cognitive advantages, there is also evidence that lifelong bilingualism maintains cognitive functioning and delays the onset of dementia in old age. In a study of 184 patients from a memory clinic in Toronto, Bialystok, Craik, & Freedman (2007) found that on average, bilinguals showed symptoms of dementia 4 years later than monolinguals. However, despite recent studies finding cognitive advantages for bilinguals, these results have not been consistent. Other studies have found no such advantage or have been unable to replicate findings by Bialystok, so the topic remains controversial and in need of further investigation (Paap & Greenberg, 2013; Salvatierra& Rosselli, 2010).

If bilinguals do have a cognitive advantage over their monolingual peers, where does this advantage stem from? Previous research suggests that there is parallel activation of semantically linked items in both languages associated with a particular concept (Green, 1998). The bilingual has to inhibit one language while selecting for the appropriate language. It is believed that the demand to continually manage two languages strengthens the Supervisory Attentional System, a system that is hypothesized to be a broad cognitive conflict system, and that these advantages extend to non-linguistic tasks. This theory of competition between two semantic units may also explain why bilinguals perform less well on verbal tasks; for example, they may respond more slowly on picture-naming tasks, produce fewer words in verbal fluency tasks, and perform less well on lexical decision tasks (Hilchey & Klein, 2011).

The overarching brain mechanism that facilitates many instances of cognitive conflict and control is referred to as the executive control system. Executive functions (EFs) are fundamental cognitive mechanisms linked to the pre-frontal cortex that regulate and control our behavior and cognitive processes such as planning, working memory, attention, inhibition, task switching, and problem solving. Because EF is such a fundamental aspect of cognition, deficits in it can have detrimental consequences on people's lives and well-being,

including such important aspects as children's success in school, and people's emotional/behavioral control or inhibition (Barkley, 1997; Biederman et al., 2004).

There currently is no agreed upon view of the exact elements of EF, as researchers vary in the ways they subdivide and categorize its components. There is however, much overlap in the various models that have been proposed. The current study combined aspects from two previously established theoretical frameworks used by Shimamura (selecting, maintaining, updating, and rerouting) (2000) and Miyake& Friedman (updating, shifting, and inhibition) (2012), to come up with five facets of EF: selecting, maintaining, inhibition, shifting, and updating. *Selecting* is the ability to focus attention on aspects of information processing, such as a stimulus or memory representations. *Maintaining* is the ability to maintain information in short-term memory after it has been selected. *Inhibition* is the deliberate overriding of a dominant or prepotent response. *Shifting* is the ability to switch flexibly between tasks or mental sets. *Updating* requires constant monitoring and coding of incoming information, and revision of items held in working memory by replacing no-longer-relevant information with new, more relevant information (Miyake & Friedman, 2012; Shimamura, 2000).

Previous studies on bilingualism have not investigated individual aspects of EF, but look at "executive control", or "executive processes" in general, as measured by one, or a few commonly used tasks. To measure this effect studies have commonly employed a Flankers task, the standard Simon task, or the arrow Simon task, which is considered to be more difficult, and is the task that was used in this study. This task was included as an extra EF task because it has been used frequently in the bilingual literature. We wanted to see if our Simon results were in line with previous findings. There are congruent trials, where the target stimulus aligns with the same side as the correct button response, and incongruent, in which the stimulus is on the opposite side of the correct button. Reaction times (RTs) are often faster when the target location and button response location are congruent. The difference between the congruent RT and the incongruent RT is referred to as the "Simon effect." Having a smaller Simon effect, or interference effect, is indicative of an advantage in inhibitory control. This effect has received

much attention as earlier findings in the literature supported a bilingual advantage (Bialystok et al., 2004). More recent studies however, including a meta-analysis, have found that this effect is not very reliable or robust in younger adults(Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009; Hilchey & Klein, 2011).Although the bilingual effects in older populations are understudied at this point, there is mounting evidence that the effect becomes much more salient in older bilinguals compared to monolinguals. A bilingual advantage that has been found to be more robust across age groups is the "global advantage", or overall RT advantage, in which bilinguals respond quicker than monolinguals on all trial types (Bialystok et al., 2004;Costa et al., 2009).

Creativity is a hard concept for researchers to define or measure, but it can be thought of as higher level processing of complex novel problem solving. Previous research has found a bilingual advantage in children on divergent thinking tasks, on measures of fluency, flexibility, elaboration, and originality (Kharkurin, 2011; Lee et al., 2011). Many of the studies on bilingualism and creativity focus on the additional cultural experiences a bilingual has had, as the catalyst of their enhanced creativity. In this study we are interested in assessing whether the fundamental aspects of cognition (EFs) enhance creative potential. That is, if bilinguals experience an advantage in EFs, will this translate into an advantage in creativity as well? Previous research by Kharkhurin (2011) found that among a group of bilingual students, selective attention had a moderate effect on the difference in creative performance. In another study, which consisted only of bilinguals, a positive correlation was found between individual's degree of bilingualism and their creativity performance as measured by the Torrance Test of Creative Thinking (TTCT) (Lee & Kim, 2011).

Because previous research has focused narrowly on inhibition, or broadly on "executive processes", the current study sought to systematically examine the bilingual EF advantage by pairing specific EF tasks to the aspects of EF proposed by Miyake and Friedman (2012) and Shimamura (2000). We hypothesized that bilinguals will show an advantage in EFs (as shown by quicker reaction times, and higher accuracy rates on tasks), which may translate into an advantage in creative performance. We are measuring five facets of EF to see if we can

find a specific realm of EF bilinguals excel in.

Methods

Participants

Eighty-three students (26 male, 57 female) from the University of Minnesota community participated in this study. There were 37 monolinguals (13 male, 24 female) with a mean age of 20.7, and 46 bilinguals (13 males, 33 females) with a mean age of 21.3.Monolinguals were defined as having no second language until high school, and bilinguals were defined as acquiring 2 or more languages by the age of 8. Participants were balanced across demographics except for education, in which bilinguals had significantly more years of education (15.2) than monolinguals (14.3). This was due to there being more graduate students in the bilingual group. Participants were recruited through a screening survey, and compensated with REP points or money ($10 per hour).

Tasks and Procedure

The tasks and procedure from this study are a subset of tasks taken from a larger study which entailed approximately five hours of computer and paper-and-pencil tasks broken up into two experimental sessions approximately a week apart. The EF tasks used in this study come from session one of the experiment, and the creativity (TTCT) task comes from session two. In all computer tasks the keyboard and monitor were set at identical distances for each participant, making sure proximity to the monitor/keyboard was not a factor in performance.

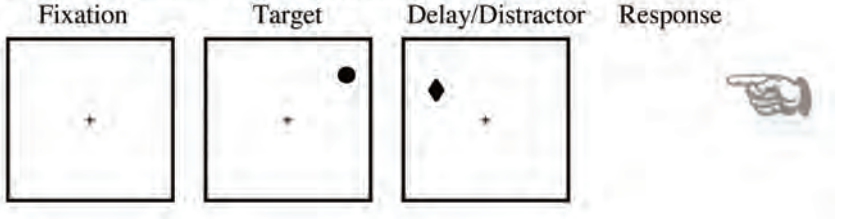
EF Tasks

Selecting - Flankers task. In this task subjects were to determine which direction an arrow was pointing by pressing a left key with their left finger or a right key with their right finger. Subjects were presented with a fixation point (+), and then one of three stimulus types was presented (congruent, incongruent, neutral). Participants responded as quickly as they could, indicating which direction the target arrow (shown in red) was facing. In congruent trials the target stimulus was flanked by congruent arrows, the incongruent trial had the target arrow flanked by arrows facing the opposite direction, and the neutral trial had the arrow flanked by diamonds.

Figure 1. Flanker Conditions

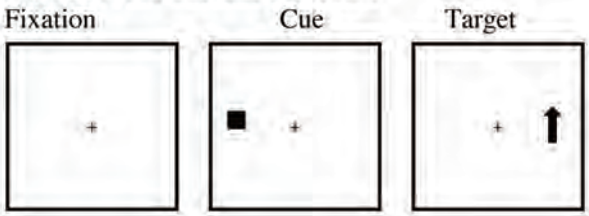
Maintaining - Spatial-Delayed Response. In this task participants were required to maintain information in their working memory of a selected stimulus. The sequence of this task goes as follows: (a) participants focus on a fixation point in the center of the screen (+), (b) a target stimulus of a circle is presented on the screen, (c) the target stimulus disappears for a delayed amount of time depending on the condition (5, 15, or 30 seconds), during which time distracter shapes appear on the screen (such as triangle, square, diamond) and the participant is instructed to press the space bar anytime they see a diamond, (d) after the delay sequence the subject is asked to point to where the target stimulus was, and then a mouse was used to click this point. Accuracy is measured by the subject's mean pixel distance away from where the target actually was.

Figure 2. Spatial – Delayed Response Procedure



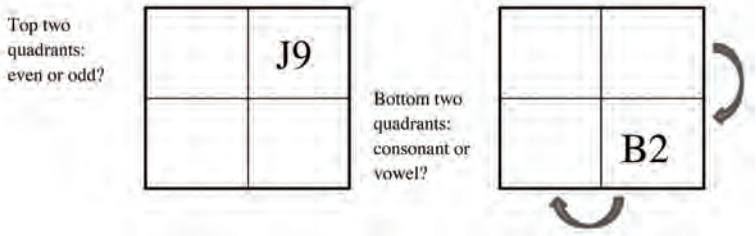
Inhibition- Anti-Saccade task. In this task subjects had to inhibit their natural response to look at a distractor stimulus in order to identify the briefly shown target stimulus. Subjects (a) fixated on a fixation point, (b) a distractor stimulus (a small square) would appear on the left or right side for 225 ms, (c) the target stimulus (an arrow pointing left, right, or up) would briefly appear on the opposite side of the distractor stimulus for 150 ms, (d) subjects responded accordingly using the keyboards up, left, right arrows. There were 90 trials composed of nine different durations ranging from 1500 – 3500 ms.

Figure 3. Anti-Saccade Procedure



Shifting- Number – Letter (NL). In this task participants were presented with a square subdivided into four smaller quadrants. In each quadrant a letter and a number would appear one at a time. For the first part of this task participants were tasked with pressing "V" whenever the number was even, and "M" whenever the number was odd. For the second part of this task participants focused only on the letter and pressed "V" whenever the letter was a consonant, and "M" whenever the letter was a vowel. For the third part of the task a number letter pair was presented in a quadrant one at a time in a clockwise order. Participants had to respond to the number being even or odd in the top two quadrants, and if the letter was a vowel or consonant in the bottom two quadrants. Participants were required to continually shift between number and letter responses.

Figure 4. Number – Letter Procedure



Updating - Tone-Monitoring. For this task participants were presented with a sequence of different pitched tones (high, medium, low) via computer speakers. They were instructed to keep track of the number of times each tone sounds, and to press the spacebar every time a tone repeated four times.

Arrow Simon – In this task participants (a) focus on a fixation point, (b) are presented with an arrow on either the left or

right side of the screen, and the arrow is pointing either left or right, (c) the participants respond with the left button (Z) if the arrow is facing left, or right button (/) if it is facing right. There are congruent trials (e.g., arrow on left side facing left) and incongruent trials (e.g., arrow on left side facing right).

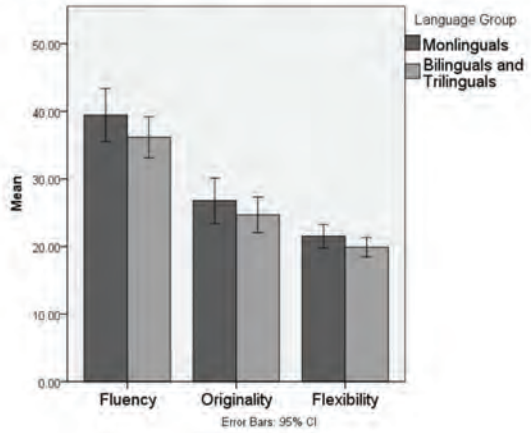
Creativity Tasks

To quantify creative ability this study used the Torrance Test of Creative Thinking (TTCT). Both the figural and verbal portions of the test were administered in the larger study, but only the results from the verbal portion of the test have been analyzed for this portion of study. The verbal TTCT comprises three different tasks that are all scored on three different dimensions (fluency, originality, flexibility). Fluency is scored as the number of acceptable responses a participant writes down. Originality is the amount of original responses written down. Responses are original if they are not on the normed word list. Normed word lists are responses that have been found to be common for a given task. Flexibility is a score of how many different categories of responses the participant gives on a task. Two raters scored the tasks independently, yielding a high inter-rater reliability of .98 (fluency), .95 (originality), and .91 (flexibility).

Results

Independent sample t-tests were conducted between monolinguals and bilinguals on the EF tasks and the TTCT. No significant bilingual advantages were found in any of the tasks, but advantages were trending in favor of monolinguals, with some significant advantages. Analyses showed that monolinguals (M= 980.56, SD = 241.71) had significantly smaller mean pixel distance to the target in Spatial – Delayed Response than bilinguals (M = 1105.73, SD = 243.04), $t(82) = -2.35$, $p = .02$. Additionally, monolinguals (M= 21.51, SD = 5.21) scored significantly higher in flexibility on the TTCT than did bilinguals (M = 19.31, SD = 4.98), $t(82) = 1.97$, $p = .05$. This difference is illustrated in Figure5.Analyses showed that monolinguals (M= 39.44, SD = 11.76) scored moderately higher in fluency than bilinguals (M = 35.7, SD = 10.45), $t(82) = 1.74$, $p = .09$. This difference is also illustrated in Figure5.

Figure 5. Creativity Results



Discussion

The results from the current study have generated more questions than they have answered, and it is hard to reconcile finding not only no bilingual advantage, but actually finding some monolingual advantages. Faced with these results, further scrutiny of the literature was necessary, and upon further investigation, many possible explanations for the disparity between findings across studies emerged. Recently, Paap and Greenberg (2013) did a study very similar to ours in the tasks used and the population tested (a mixed bilingual population), and they found very similar results. They found no bilingual advantage in any of the tasks, and actually found a few monolingual advantages. When reconciling the reports of significant bilingual advantages with findings unable to replicate this advantage Paap and Greenberg proposed two general perspectives: 1. The "bilingual advantages are real perspective," according to which the failure to replicate findings is due to methodological differences between studies such as: the tasks used, differences between tasks (number of trials, ratio of congruent to incongruent trials), the type of bilinguals used (mixed, homogenous, high/low language switching), and the cultural context the study is taking place in. 2. The "bilingual advantages are artifacts perspective," which states that when performance advantages do occur, they are due to factors other than bilingualism, such as hidden demographic factors that were not matched for, or cultural factors that contribute to the

difference.

One of the most salient variables that potentially plays a role in bilingualism and EF is age. There is not a breadth of studies done on older populations, but some studies that have not found advantages in young populations (or found smaller advantages), have seen significant advantages in the older populations (Bialystok et al., 2004; Gold et al., 2013; Salvatierra & Rosselli, 2010). Gold et al. did a study comparing young and old bilinguals to monolinguals on a switching task. They found that there were no significant differences among the young age group, but in the older age group bilinguals were found to have a lower switch cost RT, and less of a BOLD (Blood-oxygen-level dependent) activation in three brain areas of interest, indicating that the older bilinguals were processing the tasks more efficiently than the monolinguals. As mentioned earlier, Bialystok et al. (2007) found that bilingualism offset age related decline as measured by bilinguals experiencing symptoms of dementia 4 years later than monolinguals. Paap and Greenberg postulate that it is possible that the commonly tested populations (young adult college students) are already at the peak of their predetermined cognitive control capacity. Young adults fill their days with a range of normal activities that tax the EF system by attending to relevant information, planning, ignoring distractions, switching tasks, and monitoring their performance. These activities may be enough by themselves to max out this predetermined cognitive limit, if such a ceiling exists. It is only in aging that we begin to slowly see a decline in cognitive capacities, and this is when bilingualism could play a role in preserving cognitive abilities. If we assume that as age increases so does the bilingual advantage, then we can look at studies with differing results and see if it could be a product of age differences across studies. When Salvatierra (2010) tried to replicate Bialystok et al.'s (2004) findings of a bilingual advantage in the Simon task for complex and simple conditions, they only partially replicated the results. The study found only an advantage in the simple condition, and not the complex condition. Bialystok had a significantly smaller N, and lower mean age for age groups. The younger bilinguals (N=32) had a mean age of 42.6 years, and the older bilinguals (N=15) had a mean age of 70.3 years, while in Salvatierra's study both groups were larger and had younger ages, young group (N=67) had

a mean age of 26.7, and the older group (N=58) mean age of 64.1. The smaller sample size and higher age for "young adults" likely played a role in the strength of the advantage found in Bialystok's study.

Another important aspect that researchers need to be cognizant of is the prevalent entanglement between culture and language in bilinguals. Bilinguals can be bicultural as well, and this effect on EF is often not separated from language, or understood in its consequences. A study by Carlson and Choi (2009) dramatically demonstrates this entanglement between culture and bilingualism. In this study they found that bilingual Korean Americans showed a significant advantage over monolingual Americans using six different EF measures. When these bilingual Korean Americans were compared to Korean monolinguals however, the results for the two groups were undistinguishable. This leads us to believe that the EF advantages experienced were most likely not due to bilingualism, and that some cultural difference was influential in EF performance.

There is also the broader cultural context in which the study occurs, and the demographics within the bilingual sample itself that vary greatly across studies. Some studies are conducted in monolingual cultures (such as America), and some are conducted in bilingual cultures (such as Canada or India). Studies also vary in their bilingual population, some having a homogenous population (all Spanish, or all Mandarin bilinguals for example), and some studies having a mixed sample (many different types of bilinguals). It is worth mentioning that the current study, as well as that of Paap and Greenberg (2013), were both conducted in a monolingual culture (California, US, and Minnesota, US), with a mixed population of bilinguals, and with similar EF tasks, and both found no bilingual advantage, while also finding a few monolingual advantages. In contrast, the study of Bialystok et al. (2004) that found significant bilingual advantages used a monolingual group of native Canadian residents, and a bilingual group of Southern India residents. This eclectic participant selection raises questions of lurking cultural confounds.

A previously unexplored variable among bilinguals is the language they speak, and that language's distance from English. A study done comparing French bilinguals, Cantonese bilinguals, and English monolinguals found that French bilinguals

and Cantonese bilinguals showed similar patterns of brain activation in relation to faster RT on an EF task. They showed increased activation of the ACC, superior frontal, and inferior frontal regions situated in the left hemisphere. Monolinguals showed increased activation of the middle frontal area of the left hemisphere. However, even though the French and Cantonese bilinguals showed similar activation patterns, only the Cantonese bilinguals showed an EF RT advantage, over both the English monolinguals and French bilinguals (Hilchey & Klein, 2011). This suggests that something other than being a bilingual was responsible for the advantage. It is possible that languages further away from English syntactically can provide more robust advantages. For example, the differences that a Cantonese-English bilingual (hard bilingual) faces are greater than those that a Spanish-English bilingual (soft bilingual) confronts, and this additional difficulty the EF system is faced with may confer measurable advantages in "hard bilinguals." The author is not familiar with any bilingual studies which measure this factor, and suggests that future studies employ a quantitative measure of the distance between English and second languages to see if language distance has an operative effect on EF. One such measure has been established by Chiswick (2004).

Another important component that varies across studies, and that has been shown to affect the presence of the bilingual advantage is the methodology of the tasks in the study. Two main points regarding this concern the number of trials in a task, and the ratio of incongruent to congruent trials used. A possible limitation of the current study is the amount of trials used in each task. For the Simon task the current study used 8 blocks of 40 and 8 blocks of 10 trials (400 total trials). Bialystok et al. (2004) used 10 blocks of 24 trials (240 trials total). They found that bilinguals started out faster than monolinguals and remained so until block 7, in which the two groups converged. This would be roughly around trial 168, and similar results have been found throughout the literature; bilingual advantages disappearing with practice, so it is conceivable that our bilinguals' advantage got washed out in the many trials. We did however analyze the first few blocks of the Simon task, and found no such advantage, but further inspection into the other tasks is still needed. Concerning the ratio of congruent to incongruent trials Costa et al. (2009) did a series of systematic experiments varying the ratio

of trials and they found that it was a critical variable to finding a bilingual advantage in the Flanker task (a more balanced ratio extinguished the bilingual difference advantage, but increased the bilingual global RT advantage).

A final point that is worth discussing concerns environmental factors that may be unaccounted for, but which can affect EF performance such as socioeconomic status (SES), high computer use, video game play, and expertise in music, which all co-vary with EF performance (Hilchey & Klein, 2011). Failure to control SES is the most widespread unanswered criticism in studies of bilingual cognitive differences. Occasionally studies try to control for SES by asking the highest achieved level of formal education, or by selecting from middle class neighborhoods, but these methods are criticized as being relatively indirect. When Morton and Harper controlled for SES directly and replicated the Simon task they found no bilingual advantage, and found that monolinguals experienced a global RT advantage. However, this experiment was done on children only, and their interpretation is considered somewhat controversial (Hilchey & Klein, 2011). In the current study we took SES into account by asking participants to rate their SES on a scale of 1 to 5 before the age of 12 and after the age of 12. This measure is a relatively indirect measure of SES, and it is suggested that future research use a more sensitive and direct measure. Many previous studies have failed to take into account the factors of computer use, video game play, and musical expertise. In our demographics we included questions asking what video games the participants play and how many average hours a week they play them. We also asked about what instruments they play, and how many hours a week they play them. This data still needs to analyzed and inspected to see if it had an effect on EFs.

Conclusion

Studies investigating the bilingual advantage vary immensely in a wide array of factors such as methodology, cultural context, homogeneity of the language sample, and demographics (such as age and SES). Findings across studies for a bilingual advantage have been inconsistent and fickle, which suggests that the effect may not be as robust as we thought, in young adults at least. Although fewer studies have been done on older populations, there is evidence that the bilingual advantage

becomes more pronounced with age, and further research into these populations is needed to be conclusive. Further investigation into the differences among studies with conflicting findings is needed, and future research on the bilingual advantage should be mindful of the factors discussed in this study (SES, age, culture versus language entanglement, etc.). Future research could also include a language distance scale such as that discussed earlier to see if language distance has an effect on EF. In conclusion, either bilingual advantages are real but more likely more limited than previously thought, and failure to replicate them is due to methodological differences between studies, or bilingual advantages are artifacts, and the EF advantage stems from other lurking variables. With the current available evidence it is premature to conclude one way or another; additional research on bilingualism is needed to understand the possible cognitive advantages it presents.

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Expanding Rugby in the United States: a Historical Analysis

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Abstract

This study utilized a mixed methods approach to address the question of how to grow rugby, given the current obstacles faced by the sport within the United States. A comparative historical analysis of rugby, soccer, and football's fluctuating histories is presented along with an extended literature review and synthesized timeline. This paper presents historical causes for the sport's current minority status in the U.S. market. We find that the United States' sports market has unique characteristics which need to be considered as organizers seek to expand rugby in America. Specific characteristics of the U.S. market and specific obstacles are presented, along with policy recommendations.

Introduction

This mixed methods study looked at how best to grow rugby in the Unites States given the current obstacles faced by the sport there. By finding what current and historical road blocks existed, and how best they could be overcome, it was hoped that limited resources could be more effectively used, allowing the sport to grow at an expanded rate. This study was conducted with the cooperation of Minnesota Youth Rugby as well as many people involved in the game.

At the time of this study there were numbers suggesting that rugby was on the rise, but participation rates were still nowhere near mainstream sports; most kids still did not grow up immersed in the sport, and the US National teams were still nowhere near dominant internationally (The Economist. 2011). No single study had looked at how to move the sport back into the mainstream. While conducting preliminary research and interviews, a commonly agreed upon notion – that rugby was on the verge of taking off in the United States – was seen (Doreau.

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2010.). On the ground, at the local level, there was a lot of hope but also a lot of uncertainty as to how rugby should proceed. It was clear that organizers did not know why rugby was in the position it was while other sports were more popular, and there was no previous research to look to.

The overarching question which needed to be answered was "How can rugby be grown effectively in the United States given the current obstacles faced by the sport?" It became clear that to answer this question research first needed to show why rugby was in the position it was; this study looked to answer that question, and in doing so lay the foundation for future survey and focus group data. The research question for this study therefore was simply "Why is rugby not a bigger sport than it is in the United States?"

When talking to those within rugby both at the national level (USA Rugby), and the local (Minnesota Youth Rugby), people identified soccer's rise as the model they wanted to emulate, but no clear picture of what that really meant was available. They also looked at American Football as the gold standard for what a full contact sport in the U.S. could achieve. In fact the histories of rugby, soccer and football within the United States were so closely linked at their start that it would be irresponsible to talk about one without also explaining the other. In addition because so much of their histories ran parallel, many variables – for instance location and time period – were controlled for by default. Unfortunately no definitive synthesis of this shared history with in the US existed. There was no single timeline or historical analysis to look to. This study looked to fill that void.

This study took the form of an extended literature review and comparative historical analysis. The majority of data was collected through document analysis. Additionally interviews were used to direct research and to clarify findings. The historical analysis looked to clarify why the three sports were where they found themselves at the time of the study. It then looked to identify what mechanisms caused these outcomes. Three of John Stuart Mill's five "Methods of Experimental Inquiry" (Sion. 2005. p. 1) were used as the theoretical framework of this study. Because his Method of Agreement, Method of Difference and Joint Method are all related, but used for slightly different situations, it made sense to use all three.

Data was gathered from previous literature, to create a

detailed timeline of all three sports, and when possible the causes of their ups and downs were identified. Additionally moments when two sports histories paralleled each other were highlighted, this proved to be particularly key in using soccer as a model for rugby. Key elements of the US population as consumers of sports (both as participants and as spectators) were then identified in order to better understand what obstacles needed to be overcome. Key contemporary data on all three sports as well as on international rugby was then used to identify where rugby needs to get to be a global and domestic competitor. Because historical accuracy is not always a priority in sports reporting, everything that could be cross checked was, and firsthand accounts, photographs and video footage were used whenever possible.

Extended Literature Review and Historical Analysis

For an overview of the history of rugby, in the US, internationally, and its interaction with soccer and football, please see the timeline section below. According to the BBC article by Geoghegan (2011), after conducting a survey on sporting participation of 120 different sports, the Sporting Goods Manufacturers' Association found that rugby (as of 2010) was the fastest growing sport in the US. The number of people playing in the US grew from 617,000 in 2008 to 750,000 in 2009 and to 1.13million in 2010 (p. 1). Nearly a 200% increase. But as Chadwick, Semens, Schwarz, & Zhang (2010, March) show, those numbers were still too low for the US to be competitive on the international stage. Soccer boasted the 3rd most participants for a team sport with 13.7 million outdoor players and 4.9 million indoor within the U.S. Combined in 2012, these numbers put the sport behind basketball (24.0 million players) and baseball (13.8 million players), and ahead of Football (according to the Sporting Goods Manufacturers Association. 2010).

Rugby, soccer and football's early histories are confusing and muddy. While all three sports eventually became distinct in the US there are many events which all three claim in their early histories as their own; a fact which points to their early shared origins and blurred distinctions as the three sports came into their own in the US. In fact, almost every historical sporting event from the 1800s is claimed by more than one sport. As the historical and contemporary analysis was conducted, some key

points about the U.S. Market (both in terms of consumers and competitors) became prominent.

The point that American Football probably could not have developed anywhere else in the world the way it did here was prevalent in the literature. The US at the time was connected enough to the rest of the world for soccer and rugby to make their way here, but was isolated enough that it was not bound to keep rules as they were in Europe. Two phrases were used often in various books and articles to describe the United States; one was insular and the other referred to American exceptionalism.

Andy Markowitz explained that "America's sports exceptionalism, we submit, remains inextricably linked to the other exceptionalisms that have rendered American politics, American social relations, and American culture so similar and yet at the same time so different from other comparable phenomena, particularly in Europe…" (qtd. in Goldblatt. p. 96.). This phrase was also found being used to describe the peculiar fact that women's soccer in the U.S. has often surpassed men's in terms of popularity (Hong & Mangan. p. 14). A fact most often attributed to the incredible success of the women's national team, and the publicity that followed. The other phrase "insular" refers to the fact that Americans tend to prefer to keep to themselves; and to be able to do what they want independently of the rest of the world. As author David Wangerin says "To many Americans the United States is the greatest sports nation on earth. To many elsewhere it is merely the most insular" (Wangerin. p.15.).

If rugby's organizers want to grow the sport within the Unites States – it needs to be sold as an American sport, not as a foreign interest. The sport's past within the US needs to be used. There has been an attempt to emphasize that the US is the defending Olympic champions; the US won in 1920 and 1924, and rugby has not been in the Olympics since, however it will return in 2016 with the 7 a side version (A Giant Awakens). But that's not enough. As seen in the timeline below, Americans were actually big innovators of early rugby. The first rugby game played in American counted touchdowns as scores while the rest of the world (outside of Canada) was still only counting them as a try at goal. Americans were the ones who introduced numerical scoring to the game of rugby in 1883. And it was thanks to future football legend Walter Camp (Danzig. 1956.). The rest of

the world would not catch onto using numbers for three years (Waves Falcons Rugby Club. p. 1.). Football has the advantage of having been developed here, along American lines, and just as our nation was coming into its own. As Danzig says "It is interesting to note that the progress of football paralleled the growth of our great country" (P. vi). This is a very distinct advantage, but there are ways for rugby's past to be tapped into.

Another aspect of the American market that needs to be addressed is the love of things combative and "extreme" as spectators, and the desire for safety when it comes to playing a sport. Soccer has solved (as far as perceptions go) the player part, and in fact it's "safety" has been a major selling point for generations. In *The Ball is Round*, Wangerin explains why soccer grew the way it did despite there being other options; he points out that it is less expensive, easy to learn, and that "football [soccer] is played more easily and with less danger to the participants on poor quality surfaces" (Wangerin. p. 42). This may go a long way towards explaining soccer's youth boom as well. Soccer is perceived as safe, even though concussion rates among girls were second only to boy's football in 2012 (Huffington Post). On the other side football has been sold as a gladiator sport, and spectators love it. Enjoyment is found in watching gigantic professionals crashing into each other, but football is also under constant attack when it comes to injury rates, particularly when it comes to youth concussions.

The question of how rugby should be presented (extreme or safety conscious) will require follow-up survey data and unfortunately is beyond the scope of this study to accurately answer. What is clear from looking at football is that just as important as the actual statistics – is the spin that can be put on it. While football continues to be number one when it comes to concussions among youth, the NFL has made a few subtle, but highly publicized changes to their rules (NFL.com. p.1.). Most of these are designed to limit helmet to helmet contact, and to create return to play protocol (something the International Rugby Board already has). In an interview with a recent high school graduate who played football, it became clear to me that those high level changes had had very little impact on the ground where he said it remained "do what needs to be done to get the job done, body be damned" (C. McVey, personal communication, June 22, 2012). Parents still feel better because

of the steps that are being taken.

Rugby is perceived in the US as less "tough" than American football but also too dangerous because of the lack of padding. The lack of padding may actually make the game safer (Triad Youth Rugby Association. p. 1.), and internationally it is seen as one of the toughest sports in the world – convincing the US population of one or both of those things will be key, as will be figuring out where to put emphasis. I interviewed a gentleman who ran a number of rugby teams successfully in Canada and he used the phrase "contact versus collision" repeatedly to describe the difference between unpadded contact versus padded collisions. When explaining rugby, many people I interviewed proclaimed "it's like football without the pads" but this statement may do more damage than good. The contact is very different, and so is the game. What is needed is enough publicity that people don't have to explain rugby in the context of football and soccer.

And it is possible to get there; soccer has proved that much. In Soccer in a Football World, Wangerin talks about how soccer fans of his generation can recall "…the ground-breaking broadcast of the 1982 final by ABC where commentary team felt it necessary to explain that Italy's 2-1 lead over West Germany was 'like a score of 14-7 in football'" (Wangerin. p. 6). This is an almost exactly parallel experience to the NBC broadcast of the USA Rugby Sevens Collegiate National Championships in the summer of 2011 where every aspect of the game had to be explained in terms of American Football. It appeared that rugby in 2011 was in a very similar situation to soccer in 1982; and that is important because those 1982 broadcasts were at the start of a US Soccer wave, which saw soccer become a main-stream sport in the United States.

Soccer successfully sold their sport as great for kids, and had a clear pathway for player development – while independently this was not enough to build a successful national men's program, it was enough to build a successful women's program. The US Soccer program reached a pinnacle in 1999 when the women won the World Cup, at home, in front of record numbers of spectators – inspiring droves of young women to pick up soccer. Many successful soccer nations did not have the equivalent of Title IX giving the US Women's team an advantage as they leveraged their youth and college programs to form a

successful team. It took a program of sustained success to get there (that win was FAR from their first success) and it took the media, and public, falling in love with the players, team and the sport. USA Rugby has thus-far been supportive of its women's game, but perhaps not to the extent they could. USA Rugby professionalized their 7s national team in 2012 by extending contracts to 23 athletes… 15 of them men, 7 of them women (Stoney in a New York Times article). While this was a critical move in the advancement of US programs, that gender split was certainly not representative of national team success. And the women's game is a huge part of US rugby. In fact, of the top 10 nations for overall participation numbers, the United States boasts the most female players (Chadwick). The U.S. women are far more competitive than US men internationally and there is a clear model of expansion from soccer showing that a women's national team program can advance a sport.

Rugby can take this same pathway. Youth programs, emphasis on safety, clear player development, support and media attention for the women's game… Rugby needs to do all of the above if it wants to follow soccer's path. Rugby may also be able to leverage its "character building" characteristics to parents which historically helps draw boys and young men to a sport, something soccer has struggled with. According to Wangerin in the 1890s "Masculine Christianity helped make rugged, combative games accepted in higher education, where the 'extracurricular' was emerging as a feature of campus life and where 'character' needed to be 'instilled' (p.19), and the idea that sports make people better has continued for both genders. Rugby can tap into this; it is a full contact sport with a huge emphasis on sportsmanship and respect. It's a sport where, by convention, only the team captain may speak to the referee in a match; there is no back talking, no disputing plays. It is a game where it is customary to cheer the other team at the end of a match, where hugs are the norm after games, and referees are thanked regardless of how they performed. Rugby needs to make itself more known in this respect, and it needs to maintain its character as it expands.

Participation is the key to international success. In a Master Card sponsored report on emerging markets the Master Card Press Release states "though a number of other factors are important, if countries are to improve their playing quality they

need to increase participation" (p.1.). Currently in the US there is an emphasis being put on attracting cross over athletes – those people with incredible athletic ability, but no idea of how to play rugby – of course if those same people had grown up playing they would be far better. We also know from soccer that international success breeds participation. Effective planning and use of resources at all levels of the game is going to be the only way to jump start this system.

Conclusion and Results

Rugby is at a critical point in the US – it could become huge, or it could dwindle; rugby organizing bodies (local and national) need to do the research now, create an effective plan, and follow through with it. The pieces are all there already. An emphasis needs to be placed on national teams, on domestic history, on youth, on women, and on building up for the 2016 Olympics. If rugby is going to be sold effectively in the US it is going to do so by convincing people that it is not a foreign invader, but by giving them ownership of its history. It needs to be promoted as an extreme and entertaining spectator sport that is also as safe, if not safer that, other sports that people already accept the risk of playing. Rugby's best players need to be built into stars. It may be hard to build international super stars when players pick it up late, but there are some amazingly talented athletes in the U.S. who are worthy of kids hanging their posters in their bed rooms.

At the same time rugby's youth programs need to be grown. Whatever changes take place in the US, the spirit of the game needs to be maintained and its appealing characteristics need to be effectively sold to the public. One of the characteristics that should be emphasized is the fact the women and men play exactly the same game with no variation. It is the only contact team sport available to girls in High School, and the only NCAA approved contact team sport for women in college. The women's game has the numbers, and the talent, now they need the support. This all comes down to money and planning. Effective use of resources could lead to more participants, exposure and eventually more money.

Timeline of Key Events

** denotes international events*

1860 to 1870 - Widely varied rules but soccer/football/rugby

popular in US
Rules varied widely, but some variation of football/rugby/soccer was popular on campuses across the US. Depending on the campus the games would resemble one more than the other, but usually some mix thereof was played.
Author's note: differentiation between the three sports extremely difficult for any one event at this point in history. (Wangerin. p. 20).

1862 - First organized team in America

The Oneida club (which played the "Boston game") was the first organized team.
They played a version of soccer (with rugby and football thrown in), you could run with the ball but only when chased. If the chaser gave up, he could yell and the person with the ball had to stop (Wangerin, p. 20).

1869 - Princeton vs. Rutgers soccer game

Credited as being "first football game" in reality it was a soccer match. The ball is currently housed in the US Soccer Hall of Fame. (Wangerin. p. 20).

1874 - Harvard Switches to Rugby

After win over McGrill University (Canada) in one game of rugby, and one of the "Boston Game" Harvard switches their major sport to rugby (Wangerin. p. 20).

1874* - RFU Introduces Umpires

The Rugby Football Union formally introduced umpires into the laws of the union. But theses umpires had little power, and the law re-affirmed captains as the "sole arbiters" of disputes (Richards. p. 64).

1875 - Touch downs (tries) counted in Harvard vs McGrill rugby game

McGrill (Montreal, Canada) vs Harvard. Played by Canadian rugby rules where touchdowns counted, as opposed to most of the rest of the world where they were just a try at goal (Danzig. p. 9).

1875 - Yale drops soccer goes to rugby

Harvard plays Yale in rugby match. Yale drops soccer and goes to rugby (Wangerin. P. 21).

1876 - IFA picks Rugby over Soccer, count tries

Harvard, Yale, Princeton, and Columbia form the Intercollegiate Football Association (IFA). At this point they were all playing various versions of the sport – making intercollegiate

competition difficult. They held a convention where colleges had to pick which rules they would play by rugby or soccer; schools chose rugby and made the decision to count touchdowns (tries) for points. 15 players per side, 45min halves (Danzig. p. 10. Wangerin. P. 22).

1876* - Tries counted when goals were even

Before 1876, international rugby was won based on the number of goals (kicks) scored. In 1876, tries were counted in cases where teams scored the same number of goals. Numerical points were still not used (Farmer. Np.).

1885* - Referees Introduced

Umpires (who had little power) were kept, but moved to the touch lines to become touch judges. And a referee was added. (Richards. p. 64).

1886* - IRB Formed

International Rugby Board is formed. But England refuses to join. (Richards. p. 63).

1888* - Points System Accepted by the IRB

IRB (International Rugby Board) accepts the RFU (Rugby Football Union)'s laws in exchange for England joining the IRB, including penalty goals, and points for tries and goals – although the numerical value was still in flux (Richards. p. 64).

1889* - Referees gain ability to send players off.

Referees could now send offending players off the field. But captains still have major powers in disputes (Richards. p. 63).

1890 to1910 - Era of immigrant driven soccer

Almost all soccer in the US was driven by immigrants (Goldblatt. p. 98).

1893* - Point values stabilized

3 points for a try, 2 points for a conversion, 3 points for a penalty goal, and 4 points for a drop goal become standard (rugbyfootballhistory.com).

1894 - Football immerging

By this time there had been enough changes made to Rugby by Walter Camp and other Americans that the Manchester Guardian said that Americans had "spoiled and brutalized" rugby. (Wangerin. p. 23).

1894 - 1st professional soccer league

1st professional soccer league formed, league was ill fated (Goldblatt. p. 98).

1904 - 21 dead from Football

The NY Times reported 21 deaths and 200 injuries from Football (Wangerin. p. 23).

1904 - Soccer creeps back onto college campuses

Harvard plays Haverford in two games of soccer, as soccer creeps back onto college campuses (Wangerin. p. 24).

1904 - US Plays unofficial exhibition game at the Olympics

The US played an unofficial soccer tournament at the Olympics in St Louis (Goldblatt. p. 99).

1905 - NCAA Formed

After Roosevelt's concern over football, National Collegiate Athletics Association is formed. Drastic rule changes follow (Wangerin. p. 26).

1905 - Return to rugby, football too dangerous (Roosevelt)

After a number of deaths, President Roosevelt steps in says Football is too dangerous. Cal and Stanford go back to rugby (Richards. p. 25).

1905 - West coast goes back to rugby

Following Roosevelt's urging of safer rules and play for football, the major west coast universities switch back to rugby. Cal University made the switch, and began their incredible rugby history (Wangerin. p. 23).

1906 - IFA allows the forward pass

The IFA (Intercollegiate Football Association) allows the forward pass in an attempt to decrease injuries. A major victory for Walter Camp (Richards. P. 26).

1906 - Stanford and Cal return to Football

Soon after NCAA rule changes, Stanford and Cal drop rugby and return to Football (Wangerin. p. 25).

1906 - Increasing interest in international soccer competition

Pilgrim Football (Soccer) Club tours U.S., draws large crowds, and gains fans by showing what Soccer could be.

This, plus the addition of Soccer as a medal sport for the 1908 Olympics led to an increase in interest in soccer, and especially in international competition (Wangerin. p. 25).

1912 - Two major governing bodies merge, join FIFA

The two major organizing bodies in the US merge and join FIFA (Goldblatt. p. 99).

1915 - Columbia Drops Rugby

Columbia University drops rugby, returns to American Football (Wangerin. p. 25).

1918 - Soccer, only 12 colleges play each other

By 1918, only 12 colleges played soccer against each other, all were on the east coast (Wangerin. p. 26).

1921 to 1933 - American Soccer League

American Soccer League forms. Makes it for 12 years. "Golden age" of American soccer (Goldblatt. p. 99).

1922 - 1st tour by a women's team (soccer)

Dick Kerr's Ladies were the first women's team to tour (of any sport – but they played soccer) (Goldblatt. p. 100).

1925 - 46,000 fans at a single soccer game

46,000 fans attend a single soccer game; numbers that wouldn't be matched for a long time (Goldblatt. p. 100).

1925 - Soccer: media coverage, fans, players at high point

Good press coverage and media interest, radio was being used to broadcast games, league were attracting players from Europe (Goldblatt. p. 99.).

1929 - Wall Street crashes.

1930 - US Makes semifinals of world cup (Soccer)

The USA (men) made it to the semi-finals of the World Cup in Uruguay (Goldblatt. p. 99).

1937 - Leagues crash, no college game to fall back on

Soccer leagues had all gone under, and the lack of a college game became detrimental. Soccer dwindled (Goldblatt. p. 100).

1950 - Soccer: US Beats England, unnoticed event in US

The US Men's Soccer team beat England at the World Cup in Brazil. Win was nearly unnoticed at home where soccer interest was nearly none (Goldblatt. p. 100).

1966 - Soccer: ABC airs World Cup

ABC Airs Men's World Cup. Some US interest (Goldblatt. p. 101).

1984 - Rise of indoor soccer

Indoor soccer on the rise. Also the year the NASL went under (Goldblatt. p. 782).

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The Federal Funds Rate and Unemployment Relationship: Does Business Confidence Matter?

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Abstract

Following the 2008 financial crisis, the United States' economy went into one of the most severe recessions since the Great Depression. In an attempt to stimulate the economy, the Federal Reserve lowered the federal funds rate to near zero in 2008. The unemployment decrease is not as large or fast as many had hoped, spurring much debate on whether business confidence may play a role in the federal funds rate's inability to affect the unemployment rate. It was hypothesized that high levels of economic policy uncertainty and low levels of business confidence negatively affect the unemployment rate. Using a regression analysis, results indicate that a negative contemporaneous relation exists between the federal funds rate and unemployment. Given the long term positive relationship between the federal funds rate and unemployment, lowering the federal funds rate should have brought down the unemployment rate, but that hasn't happened. The persistently high unemployment exists because the low level of business confidence is deterring businesses from hiring in the face of economic policy uncertainty despite the incentive of a low interest rate's incentive to do so.

Keywords: Federal funds rate; unemployment rate; business confidence

Introduction

Following the 2008 financial crisis, the United States' economy went into a deep recession with a peak unemployment rate around 10% during the summer of 2009. To stimulate the economy, the Federal Reserve lowered the federal funds rate to near zero shortly after the crisis broke. Historically, when there

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was an increase in unemployment, the Federal Reserve would lower the current federal funds rate to help lower the future unemployment rate. The logic behind this decision is simple: a lower interest rate incentivizes businesses to borrow more for investment to produce capital, ultimately leading to a higher demand for labor and a lower unemployment rate (Gavin, 2013). Modeste and Mustafa (2011) found a significant long-term relation between the federal funds rate and unemployment both with the Engle-Granger ADF test and the Johansen-Juselius cointegration; To test the long-run relationship between the federal funds rate and unemployment, Modeste and Mustafa (2011) used both the Engle-Granger ADF test and the Johansen-Juselius cointegration, they found a significant cointegration relation; also that one percent change in the federal funds rate results in a three-tenths of a percent change in the unemployment rate in the same direction. Given this relationship between the two variables, lowering the federal funds rate should have produced a larger reduction in the unemployment rate, but the unemployment rate remains high despite a federal funds rate frozen close to zero.

The ineffectiveness of the federal funds rate in lowering the unemployment rate has sparked debate surrounding the role that economic uncertainty and business confidence may play. Economic uncertainty has been pinpointed as a major factor that exacerbated the latest recession, but uncertainty usually increases during recessions. The difference is that the increase in uncertainty during the Great Recession was much greater than the normal expected increase and led to an increase between one and two percentage points in the unemployment rate (Leduc & Lui, 2012). Uncertainty is able to influence the unemployment rate because it makes businesses more cautious and reluctant to invest when uncertainty is high.

This paper's focus was on the role of economic uncertainty and business confidence in the relationship between the federal funds rate and unemployment. With a federal funds rate frozen close to zero and an unemployment rate still high above the natural rate of unemployment[†] , this is a relevant topic not only to the understanding of current economic conditions, but also policy matters concerning a way to correct for them. A multiple-regression analysis was used to analyze data concerning the federal funds rate, unemployment and business confidence to

[1] *In the United States, the natural rate of unemployment is between 4 to 6 percent.*

establish any relationship between the variables.

Literature Review

The lowering of the federal funds rate was not the only action taken by the Federal Reserve to help stimulate the economy. In what is known as Quantitative Easing, the Federal Reserve also started buying long term US bonds (Krugman, 2013). The Federal Reserve has continued to pump $85 billion a month into the economy and will continue to do so until target unemployment is reached. Despite the lowering of the federal funds rate and the monthly stimulus, unemployment isn't responding as quickly or dramatically as expected. Although the desired results haven't been obtained yet, there appears to be no indication that either action is likely to be reversed anytime soon. This creates a certain amount of anxiety within the business community since a high persistence of unemployment supports the continuation of stimulus packages during recession recovery beyond pre-crisis output levels (Calvo, Coricelli, & Ottonello, 2012). A stimulus is only intended to help a country rebound from low crisis output levels to those from before the crisis. With the exception of unemployment, the recovery from the Great Recession looks fairly normal: profits, productivity and GDP, gross domestic product, have all risen.

Unemployment is the lasting effect from the Great Recession in an otherwise normal recovery. Unemployment peaked at 10% in 2009, but has since gone down to 7.0%, as of the latest data released on Friday December 6, 2013. Although this looks like progress, Krugman (2013) warns that these numbers may be deceiving, especially since he believes that the majority of this decrease results from discouraged workers. He warns that to obtain target unemployment numbers, we may have to cover a lot more ground than anticipated as workers who left the labor force in 2007 are likely to reenter the workforce at some point. Whether or not the unofficial unemployment rate is completely representative of the unemployment reduction task at hand, the slow progress we are experiencing isn't typical. Following a normal recession, employment numbers are just three or four months behind the business cycle recovery, but we are currently years behind (Freeman & Rogers, 2005). Despite the Federal Reserve's use of conventional and unconventional tools of monetary policy, we still have a high unemployment rate,

leading many to seek another explanation. Uncertainty has been emphasized as a key driving factor in the 2007-2009 recession according to the Federal Open Market Committee minutes (Bloom et al., 2012). It appears that economic policy uncertainty deters businesses from investing despite the incentive from low federal funds rate to do so.

The unusually high levels of economic uncertainty also influence business confidence, another keyword in explaining the slow movement of the unemployment rate. The expectation of profits is one of the deciding factors when it comes to investment decisions for a firm according to Keynes (Gelissen, 2010). If firms are uncertain what to expect for profits or from the economy in general, their confidence would decrease. When firms are being presented with great uncertainty, many are choosing the more conservative option and delaying investment. In her Washington Post article, Ghei (2012) presented the report by investment bank Credit Suisse that almost a third of businesses were delaying investing in planned projects because of economic uncertainty. Current Federal Reserve chairman Ben Bernanke, in 1993, indicated that if firms are reluctant to invest, an economy can slow down (as cited in Sum, 2013). This currently appears the case, as economic uncertainty has increased, business confidence has decreased just like the amount of investments have, which in turn has led to fewer job creations.

The unemployment rate hasn't been decreasing as quickly as expected, and low business confidence as a culprit is not a novel idea. Bernanke (2010) reflected on the beginning of a recovery from the recession based on restored business confidence, represented by stabilized demand, increases in production and slower inventory liquidations. He asserted that expansion is dependent on the expectations of future demand increases, not financing costs. This appears to be true following the Great Recession. The Federal Reserve lowered the federal funds rate to make it cheaper for businesses to finance expansion projects. Under circumstances with high confidence in future demand, firms would have quickly seized the opportunity to expand; under circumstances with lower confidence in future demand firms are more hesitant about expansion. Bernanke explained that firms have been reluctant to expand, or add permanent employees, because of elevated economic uncertainty. This brings the argument full circle. Firms, faced with elevated

economic uncertainty, have low confidence in future demand thus deterring expansion projects despite the tempting financing options presented by a low federal funds rate.

Prior research has established the ability of the federal funds rate to influence future employment. Research has also looked at the impact of uncertainty on the unemployment rate. This study's contribution is to show the role that business confidence plays on the federal funds rate's ability to influence future unemployment. It was hypothesized that low levels of business confidence would lessen the federal funds rate's influence on the unemployment rate. Similarly, high levels of business confidence would strengthen the federal funds rate's ability to influence the unemployment rate.

Data

The majority of the data used in this research was compiled from an array of electronically published data sets. One of the major contributing sources of data was the Federal Reserve Bank of Saint Louis which provided employment and federal funds rate data. The Organization for Economic Cooperation and Development database was used to establish Business Confidence data. Macroeconomic uncertainty data was derived from the Economic Uncertainty Index used in Baker, Bloom and Davis (2013). Monthly data between the years 1960 and 2013 was used in the analysis. The descriptive statistics of the data set are shown in table 1.

Table 1

Descriptive Statistics

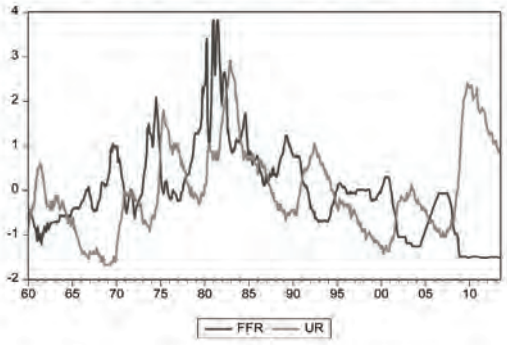
Variables	Mean	Std. Dev.	Observations
Federal Funds Rate	4.1926	2.7066	343
Business Confidence	99.7703	1.0513	343
Economic Policy Uncertainty	107.5665	32.8409	343
Unemployment Rate	6.1303	1.5095	343
Employment Population Ratio	61.9667	1.7542	343
Inflation	2.8309	1.1059	343

The federal funds rate is the interest rate at which depository institutions lend reserves to one another overnight. The variable Business Confidence indicates how managers feel about their

companies' prospects given the outlook of the overall economy. The index is centered around the value "100", representing the long term average. A value of less than this indicates higher pessimism, while a value greater than 100 indicates optimism.A similar measure is economic policy uncertainty, defined as periods of time where uncertainty surrounds future government policy. Both business confidence and economic policy uncertainty measure similar variables. Low business confidence is positively correlated with high economic policy uncertainty. The unemployment rate is the ratio of unemployed workers to the labor force at any given point in time. The unemployment rate doesn't account for discouraged workers, thus is arguably not always the best measure of joblessness in the economy. To accommodate for this weakness, the employment population ratio, or ratio of employed workers to the total working age population, was also considered in the regression. Inflation measures the increases in the general price level within an economy.

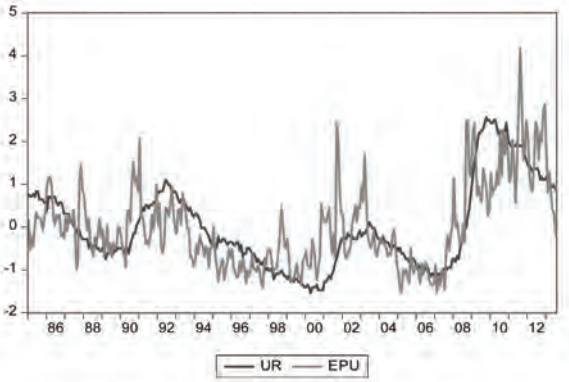
The unemployment rate and federals funds rate have a negative contemporaneous relationship as shown in figure 1. When the unemployment rate is at its highest, we expect the federal funds rate to be at its lowest. It is not uncommon to see a lower federal funds rate in a weak economy. The limitation to this graph is that it only shows the present relationship between the two variables, not taking into account any lagged effects. The graph is unable to capture the influence of the current federal funds rate on future unemployment. The analysis was able to accommodate for this type of relationship however by using a lagged federal funds rate.

Figure 1. The Contemporaneous Relationship between the Federal Funds Rate and the Unemployment Rate. This figure illustrates the negative contemporaneous linear relationship.



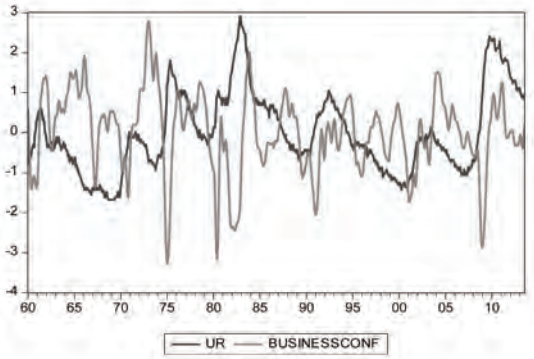
The main purpose of this paper was to look at the role of business confidence and economic uncertainty played on the relationship between the federal funds rate and the unemployment rate. High economic policy uncertainty leads to lower business confidence. For the sake of simplicity, business confidence was used in the regression analysis to account for business sentiment. However, the relationship between economic uncertainty and the unemployment rate is shown in figure 2.

Figure 2. The Contemporaneous Relationship between Unemployment and Economic Policy Uncertainty. This figure illustrates the positive contemporaneous linear relationship between the variables.



These two variables have a strong positive relationship: normally when uncertainty increases, there is also an increase in the unemployment rate, except during 2008-2010. When there is a high level of economic uncertainty, firms don't know what to expect from the future and as a result are faced with layoffs or are hesitant to hire new positions. Business confidence moves in the opposite direction of the unemployment rate, as demonstrated in figure 3. When business confidence is high the unemployment rate is low; firms are more confident about the economic conditions of the future and are willing to hire new employees. On the other hand, when business confidence is low the unemployment rate is high because of their negative relationship.

Figure 3. The Relationship between Unemployment and Business Confidence. This figure illustrates the negative contemporaneous linear relationship between the two variables.



Methodology

In order to investigate the relationship between unemployment rate, federal funds rate and business confidence, the regression equation below (equation 1) was estimated using an ordinary least square method. Since the time series variables used are not stationary, the first difference was used to correct for possible autocorrelation. It is also assumed that the explanatory variables are exogenous.

$$\Delta UR_t = \beta_0 + \beta_1 \Delta FFR_t + \beta_2 \Delta FFr_{t-4} + \beta_3 \Delta BC_t + \beta_4 \Delta (BC * FFR)_{t-4} + \beta_4 \Delta Infl_t + {}_{Et} \quad (1)$$

In the above equation a change in an unemployment rate at a time t is represented by ΔUR_t. The changes in federal funds rate and business confidence are denoted by ΔFFR_t and ΔBC_t respectively. A four month lagged value was also included since it takes some time for policy measures to affect the unemployment rate. Moreover, the interaction term, $\Delta (BC * FFR)_{t-4}$ was included to see how the federal funds rate changed for a given level of business confidence.

It was expected that federal funds rate and unemployment would be contemporaneously negatively related (i. e β_1 is expected to be negative). In other words, a period of low unemployment is associated with high level of federal funds rate. However, past federal funds rate is positively associated with the current level of unemployment rate (i.e. β_2 is expected

to be positive). I also expect that business confidence is negatively associated with unemployment rate ($ß_3$ is expected to be positive). We expect a negative relationship between unemployment and inflation as suggested by the Phillips curve.

Results

To test the hypothesis that the change in the unemployment rate is a function of a federal funds rate, business confidence, a business confidence and federal funds rate interaction, and the inflation rate, a least squares regression analysis was performed. Regression coefficients are shown in table 2.

Table 2 Regression Output (Dependent variable: Unemployment Rate)

Variables	Coefficients
Constant	0.0033 (0.0066)
ΔFFR_t	-0.0603*** (0.01247)
ΔFFR_{t-4}	1.3371*** (0.2651)
ΔBC_t	-0.1246*** (0.0230)
$\Delta(BC * FFR)_{t-4}$	-0.0139*** (0.0027)
$\Delta infl$	-0.0529* (0.0256)
R-squared	0.1258

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

Each of the predictor variables had a strong significant ($p<0.0001$) relationship with the unemployment rate with the exception of inflation whose relationship was not as strong but still significant ($p<0.05$). As predicted, there exists a negative relationship between the federal funds rate and unemployment rate ($ß_1 = -0.0603$). While they have a negative contemporaneous relationship, there exists a positive relationship between the unemployment rate and the lagged federal funds rate ($ß_2 = 1.3371$). The third prediction was also confirmed, a negative association exists between business confidence and the unemployment rate ($ß_3 = -0.1246$). This model was able to explain 12% of the variability in the unemployment rate ($R^2 = 0.1258$, $F=19.3363$, $p<0.001$).

The same regression was run using the employment

population ratio in lieu of the unemployment rate to accommodate for the discussed flaw in in the unemployment rate statistics. The results of the least squares regression using the employment population ratio is shown in table 3.

Table 3 Regression Output (Dependent variable: Employment Population Ratio)

Variables	Coefficients
Constant	0.0040 (0.0065)
ΔFFR_t	0.0439*** (0.0123)
ΔFFR_{t-4}	-0.9870*** (0.2651)
ΔBC_t	0.0584* (0.0227)
$\Delta(BC * FFR)_{t-4}$	0.0104*** (0.0026)
$\Delta infl$	0.0157 (0.0252)
R-squared	0.0609

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

Similar significant results were found using this measure of employment. The federal funds rate, lagged federal funds rate, and the federal funds rate and business confidence interaction were all still highly significant ($p<0.001$). Business confidence was also significant ($p<0.05$). The second model indicates that 6% of the variability in the employment population ratio is explained by changes in the explanatory variable ($R^2=0.0609$, $F=9.2557$, $p<0.001$).

Discussion

Historically a change in the federal funds rate was able to influence future employment in the same direction. Following the Great Recession, there hasn't been as significant decrease in the employment rate from the dramatic lowering of the federal funds rate as was expected. In this research, it was hypothesized that low levels of business confidence were deterring firms from expansion and hiring for permanent positions despite the low federal funds rate's incentive to do so.

The least squares regression analysis results confirmed my hypothesis. There is a significant relationship between business confidence and the federal funds rate's ability to impact future unemployment. Today's federal funds rate isn't intended to

influence today's unemployment rate but that of tomorrow, hence a negative contemporaneous relationship ($ß_1$ = -0.0603). When the federal funds rate is low, the unemployment rate is high, and vice versa. While this relationship is significant, it produces a small coefficient; that is, the change in the unemployment rate as a result of a change in the federal funds rate in the same period is limited. Today's federal funds rate is intended to influence future unemployment, as demonstrated by the lagged federal funds rate ($ß_2$ = 1.3371). A low federal funds rate today will result in a lower unemployment rate in the future because of the time delay of policy action. The lagged federal funds rate produces a much larger coefficient than the current federal funds rate, thus a change in the federal funds rate will have a larger impact on future unemployment than current unemployment.

The unemployment rate doesn't always respond has predicted however, and business confidence has been used to explain these variations. Business confidence and the unemployment rate have a negative relationship ($ß_3$ = -0.1246). When business confidence levels are low, we expect to see high unemployment; when business confidence levels are high, we expect to see low unemployment. The interesting result is what happens as a result of the interaction between business confidence and a lagged federal funds rate ($ß_4$ = -0.0139). Given the negative relationship between these variables, when business confidence and the federal funds rate increase, we expect that the unemployment rate will decrease slightly. Similarly, when business confidence and the federal funds rate decrease, we expect the unemployment rate to increase slightly.

Following the Great Recession, the decrease in the federal funds rate should have brought down the unemployment rate, holding all other factors constant. When business confidence isn't held constant, but is allowed to fluctuate, we see a different result. The decrease in the federal funds rate in the presence of low business confidence actually raised the unemployment rate slightly instead of lowering it. This is consistent with the slight increase in the unemployment rate that was found by Leduc and Lui (2012). So not only was this policy action ineffective in lowering the unemployment rate, but it actually worsened the situation. The same relationship exists when the employment population ratio is used in lieu of the unemployment rate.

The interaction between business confidence and the federal funds rate has a statistically positive impact on the employment population ratio ($ß_4 = 0.0104$), indicating that a decrease in business confidence and federal funds rate will result in a slight decrease in the employment population ratio. A lower federal funds rate is intended to raise the employment population ratio, but when done in the presence of low business confidence, it actually results in a decrease instead of an increase in employment.

Recent literature has looked into why this occurs. Leduc and Lui (2013) have demonstrated through their actual and fitted Beveridge curve that for a given level of job openings we are currently experiencing a higher level of unemployment than we traditionally would have. They suggest that under conditions of higher economic policy uncertainty that firms are reducing their recruitment efforts. This is consistent with the findings from this research: when companies are more pessimistic about their prospects, they are more reluctant to hire. This is why the unemployment rate remains stubbornly high despite everything that the Federal Reserve has done, through both conventional and unconventional monetary tools.

A better understanding of this relationship will allow for more accurate predictions of future unemployment rates. Instead of strictly looking at how a change in the federal funds rate will affect the unemployment rate, business confidence can be taken into consideration as to how it will strengthen or lessen the change in unemployment. Specifically, it can be used to explain the slow reduction in the unemployment rate following the Great Recession. The low levels of confidence are inhibiting the federal funds rate's ability to lower future unemployment rate, and are actually causing it to rise slightly. This demonstrates business confidence's ability to hinder progress in lowering the unemployment rate when the federal funds rate is targeting unemployment. This is not always the case; sometimes the federal funds rate is used to control inflation. Under these circumstances, we expect business confidence to be high since the economy is doing well. As the federal funds rate increases to influence inflation, we expect to see an increase in the unemployment rate only considering the relationship between business confidence and the unemployment rate. When this increase occurs in the presence of high business confidence,

we actually expect to see a decrease in unemployment not an increase. In this situation, business confidence actually helps maintain a lower unemployment rate.

While the results of this study provide valuable information regarding business confidence's influence on unemployment, there are also limitations to the study. Within the study all of the predicting variables had to be assumed as exogenous variables coming from outside the model. This is not necessarily true in the real economy. Just as the current federal funds rate is able to influence future unemployment, the current unemployment rate also influences the future federal funds rate. This relationship was not taken into account using this model. There is also a bi-directional relationship between business confidence and the unemployment rate, but this wasn't accounted for in the model either. Future studies may loosen the assumptions in this model to accommodate for these directional relationships.

Conclusion

After the financial crisis and onset of the Great Recession, one of the ways the Federal Reserve attempted to lower the unemployment rate was by drastically lowering the federal funds rate, which is actually one of the conventional tools of monetary policy. Given the positive relationship between the federal funds rate and unemployment rate, it was expected that the decrease in the federal funds rate would produce a reduction in the unemployment rate. This was not the case however, and this paper looked at the role business confidence may have played. It was hypothesized that low levels of business confidence would hinder the ability of the federal funds rate to lower unemployment. The results confirmed this hypothesis. The interaction term between the federal funds rate and business confidence has a negative relationship with the unemployment rate, indicating that a decrease in business confidence and the federal funds rate would actually produce an increase in the unemployment rate. While the goal of lowering unemployment was meant to be achieved by lowering the federal funds rate, its decrease in the presence of low business confidence actually led to an increase in the unemployment rate. This seemingly startling result is confirmed by the second specification model where the employment ratio was used in lieu of the unemployment rate. The ineffectiveness of using the federal funds rate to stimulate the economy during

the Great Recession has led the Federal Reserve to experiment with the nonconventional monetary policy tools such as the Quantitative Easing and Term Auction Facility. The findings of this paper highlight the limit of using conventional monetary policy when business confidence is low. A better understanding of this interaction and its implications will help direct future policy and predictions about changes in the federal funds rate.

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Fractured: Perceptions of the Frac Sand Mine Industry in the Chippewa Valley

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Abstract

This project is an attempt to gain a better understanding of public opinions about sand mine expansion in west-central Wisconsin. Opinions on the expansion of mining are mixed, with many stating this expansion is a good thing for Wisconsinites. They claim the mines and processing centers are increasing jobs in the area, which will, in turn, boost the local economies. Others have concerns about the potential environmental impacts of the mining. There are many unanswered questions, however, involving health effects, environmental degradation, and economic usefulness. This project will attempt to gain further statistical knowledge on this topic. We explore three themes that are correlated to environmental and economic issues. They are: Awareness/Education, Opinion, and Involvement. Previous research has shown the importance of the public's opinion of developing environmental concerns, but such research has not been conducted in the context of frac sand mining (Hunter & White, 2009). With all of the controversy behind hydraulic fracturing, frac sand mining remains an understudied topic. This research is an attempt to understand the social, economic, and political dynamics of frac sand mining and how/why it affects local stakeholders.

Keywords: Frac, Sand, Mining, Perceptions, Society, Industry, Public

Introduction/Literature Review

The need for silica sand in the process of natural gas extraction has given rise to a new entity. The frac sand industry of northwestern Wisconsin is now bustling and expanding at a fast pace. Local mediascapes are heading the pro- and anti-mining ideologies in the area. Most bystanders sit by and watch the squabbling between those who are "for" and those "against"

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the frac sand industry. This creates a disjuncture between what a select few and what the public perceives as a local issue. What is the general consensus amongst the population?

The word "environmental" can be construed in a different ways, but two senses of the word predominate. One is an idealized version of the environment which sees it as pure and untouched nature. The other perspective lies in the way that humans act and react to environmental forces. Humans often act upon their surrounding environment for basic needs. For the sake of this discussion, environment will be understood as a product of human interaction with nature. This connection between humanity and ecology is a basic tenet of environmental sociology. This school of thought recognizes the fact that we are a species that has co-evolved and followed the same evolutionary patterns as other species on our planet. However, as a species, humankind has gained the ability to use different cultural establishments to move our species to an apex position (Walker, 2005). Humans have the ability to become extremely innovative and advanced in our thinking patterns. This innovation has provided humankind the ability to act upon its surroundings (Walker, 2005). In the most basic sense, humans have created the idea of environment. It is nearly impossible to talk about the topic of environment without talking about human interaction.

Environmental issues have been central to frac sand mining. From initial surveying, we have found that fugitive silica sand, water sanitation, and dust are the important perceived issues within the Chippewa Valley. Such concerns led the Wisconsin Department of Natural Resources (DNR) to produce a report on silica sand and the health risks. The study stated that the silica dust is a known human carcinogen. Without proper equipment and regulation, this dust travels freely through the air. Crystalline silica particles can then be inhaled and, "engulfed by cells in the lungs called alveolar macrophages." Macrophages are essential in the process of suppressing pathogens in our bodies. Macrophages line the lungs and react to inflammation by producing antibodies to fight foreign bacteria, virus, etc. The DNR study claims, "…silica is toxic to the macrophages, and the silica particles are not soluble, they are not easily cleared from the lung. Particles build up in lung and lymphatic tissues." Furthermore, silica dust provokes inflammation in the lungs, which leads to silicosis (lung fibrosis) and cancer. If the crystalline

silica were to go unmonitored and unregulated, these particles would be free to travel through the air. The most exposed are plant workers and those who live near the sand processing plants and the mines.

The second environmental issue is related to water sanitation and possible pollution. This potential problem originates from information gathered at a 2011 town-hall-style meeting, which the Wisconsin Towns Association sponsored. This open-session meeting generated an assembly of local legislators, Wisconsin DNR representatives, members of the mining industry, and the general public.

The processing plants harbor settling ponds, allowing water used in the washing process to settle out. Any debris collected in this process generally sinks to the bottom. If the ponds are not properly lined, there is a potential issue of acrylamides leaching into groundwater. Acrylamides are used in the process of cleaning silica sand and are a known carcinogen to humans, and without the correct protocols in place, acrylamides could potentially enter the watershed. This could be damaging to society if proper precautions are not taken

Every action has a reaction and human society is so deeply integrated in our ecosystems and environments we start noticing that ecological disturbances lead to social inequalities (Laurent, 2013, pg. 2). Examples in the existing literature help provide evidence to this. The interconnectedness of societal issues and resource mining will be discussed in the next section.

Another concern owing to large scale mining is the issue of population displacement and possible extinction of the surrounding communities. Different countries have different regulations, some being less stringent than others. Abigal Abrash (2001) provides one such case, involving an operation was located in Papua New Guinea. Freeport is an American mining company who wanted to mine the lands of the Amungme and Kamoro people for gold and copper. The inhabitants of this region were diligent laborers who practiced sustainable agriculture. Much of their land held both sacred and ritualistic meanings for daily life. With the aid of the government, Freeport was allowed to mine these native lands. As a result, the Kamoro and Amungme were displaced from their homes and villages. The mining corporation of Freeport almost destroyed the indigenous land, leaving the people with little to survive on

(Abrash, 2001). Not only was the mining process depleting resources for humanity, it was also tainting other essential resources needed for survival. Though this isn't common in the United States, it transpires throughout other regions in the world. Mining practices executed by Freeport almost caused the disappearance of two communities (Abrash, 2001). This example leads us to wonder, what can sand mining do to the future of Wisconsin communities? Of course, different countries have different regulations, some being less stringent than others.

Our literature review highlights previous social and environmental problems stemming from resource mining around the world. From the information gathered, we can understand the extreme positives and negatives of the sand mining industry. Initial interviews has shown us that the general population does not entirely stand for or against the new industry as a whole, but when it comes to specifics, we tend to see changes in this trend. In our research, we noticed a trend of "out of sight, out of mind". We can equate this to Bibb Latane's Social Impact Theory. The theory states that social impact relies on forces that include: the strength of the source, the proximity of the event, and the number of "sources" exerting the pressure (Latane, 1981). Simply stated, the forces and pressures of having sand mines and processing plants within an individual's scope of being, makes them more aware of said mines. Consistent with this theory, we found that individuals who live closer to sand mines or plants will be 79% more likely to be against mining.

A town hall meeting we attended in 2011 provided captivating information. Much like Freeport, the Wisconsin DNR has been helping the frac sand industry grow. Governor Scott Walker's prior state budget plans included the downsizing of DNR staff. To allow sand mine companies to start exploiting silica sand, they need to prospect the land and start mining as soon as possible. The DNR simply does not have enough staff to permit and regulate every mine throughout northwestern Wisconsin. In response to the staffing shortage, they have issued air and water permit waivers. This has allowed mines and processing plants to begin production without initial air and water surveying. However, the DNR fervently stands by its findings that fugitive silica dust is not an issue that the public should worry about.

Ulrich Bach and Anthony Gibbons' risk society theory can help explain part of the trend we are observing towards reduced

regulation. It states that risk is a systematic way of dealing with hazards and insecurities introduced by modernization. Often, people wait for scientists to figure out problems, in regards to environmental issues. This has proven to be quite problematic. People are beginning to question the institutions of modernity because the security they are supposed to provide may fail: 3 Mile Island, Chernobyl, etc. People are reluctant to trust new technologies because of the risks that they may involve (Bach and Gibbons, 1992). With frac sand mining, it is possible that this may lead to an individual's reluctance to trust the scientific data on the topic. As a result, this individual may rely on gathering their own information, which may develop a bias towards a specific side of the debate. As will be addressed in table 2 of the results section, there is a clear difference in an individual's education levels and their perceived knowledge on frac sand mining.

News outlets, forms of social media, and initial canvasing clarified that many proponents believe that a benefit of the frac sand mining industry is the increase in local jobs. Several articles from the Eau Claire Leader-Telegram validate the benefits of the new mining industry. One such headline read, "MR. SANDMAN brings more than a dream" (Marlaire, 2011). Marlaire stated that "MR. SANDMAN" (Frac Sand Industry), "delivers jobs and money to the region, and a host of industries and area residents are expected to benefit financially from the industry." Deeper into this November 6th edition of the Leader-Telegram, Marlaire wrote another story with the headline "Frac sand industry bringing jobs to region" (Marlaire, 2011). The article briefly communicates how the sand mining industry is offering jobs to soon-to-be graduates of the University of Wisconsin-Eau Claire. Indeed, these are good, high paying jobs, but the article tends to only focus on the jobs that are for highly trained "professionals."

In many cases, the frac sand mine debate comes down to job creation versus environmental degradation. Is it possible to achieve job creation and environmental sustainability at the same time, or will these forces always clash? Obach (2002) states that many labor workers are in favor of the environment because it is what provides them with a job. In contrast, Obach states that, often times, environmentalists place the blame on the labor workers and make false claims, stating they hate the

environment, which in most cases, is not true (Obach, 2002). During this time of economic uncertainty, we tend to focus on economic benefit over environmental benefits.

Economic benefit is the main catalyst for this sudden surge of sand mines in Wisconsin. As discussed above, our perceptions of the world as presented to us by mediascapes, such as newspapers, radio, and television tell us that frac sand mining has an economic value. It will create new jobs and stimulate the local economy. Arjun Appadurai's disjuncture theory helps us think about how different "scapes" might drive the frac sand industry. By creating these disjunctures in our society via ideoscapes (international flow of ideologies) and mediascapes the industry also creates deterritorialized areas of the US. These areas are no longer small villages, but the homes to corporate mining operations, where there is a lot to be gained (Appadurai, 2007). We see conflicts between the common idea, presented in the media, that the sand mining industry is beneficial and the views of some of these communities who see what is actually happening to their landscape. To some in these communities, "economic gain" seems to only support powerful entities, such as corporations and special interest groups, who are at the forefront of promoting frac sand mining. Corporations have taken these steps in the context of a movement to lessen our dependence on foreign crude oil and move to local energy sources. This region of the country has large amounts of silica sand, and industry is drawn to extract this natural resource which aids in natural gas removal.

Despite the importance of this issue, previous literature has not addressed public perceptions of frac sand mining and its costs and benefits. Not only has the existing literature not focused on the issue of frac sand mining, it is also lacking in terms of public perceptions from both sides of the debate. By surveying, interviewing, and observing members of the general public, we will be contributing to a greater understanding of the positive and negative perceptions of local impacts of frac sand mining.

Methodology

We conducted an online survey that asked respondents to provide demographic information, to rate their knowledge of global and local news, to rate their knowledge of the frac

sand mining industry, and to state their views on the costs and benefits of the industry. We also provided an open forum for respondents to voice their opinions on the industry. Our sample population included community members 25 years old and older. The reasoning behind choosing this demographic was because we thought that 25 year-olds and up are more instilled in their community. We assume that the majority of this large age group are involved in careers and out of the typical "college age". The university's research clearinghouse provided the emails of all the UW Stout's participants, including faculty, staff, and non-traditional students. In addition, we contacted local media outlets around the Chippewa Valley and asked them to share our survey link with the public.

We also canvased randomly selected neighborhoods in the Chippewa Valley region, as well as high-traffic public areas to find subjects to whom the survey would be administered. We chose this method because we felt we would reach a more representative sample of the community population. We successfully collected a total of 421 survey responses from our canvasing and our online surveying, which had a response rate of approximately 33%. Of these responses, 398 were fully complete. This not only provided us good information for statistics, but it provided us with significant amounts of qualitative information. Themes and statistics can be found in the quantitative and qualitative analysis section below. We also conducted interviews with members of the local frac sand industry and local government officials. We gained access to these individuals via a snowball sampling methodology.

The questions in the survey focused on the participants' awareness, opinions, and involvement in the frac sand mining industry in their area. Additional probing questions involved: "good neighbor" policies, governmental regulations, and other initiatives aimed at facilitating sustainability and corporate responsibility. The data gathered from the survey and interview process were then analyzed with a mixed methods approach to gain a full picture of the local issues and perceptions surrounding sand mining in our region. The survey also gave the respondents an option to address their views in the open forum field. These responses were transcribed along with the interviews we performed and the data was coded to find underlying patterns in our respondent's responses.

Analysis

We found patterns in both the perceived benefits and the perceived issues of frac sand mining. Among the benefits, our respondents generally focused on the economic impacts. The respondents also had many perceived issues. 98% of the people who took the survey believed that the industry causes harm to the environment. 48.3% of the individuals surveyed also believe that the industry brings property damage to the nearby citizens. They believed that it devalues homes in the area and creates an unnecessary form of noise pollution. According to a local government employee, much of the population also believes that the industry creates road degradation and a net economic loss for the community.

We utilized two binary logistic models to further analyze our data. The first model included a dependent variable corresponding to the question "Do you believe more regulations should be in place for frac sand mining?" and explanatory variables relating to demographics of the respondent. The second model we used had a dependent variable corresponding to the question "Do you believe that frac sand mining has benefits?" and included the same explanatory demographic variables. Our main explanatory variables of interest were: Gender, educational background, and the respondents perceived knowledge on frac sand mining. Demographic results of our survey data are summarized in Table 1.

Table 1: Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Gender	398	1	4	1.64	.566
Age	398	1	6	4.35	1.357
Education	398	1	6	5.03	1.290
Perceived Knowledge	377	.00	10.00	6.5915	2.04932
Valid N (Listwise)	377				

Of the 398 survey responses, 238 respondents identified themselves as female, 154 respondents as male, and six chose not to answer the question. The educational background of the respondents was a very significant element when analyzing socio-economic issues. For this question, participants had six options for educational attainment: some high school, high school graduate (or equivalent), some college, two year degree, four year degree, and higher degree. If the respondent chose higher degree, they were asked to explain. Since we chose a sample including UW-Stout faculty and staff, about 50% of the total population had a higher degree. The last area we chose to address in detail was their perceived knowledge of frac sand mining. We asked that the respondent rates their overall frac sand knowledge on a one to ten scale. We found that, generally, people were most likely to rank themselves somewhere between five and nine on the scale.

Table 2 shows the results of the binary logistic regression with the dependent variable corresponding to the first question of interest: "Do you believe more regulations should be in place on frac sand mining." We chose to use a binary logistic regression because of the dichotomous dependent variable. Doing this allowed us to better fit the model to the data.

Table 2: Binary Logistic Regression Results
Dependent Variable: Do you believe that more regulations should be in place for frac sand mining?

Variables	Coefficient	P. Value
Gender	2.360*	.004
Age	.869	.207
Education	1.333*	.009
Knowledge on Frac Mining	.825**	.027
Constant	2.086	.506
*,**,*** Signifies P. Value of 1%, 5%, and 10%		

Table 2 reveals that two of the four explanatory variables were statistically significant. This regression showed us a correlation between gender and views on frac sand regulations. We found that females are more than twice as likely (136% more likely) to believe that more regulations should be in place for frac sand mining. In the same model we see high significance in the level of educational attainment. This regression states that respondents with higher educational attainment are more likely to believe that frac sand mining should be regulated. To paraphrase Socrates, one possible explanation is that the more you know, the more you know you don't know. In other words, it seems that highly educated people may be more likely to believe that there are unknown issues about mining that might need to be covered by regulations and oversight.

Finally, we explored the importance of an individual's perceived knowledge of frac sand mining. The more people thought they knew about frac sand mining, the more likely they were to believe that new regulations were not needed. To be more specific, for every one unit increase in perceived knowledge on the ten-point scale, a person is 17.5% less likely to believe that there is any need for increased regulation.

There are a couple possible explanations for the result that the higher an individual perceives their knowledge on frac sand mining, the more likely they are to believe that fewer regulations need to be in place. One possible explanation is that these individuals are, in fact, correct in that there really is no need for the amount of regulations in place. Another possible explanation for this result is that the readily available information and "knowledge" on the debate is that sand mining results in job creation. The side of the debate that focuses on the possible risks involved with frac sand mining has not been well enough or loudly enough articulated, resulting in many individuals missing out on that knowledge.

Our second model was estimated using a binary dependent variable corresponding to the belief that frac sand mines have benefits. The results are summarized in Table 3. The dependent variable for this regression was the belief that frac sand mines have benefits.

Table 3: Binary Logistic Regression Results
Dependent Variable: Belief that more regulations should be in

place for frac sand mining.

Variables	Coefficient	P. Value
Gender	2.361*	.000
Age	1.008	.924
Education	1.118	.183
Knowledge on Frac Mining	1.134*	.020
Constant	.000	.045
*,**,*** Signifies P. Value of 1%, 5%, and 10%		

Table 3 illustrates that with every one unit increase in an individual's perceived knowledge on frac sand mining; they are 13% more likely to believe that frac sand mining has benefits.

In order to gain a richer understanding of these perceived risks and benefits, we also analyzed the qualitative information acquired from our interviews and the responses in the open forum sections of the survey. The theme of perceived issues largely centered on topics of environmental health and human well-being. 98% of respondents found that environmental degradation was a major issue with frac sand mining in the Chippewa Valley. These environmental factors included: altering major landscapes; the loss of aesthetic value; air/water quality issues; and subsequent health risks. These factors portray environmental issues as threats to the human aspects of environment.

The perceived issues can also be characterized as threatening to personal monetary gains. For instance, one of the main perceived issues is that of property degradation and home value. If there was sufficient evidence proving that the industry had adverse effects to the air, water, and human health, we would most likely see a loss in property value to those centrally located by processing plants and mines. According to our initial survey, 22% of respondents believed that property damage (physical damage and depreciating property value) was a consequence of the new frac sand mine industry. The survey also showed that 31% of the opposition believed environmental issues were an issue and 27% thought noise pollution was a

major consequence of the frac sand mine industry.

One of the last perceived issues is degradation to public roadways. Road degradation is to be expected when large semi-trucks filled with sand operate at maximum capacity. The public believes that their tax money will be the only capital funding road repair and upkeep. One would believe that this could be a major issue; however, an interview with a local government employee eases the worry. When asked how road repairs will be funded, the government official stated, "we hold the hammer. When the mining operation came into [the area], we found that they were operating at higher levels than previously expected. We then made a point to maintain strict road guidelines to force the industry to pay us for road repair." The official then explained that they had the regulatory power to freely raise and lower weight restrictions on county roads. This forces companies to comply with weight regulations. If they did not offer compensation, their production would be halted due to lack of transportation options. While the total figure was not disclosed, we had learned that one company was allocating $5 million per year for road renewal/upkeep. The figure seems quite large, however, another interviewee who works in road construction stated that it costs nearly $95,000 to pave one mile of county road. With both figures in mind, we understand that the aforementioned sand company can repave approximately fifty-two miles of road. Local citizens seem to be unaware of this road repair allowance, however, in their responses to our survey.

The primary benefits that were cited qualitatively were generally focused on the economic impacts. They saw it as beneficial on both personal and institutional economic levels. 63% of the respondents believed that the industry would provide jobs to the general public and provide growth in local business. 63% believed that the frac sand industry brings tax benefits to the state. The respondents also believed that the industry would help the nation as a whole, providing institutional gains. These responses focused on the energy needs of the country, and the belief that the use of natural gas is the best way to wean the nation off of foreign oil and to use forms of energy that can be produced locally. When looking at the recent election, President Obama stated:

> Right now Congress needs to extend the tax credits for clean energy manufacturers that are set to expire at the end of this year. I was talking to Dave Cote. The issue of energy efficiency and everything we need to do to shift away from dependence on foreign oil, we're making huge progress. We're actually importing less oil than any time in the last 8 years. We're down under 50 percent, but we can do more (Obama, 2012).

President Obama and Governor Mitt Romney also focused on job creation throughout the recent presidential campaign. Most of the rhetoric focused on how to focus on industry and job expansion. Frac sand mining falls within this scope of "building industry" and "decreasing dependency" on foreign oil. The survey results validate the themes of the election as a direct connection between mediascapes and the given audience. The messages are not just coincidental. As one would expect from field theory, it seems that "skilled actors" have helped shape a coherent narrative of the benefits of frac sand mining.

We are noticing that institutional frameworks are coinciding with one another to manifest dissonance amongst the general population. This leaves the local population confused and unwilling to take a cohesive stance on how they feel about the frac sand industry.

Conclusion

The frac sand industry has created an interesting political climate in the Chippewa Valley. As researchers, we have had the rare opportunity to witness how local citizens feel about a relevant, pressing issue. We have found that there is a dividing line within the public sphere that is creating a disjuncture within our communities. We have to wonder what will happen within these communities if we maintain these feelings over a long period of time.

The research may seem inconclusive; however, we found that new questions were raised. The local community needs to consider these questions, because they are a part of the big picture and they may be the key to restoring cooperation within our communities. Our results show that a significant proportion of respondents saw both important risks and important benefits in the potential for an increased frac sand mining presence in

the region. We found that there were significant divides across gender lines and across lines of educational background (an important consideration for the region with its numerous higher education institutions situated among rural communities). We also found an interesting result in the level of public knowledge and information and its impact on perceived benefits and costs. These findings leave us with two key questions surrounding the future of frac sand mining: First, should we strive to grow our economic sector in a manner that integrates society and environment in a sustainable way? Second and perhaps more importantly, how will the perceptions about this issue be shaped within the community?

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The Impact of Depression and Anxiety on College Transition Stress

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Abstract

This study investigated whether students who had a previous diagnosis of depression and/or anxiety would have higher levels of stress related to the college transition than students who did not have such diagnoses. Fifty-seven participants took an online survey on the level of stress in various college life domains. The results revealed that there were significantly higher stress levels in dorm stress and social life stress among students with a diagnosis than among those with no diagnosis. There was no significant difference between students with a diagnosis and those without a diagnosis in overall stress, financial stress and academic stress. Implications, suggestions, and future research are discussed.

Keywords: Depression, anxiety, stress levels, college transition, first semester experience.

The Impact of Depression and Anxiety on College Transition Stress

Depression and Anxiety on the College Transition:

The transition to college can be very stressful due to the changes that are occurring at that time. Kitzrow (2003) found that students can experience emotional and psychological distress while adapting to college. Students can feel stress because of the different expectations that come with transitioning to college such as new social and academic environments and increased responsibility (Larose, Bernier, & Tarabulsy, 2005). Having a pre-existing mental health condition such as depression and anxiety can make the transition to college more stressful (Hadley, 2007). For example, research has shown that depression and anxiety impact academic performance among college students (Andrews & Wilding, 2004; National College Health Assessment

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[NCHA], 2012). Additionally, a link has been found between academic performance and stress levels (Stewart, Lam, Betson, Wong & Wong, 1999). These studies suggest an interconnection exists between these areas which may exacerbate academic stress.

The impact of depression and anxiety on stress in the transition to college has not been investigated adequately. Therefore, this study investigated whether a previous diagnosis of depression and/or anxiety could lead to a more stressful adjustment to college.

Depression and Anxiety in College

Depression is one of the most common mental health disorders in the United States. According to the National Institute of Mental Health (NIMH; n.d.), 6.7 percent of U.S. adults experience a major depressive disorder in a given year. The NIMH states that symptoms of depression are, but not limited to, continuing feelings of sadness or anxiousness, feelings of hopelessness, feelings of guilt, irritability, loss of interest in previously enjoyable activities and hobbies, fatigue, difficulty concentrating, insomnia, overeating or loss of appetite, suicidal thoughts or attempts, aches, and pains. More specifically, the National College Health Assessment, conducted by the American College Health Association (ACHA) for the fall of 2012 showed that of the 28,237 college student respondents, 10.6 percent reported being diagnosed or treated for depression by a professional.

Anxiety is another common mental health disorder in the United States. Anxiety is also known to accompany depression (NIMH, n.d.). According to the NIMH, anxiety disorders affect nearly 40 million adults in the United States. The NIMH says that while there are several different types of anxiety disorders, all the symptoms revolve around irrational and unnecessary fear(s). The NCHA for the fall of 2012 reported that 12.1 percent of the college student respondents stated being diagnosed or treated for anxiety by a professional and seven percent reported being diagnosed or treated for both anxiety and depression by a professional.

Depression/Anxiety on College Transition Stress

Research shows that students experience emotional and psychological distress in adjusting to college (Kitzrow, 2003).

This can happen because of the newer and greater expectations while attempting to navigate new social and academic settings (Larose et al., 2005). According to Dusselier and colleagues (2005), college transition-related stress could include academics, relationships, finances, moving, death of a family member, and sex, with many of these challenges specially pertaining to college life.

The transition to college can be especially difficult for those who have underlying mental health disorders (Hadley, 2007). The NCHA (2012) found that 11.3 percent of college student respondents reported that depression affected their academic performance and 19.3 percent reported that anxiety affected their academic performance, which could lead to additional stress in those students.

The preexisting condition of depression and anxiety could increase the reaction to stressors in college thereby making the transition to college more difficult. A study done by Andrews and Wilding (2004) looked at student anxiety and depression and if it increased after entering college and how anxiety and depression can impact exam performance in college students. They found that by mid-course, 9 percent of students that had been originally symptom free now were depressed and 20 percent were anxious. In addition, they found that depression and financial issues did predict a drop in exam performance (Andrews & Wilding, 2004).

Another aspect in which preexisting depression and/or anxiety can make the college transition more difficult is the risk of rejection or finding a place to belong in the college setting. Having a group to belong to is essential for support. It is also important in establishing one's identity and having the opportunity to socialize when entering college (Paul & Brier, 2001). Further, it is important for students to adjust personally, emotionally, and academically to continue in their college career (Kitzrow, 2003). Students with psychological disorders may face challenges when it comes to adjusting to college and finding a group to belong to.

Rationale of the Study

Understanding how depression and anxiety can increase stress in the first semester of college is important to college faculty, counselors, and administrators so they can work with incoming students to make the transition as smooth as possible. Despite its significance, it appears that not much scholarly

research has been made on this topic. Therefore, the current study investigated whether depression and anxiety could increase stress in various domains during the college transition. Specifically, the study hypothesis was that those previously diagnosed with depression and/or anxiety would have higher stress levels in the domains of dorm life, social life, academics, and finances during the first semester of college than those who have no such previous diagnosis.

Methods

Participants

This study was conducted at a predominantly white Midwestern university in the United States with an enrollment of approximately 10,000 undergraduate and graduate students. Participants were contacted through professors and by requesting a random sample of 2,000 students from the university research office. The study had 57 participants, with 27 females, 11 males, and 19 participants choosing not to respond (Table 1). The age range of participants was 18 to 39 ($M = 20.08$, $SD = 3.93$). The sample had 6 (10.5%) freshmen, 27 (47.4%) sophomores, and 20 (35.1%) juniors. Seniors were not recruited and 4 (7%) participants chose to not respond. Out of all participants, 3 were diagnosed with depression only, 5 with anxiety only, 3 with both depression and anxiety, 42 reported having no diagnosis, and 4 did not report whether they had either diagnosis (Table 1). It was not checked to see if the participant had been diagnosed with depression and/or anxiety before entering college. After completing the survey, participants earned research credits or were able to enter a drawing to win a $10 gift card.

Materials

The survey consisted of 47 questions. The questions included demographic information, questions about current or previous clinical diagnoses of depression and/or anxiety, and questions to assess stress level in areas that were deemed important to the first semester of college (i.e., academics, finances, social life, and dorm life). The questions on the survey used Likert-type scale questions or free response format questions (Appendix A).

Procedure

Participants viewed the informed consent form prior to completing an anonymous online survey. Filling out the survey implied the participant's consent. The order of questions asked were demographic information, clinical diagnoses of depression and/or anxiety, and stress level in academics, finances, social life and dorm life. The data collected were then analyzed using SPSS software 20.0.

Results

Average stress scores were calculated so scores could be compared across domains. An overall average stress score was calculated as well as an average score for each of the domains (dorm life, social life, finances, and academics).

The study hypothesis, students with a diagnosis of depression and/or anxiety would have higher stress levels than those without a diagnosis, was partially supported (Table 2). Overall stress level was not different between the two groups, $t(48) = 1.64$, $p = .107$, Cohen's $d = .67$. However, there was a significant difference in dorm life stress between the two groups, $t(48) = 3.78$, $p = .001$, Cohen's $d = 1.28$. Students with a diagnosis of depression and/or anxiety ($M = 2.55$, $SD = .54$) had higher levels of dorm-related stress than students without a diagnosis of depression and/or anxiety ($M = 1.91$, $SD = .46$; Table 2).

There also was a significant difference in social life stress between the two groups, $t(48) = 2.62$, $p = .012$, Cohen's $d = .85$. Students who had a diagnosis of depression and/or anxiety ($M = 2.54$, $SD = .67$) had higher levels of social life stress than students who did not have a diagnosis of depression and/or anxiety ($M = 2.04$, $SD = .50$).

There were no significant differences between the two groups in the other domains of finances, $t(48) = -.21$, $p = .831$, Cohen's $d = -.08$, and academics $t(48) = .00$, $p = 1.000$, Cohen's $d = 0$.

Discussion

A series of independent samples t-tests were used to compare participants' average stress scores between the group with depression and/or anxiety diagnoses and the group with no diagnosis. In the domains of finances and academics, the means of the two groups were very similar. This might indicate that finances and academics are stressful to all college students and does not cause additional stress for those with a diagnosis

of depression and/or anxiety. Ross, Niebling and Heckert (1999) found that 71% of the college students they surveyed reported finances as being a source of stress for the average college student. Perhaps it is just an area that is stressful to most college students.

The current study did find significantly higher stress levels among participants with a diagnosis of depression and/or anxiety in the domains of dorm life and social life than those participants without a diagnosis. One possible explanation is that aspects of dorm and social life create a more stressful environment for those with a diagnosis of depression and/or anxiety. Another possible explanation is that for students without a diagnosis of depression and/or anxiety, dorm life and social life become a source of support. Hence, they would not feel higher stress levels in these domains. Consistent with this speculation, Friedlander, Reid, Shupak, and Cribbie (2007) found that social support was very important in assisting students with the transition to college. The group with a diagnosis of depression and/or anxiety did have higher stress levels about dorm and social life which might indicate that these parts of college life are a source of stress. Perhaps, they may struggle with finding a group of friends or fitting in with the other students. The overall stress level for those with a previous diagnosis of depression and/or anxiety was not significantly higher than those without a previous diagnosis. However, despite being nonsignificant, the effect size for overall stress was medium (Cohen's D = 0.67, Cohen, 1985).

There are several limitations in this study. One limitation is the small sample size. There were only 57 participants that took the survey, with 4 choosing to not respond who were excluded from the results. Within the sample size, there was also a small sample size of participants that reported being previously diagnosed with depression and/or anxiety. Out of the 53 participants who responded to the survey, only 11 reported being diagnosed with depression and/or anxiety and 42 did not report a diagnosis. Further research could include recruiting a larger sample size to confirm the current result.

Additionally, a potential reason for the small sample size is that the study was done over the summer term and many students are not on campus during the summer. Also, it was not specified in the survey if the participant was or was not currently

enrolled in summer courses. Conducting the same study during the fall or spring semester could potentially get a larger sample group.

Another limitation is that when comparing both groups, depression and anxiety were put into the same group to allow for better comparison due to small sample size. Future research could expand on this by looking at depression and anxiety separately to see if there would still be a significant difference between groups. Further research could also include students that have not been clinically diagnosed with depression or anxiety, but do meet the criteria for being clinically depressed or suffer from anxiety.

A final limitation is that seniors were excluded from the sample. This was due to the potentially larger recall bias in seniors because of the length of time that has passed since a senior would have gone through the college transition. However, such bias could exist at all academic levels because of the time passed from when transitioning to college to the time the survey was taken. One way to further research this would be to survey only freshmen and conduct the study shortly after the beginning of the semester to limit the chance of recall bias.

Despite these limitations, the results of the current study do indicate that students with a diagnosis of depression and/or anxiety do retrospectively report greater levels of stress related to dorm life and social life than students without a diagnosis. These findings may be useful to college counselors and other faculty to design better programs about coping strategies and to offer more support for students with depression and/or anxiety that are adapting to dorm life and social life on campus. This may include designing and providing a peer mentor program between freshmen and upperclassmen or finding ways to help those students with mental health issues fit into the college scene, to overcome interpersonal stress that arises when meeting new people or roommates, or adjusting to the dorm life.

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Table 1

Survey Demographics for Participants.

Demographic Variable			Frequency (Percentage)
Age	*M* = 17.0 *SD* = 2.46	Range = 18-39	
Gender		Male	11 (19.3%)
		Female	27 (47.4%)
		Missing	19 (33.3%)
Ethnicity		White/European American	35 (61.4%)
		Latino/a	1 (1.8%)
		Asian/Asian American	2 (3.5%)
		Missing	19 (33.3%)
Year in School		Freshmen	6 (10.5%)
		Sophomore	27 (47.4%)
		Junior	20 (35.1%)
		Missing	4 (7%)
Diagnosed w/ Depression & Anxiety			3 (5.3%)
Diagnosed w/ Only Depression			3 (5.3%)
Diagnosed w/ Only Anxiety			5 (8.8%)
No Diagnosis			42 (73.7%)
Missing			4 (7%)

Note. $n = 57$

Table 2

Level of Reported Stress within Different Domains for Student with a Diagnosis of Depression and/or Anxiety and Students without a Diagnosis of Depression and/or Anxiety.

	Diagnosis *(n – 10)*		No Diagnosis *(n – 40)*			
Stress Domain	*M*	*SD*	*M*	*SD*	*p*	Cohen's *d*
Overall	2.55	0.29	2.32	0.41	0.107	0.67
Dorm life	2.55[a]	0.54	1.91[b]	0.46	0.001*	1.28
Social life	2.54[a]	0.67	2.04[b]	0.50	0.012*	0.85
Finances	2.60	0.71	2.66	0.73	0.831	-0.08
Academics	2.51	0.39	2.51	0.52	1.000	0.00

Note. a > b. *$p < .05$.

Appendix A: Survey Questions

Please rate the following statements based on your level of stress regarding your first semester at UW-Stout.

Please rate the following statements based on your level of stress regarding dorm life.

	No Stress (1)	Mild Stress (2)	Moderate Stress (3)	Severe Stress (4)
Having a random roommate.	○	○	○	○
Lack of privacy.	○	○	○	○
Having to use a communal bathroom.	○	○	○	○
Having to eat campus food.	○	○	○	○

Please rate the following statements based on your level of stress regarding social life.

	No Stress (1)	Mild Stress (2)	Moderate Stress (3)	Severe Stress (4)
Meeting new people.	○	○	○	○
Deciding or joining a club or sport.	○	○	○	○
Not having old friends around.	○	○	○	○
Partying/going out.	○	○	○	○
Safe sexual behavior.	○	○	○	○

Appendix A continued

Please rate the following statements based on your level of stress regarding finances.

	No Stress (1)	Mild Stress (2)	Moderate Stress (3)	Severe Stress (4)
Paying for school.	○	○	○	○
Paying for basic living expenses.	○	○	○	○
Being able to afford entertainment/social activities.	○	○	○	○
Finding a job.	○	○	○	○
Being able to balance work and school.	○	○	○	○

Please rate the following statements based on your level of stress regarding academics.

	No Stress (1)	Mild Stress (2)	Moderate Stress (3)	Severe Stress (4)
The first day of class.	○	○	○	○
Having a (good or bad) professor.	○	○	○	○
New classes.	○	○	○	○
Homework load.	○	○	○	○
Testing.	○	○	○	○
Choosing a major.	○	○	○	○
Maintaining a good GPA.	○	○	○	○

Impact of Limited Autonomy, Bargaining, and Legal Rights on Firm's GMC Application

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Abstract

Genetically modified crops have various economic costs and benefits. Their significance and benefits are numerous with highly concentrated biotech seeds controlling 88-94% of all corn, soybean, and cotton production. The purpose of this market analysis research is to determine if there is any negative impact on farmer autonomy when determining the use of seed in agriculture production. Negative aspects of adhesion contracts such as autonomy loss, bargaining and legal rights, and future potential market risk should be considered; however, if a producer mitigates risk exposure and acknowledges the loss of bargaining and legal rights GM crops are often advantageous and should be implemented. The negative aspects of the contract are evaluated using market concentration analysis, patent data, legal analysis of stewardship/technology agreements, and referencing peer reviewed research.

Keywords: Genetically modified organisms, intellectual property, firm autonomy, risk mitigation, Concentration Ratio, Farmers, GM crops, Monsanto, bargaining rights

Introduction

Imagine the grocery store produce section. The vast array of full, fresh, and vivid colors with the best Earth's ecosystem can offer. It isn't an accident or a natural process that brings this food to your local store. It is the sum-total of 10,000 years of the greatest achievement in human history: It is agriculture. It is the pruning, processing, and constant tinkering that brought to you a potato that didn't cause illness, a tomato that started in Peru at the size of a golf ball, and it is this process that has developed over 7,500 botanical varieties of apples worldwide. Agriculture is

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no longer the farmer artificially selecting preferred traits for their goals: It has reached the level of biotechnological engineering to create foods that have genetically been modified for targeted attributes. It is natural selection on steroids with higher yield goals in mind. Agriculture has shifted the destination of farmers' harvest from the local market to the global commodities market. A genetically modified crop (GMC) is a plant that has been genetically modified by adding a small quantity of targeted genetic code into an organism to create an organism's desired phenotypical trait. Genetically modified organisms (GMO) have been altered in a way that provides protection from predation, pesticide resistance, and/or improvement to plant quality. The economic significance for GM crops is that they can produce a larger number of bushels per year by using a GM crop over its organic counterpart and the market price of corn decreases due to higher supply. A concern in the general public is that genetic modification may have unwanted health risks associated which are yet undiscovered (Morris, 2011).

The scientific evidence currently does not support a claim that health complications have risen due to consuming GM crops (Kimbrell, 2006; Kayabasi, 2011; Maghari, 2011).The Food and Drug Administration (FDA) has a clear policy that a GM-crop must be substantially equivalent to organic root plant's nutritional value to be treated equally as non-GM-regulation without approval (Food, 2006). The industry has an impressive track record for safety and is nearly unblemished in terms of the number of products they have produced against public safety violations that have occurred. Market analysis studies the attractiveness and dynamics of a special market within a special industry. This market analysis has shifted away from the traditional Strength, Weaknesses, Opportunities, Threats (SWOT) archetype and offers breadth that couldn't otherwise be achieved. The following key attributes are encompassed within this research: current and future market size, market trends, market growth, industry structure, market profitability, and pertinent legal information. The primary purpose of this market analysis research is to determine if there are any negative implications on farmer autonomy[2] and bargaining rights when determining the use of seed in agriculture production. It has been designed for a reader with a basic knowledge of economic theory but does not require a quantitative research background.

[1]*Autonomy: state of existing or acting separately from others*

This analysis hopes to offer the reader information on the costs, current market distribution, potential market changes, and implementation requirements of GM-seeds.

Historical Analysis: Market and Case Study of Monsanto

The story of GMOs begins with the discovery of the double-helix structure of deoxyribonucleic acids (DNA) by Watson and Crick in 1953: the genetic "blueprint" that creates all living organisms. This discovery allowed scientists to splice targeted DNA from one organism to the DNA of a completely different organism. In 1973, Herbert Boyer and Stanley Cohen were the first to successfully create a recombinant DNA organism. In 1980, *Diamond V. Chakabarty* ruled that genetically-modified organisms are intellectual property and eligible for patent protection. In 1986, 1987, and 1992 plants such as GM tobacco and tomatoes were approved by the US Department of Agriculture for commercial production. It was a significant time period as well for GMO production firms because the FDA ruling declared that GMOs are not inherently dangerous and do not require any special regulation (Qaim, 2009). The largest genetically modified seed distribution company will be used as an example of some of the conflicts presented between farmers and the use of genetically modified seeds in North America. Monsanto has become a global leader in seed development, production, and distribution. Monsanto shares this market with other transnational agri-business like Du Pont, Shell, and Sandoz. Monsanto alone currently holds a dominant control 90% of the seed distribution market with a 95% market control in all soybeans and 80% of all corn (Schimmelpfennig, 2004).

Market Concentration: Hypothetical Case of Mealybugsi Impact on Orange Market

Market distribution raises concerns of subcompetitive performance resulting from interdependence among rivals (Varian, 2009). The presence of oligopolistic market conditions will artificially alter the market on supply-side product distribution by restricting product output and present a higher nominal price while reducing market welfare. Corn markets for individuals can be stated as generally elastic[3] (Slaughter, 2001). Farmer's demand for liquid capital is often inelastic meaning they have a much higher tolerance to price fluctuations in a

[2] *Elasticity: How sensitive the demand for a good is to changes in economic variables (specifically price)*

highly unstable commodities market. Economies of scale[4] do this to reach optimal profits while shaving product surpluses. To demonstrate this point I will take the example of the orange market. Suppose that it is 2019 and a recent outbreak of pesticide-resistant *Mealybugs* has spread throughout the Southern United States and caused a 40% loss in orange production domestically. The lack of production has direct consequences to the local markets that grow the orange trees with lower production on the supply-side and less demand for workers to harvest the oranges. It forces businesses to adjust by cutting expenses with layoffs and pay cuts. The loss of production causes an increase in prices in the short run and consumers may lean towards substitute products that have a steady price within their willingness-to-pay range such as apples or pears. The aggregate wealth of the producer will decrease as they must encounter increased waste in opportunity cost. The market equilibrium will eventually be reached over a long-term shortage as the consumers who previously demanded oranges now prefer apples due to their lower market price. This seems fair and advantageous to a both consumers and producers.

The example of genetically modified seeds is different. It is not a simple task to produce a successful, viable, and safe genetically modified organism that can be harvested and sold in a global economy. A new company would need a group of highly skilled scientists, research and development facilities, competitors' contractual agreements with consumers, advanced laboratory, a group of specialized biotechnological engineers, patent lawyers, and endure the strenuous amount of testing on the product's safety and efficacy. This high capital requirement acts as a barrier to entry into the market, decreasing the incentive to enter the market which inhibits any change in the market equilibrium.

Market Concentration: Patent Data, and CR Concentration

Limited monopoly power is necessary to provide an incentive for profit-seeking firms to enter a market with such high initial capital demands. The firm's largest cost is Research and Development. The cost of research to find a viable GMO is relatively high but the cost of production of GM-seeds once established is relatively low. The market's external forces are what have caused an imbalanced firm distribution at the equilibrium

[3]*Economies of Scale: the cost advantages that firms obtain due to size or scale of operation, with cost per unit of production decreasing with increasing scale because fixed costs are spread out over greater units of output*

point considering all factors (King, 2000). Table 1 demonstrates the market share of genetically modified seed companies in terms of the number of patents assigned to each. These data are representative of a few key factors when analyzing this market distribution in that the top firms maintain a high number of assigned patents and we can infer that they will also maintain dominance in this market due to the extended intellectual property rights they will maintain in future technology and development (Qaim, 2009). It uses a concentration ratio of the top 4 firms within the market (CR4)

A01H0001 Top Eight Firm Patent Assignees

1. Monsanto LLC.	1. Monsanto LLC.
2. Pioneer Hi Bred Inc.	2. Pioneer Hi Bred Inc.
3. Syngenta Participations Inc.	[illegible]
[illegible]	4. Syngenta Participations Inc.
5. Stine Seed Farm Inc.	5. Mertec LLC.
6. Nat. Inst of Agrobio Science	6. D&PI Technology Holding
7. Seminis Vegetable Seeds Inc.	7. Seminis Vegetable Seeds Inc.
8. Mertec LLC.	8. Kirin Brewery

Table 1: Source (King, 2000, Fuglie, 2012)

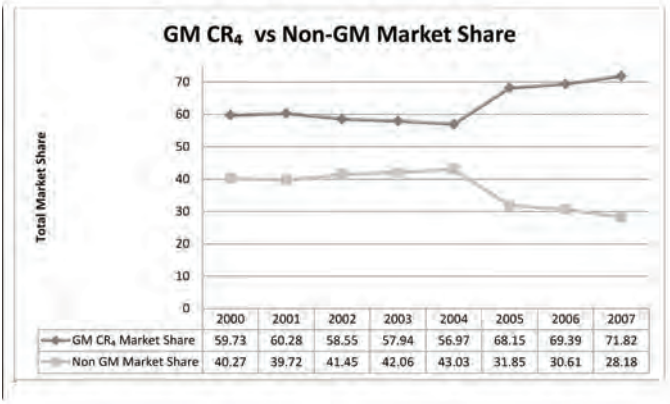

Figure 1: Source (Fuglie, 2012; King 2000)

These data were collected from Fuglie (2012) and King (2000). The market is oligopolistic[5] and we can assume that this will be unchanged in the future if the market conditions are relatively similar. The important factor to notice is the high disparity between the Top 1-4 and Top 5-8. It illustrates further the increasing market power that a single firm can possess when

[4]*Oligopolistic: A market condition consisting of so few sellers that any action committed by one of them will materially affect price and have a measurable impact on competitors*

high barriers to entry are present; namely limited inter-firm price taking, subcompetitive dependence, and few larger producers. I have compared the two variations of patent data in the table as A01H001 and A01H002. These patent codes refer to their biological terms. The GM seed market maintains a CR4 value of over 40%. The scale uses the top four market leaders combined in a single industry to compare with the rest of the total output in that industry (Rhoades, 1995). The graph below demonstrates the CR4 and the growing disparity over the total length of time in the market.

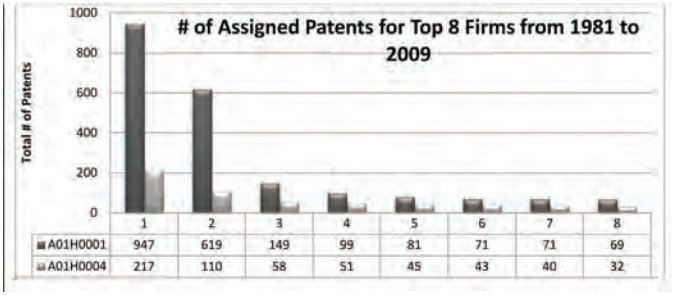

Figure 2: Source (Fuglie, 2012; King 2000).

This graph provides further clarity in the increasing market change over the length of seven years. The table represents the total seed market. The restrictions we have assumed are that a producer purchasing a GM seed would in turn not be purchasing non-GM seeds due to contractual agreements set in purchasing GM seeds from firms (e.g. Monsanto Stewardship Agreement). The distinction being a producer would have either a homogenous field of GM-corn or Non-GM corn based upon contractual agreements.

Adhesion Contract: Limiting Autonomy and Legal Protection

Bt-corn is a genetically modified plant altered to express a specific gene which produces Bacillus Thuringiensis (Bt) toxins within the plant. The gene activates the production of a protein which is an effective endotoxin to a variety of insects. It efficiently exterminates the European and Southwestern Corn Borer. The agricultural industry was animated about the production of a nontoxic plant that actually created its own pesticide. In 1996, the FDA approved production of Bt-Corn in the United States. Monsanto began seed production through

private seed producing farms in preparation for public release. 1992-1996 was a crucial time period for both farmers and seed companies. Seed companies needed to hit the market quickly to contact, and sign farmers onto "technology agreements". An example of a product usage contract is the Monsanto Stewardship Agreement. Monsanto also issues a similar product usage agreement with independent companies that distribute seeds to Monsanto's clients. Farmers used this time period to research, budget, and meet with Monsanto sales representatives if they wish to use Bt-corn. The product usage agreements the farmer and distributors sign are restrictive to grower's autonomy. Contract's mandate price premiums varying $8-30 per acre on which Monsanto seeds are planted. The end of each harvesting year requires that the farmer delivers all crops to a grain-elevator or crushing plant and no seeds from previous year can be used or kept the following harvest. Adhesion contracts bind the firm to the producer. The contracts contain limited grower remedy clauses (only cost of seed covered if wronged by company) but also contain one-sided clauses for the firm to recoup attorney fees, inspection costs, and damages by the grower. The farmer is recommended to spray the glyphosate broad-spectrum herbicide on acreage as specified by the Monsanto Technology Agreement. They also must open their records to any Monsanto representative at any time under contract as to maintain a paper trail of their product through the process. If farmers decide to dissolve this agreement the following harvest they are subjected to random inspections of land by Monsanto for three years to ensure no patented crops had been harvested without contract. Monsanto contracts also stipulate that a grower must notify them within 15 days of first noticing a problem with the seeds before he/she is able to sue. If growers do pursue legal action against Monsanto, they are required to litigate all cases in the Eastern District of Missouri, increasing the costs of litigation with travel expenses. Patent data show a significant concentration of three out of the four top firms in both categories with total firm distribution becoming increasingly polarized (Nachtigal, 2001). Significantly imbalanced agreements exist between large seed production firms and small scale farmers. Key disadvantages are the following: per acre premium, seed costs, required pesticide usage, increased log keeping, and extensive cleanup of seeds after harvest.

Global Trade, Role of Multinational Corporations, and Industry Risks

The focus throughout this research has been on North American trade of Bt-corn but the transition that chemical companies like Monsanto, Du Point, Shell, and Sandoz made by becoming a force in biotechnology is an important point to be analyzed. The economy has become globalized and transnational corporations have distinct role in agriculture. Economic systems benefit from trade between nations. Firms in perfect competition systems as relative costs for production differ from the between specialized firms for certain goods (King, 2001). The correlation between high firm concentration and innovation is disputed among economists. The two schools of thought are that high concentration has a negative impact on market efficiency (King, 2001) and economies of scale can provide credibility, lower average costs, and gain in efficacy due to lower fixed costs (McCorriston, 2002). Transnational agricultural companies (TNC) can control prices because of their ownership in processing plants, wholesalers, and retailers. They are able to control large stocks of a variety of foods. The United Nations Economic and Social Development Department states that "61% of flour mills are owned by four companies, 81% of beef packing facilities are owned by four companies, 60% of terminal grains handling facilities are controlled by four companies, and 82% of corn exporting is handled by three companies" (Schimmelpfennig, 2004). They are given access to political arenas, greater access to information, and capital. Small players like a farmer of Bt-corn in North America simply have no chance to compete directly against these large TNC because if current technology rates and corn prices remained static it would push small-scale farming operations out of the market. The transnational corporation however has the ability to wait out the costs for a longer period of time. It is analogous to the formation of union strikes. The cost within a private sector corporation is minimal per employee production in comparison to per hour worked by the employee. A potential solution that could be implemented is increasing the comparative advantage for producers to enter the field in spite high barriers of trade. An equalizing balance may be achieved by increasing the effectiveness of economic policies within the World Trade

Organization. An alarming trend since GM-crops have taken dominance in certain markets is the drop in University Study Grant Aid for conventional crop seeds. It is crucial to study because farmers might be feeling without an answer to GM-crops. A nominal increase in funding will increase the probability that new data will be discovered in genetic information, and crop health. The current market concentration cannot and should not be dismantled using antitrust regulation. Creating, altering, or enforcing antitrust laws would prove costly to the total economy because it increases attractiveness of foreign markets while decreasing the incentive to perform business domestically (Smith, 2010).

Possible Future Market Changes

It is estimated that 88 to 94 percent of soybean, corn, and cotton is devoted to a genetically modified variant domestically in the United States. The economic incentive to forego self-sufficiency is higher than the incentive to use collective non-GM seeds (Ma, 2012). A risk of structural change in GM food labeling laws would cause burdensome regulation on the segregation of food (Golan, 2001). As stated previously, GM crops have been noted as safe, effective, and are substantially equivalent to non-GMs. This has been documented in numerous studies (Committee, 2004). However, a consumer base that perceives a differentiation between the two goods may be benefited by mandatory labeling regulations to reduce search costs, increase market efficiency, and attach a price premium to non-GM products. It would also alleviate consumer concerns on asymmetrical product information (Siipi Uusitalo, 2008). If it is important for consumers and their demand for labeling requirements is high enough, the market will surely provide it to them. The concern is regarding production externalities to farmers. Firms producing non-GM crops would face increase production costs in ensuring no cross-contamination occurred. Examples would be separate shipping containers, genetic testings, etc. They might also need to develop crop sector strategies such as surrounding a large acreage U-shape of targeted non-GM crops with the rest of the area filled with targeted GM crops. This decreases the chances of genetic drift from neighboring farmers. It increases the opportunity cost of non-GM crops. Consumers could also face a market

with increased cost and a similar product if precautions cannot guarantee product differentiation. If regulatory changes occur it would alter the entire seed market. Non-GM seeds with credentials (e.g. product certifications, approval from third party) of their product's purity could command a higher selling price while GM-seeds may become less lucrative.

Conclusion

A firm producing agricultural goods presented with an opportunity to implement GM-crops should make consideration of personal circumstances, risk analysis, and implementation costs. The imbalance of contract rights is not a strong enough deterrent in most cases to prevent GM-crop implementation. Market price is the strongest incentive to produce GM-crops. Farmers should absolutely be concerned and note their loss of autonomy and bargaining/legal rights; however, the benefits of implementing GM-crops outweigh these negative consequences in the current market structure. A producer of Monsanto Bt-corn who properly uses the product, follows mandatory guidelines, and sacrifices some bargaining rights allows their firm legal access to a seed which increases yields, decreases pesticide use, and does so on less acreage. Monsanto has a restrictive contract and annual seed limitations to recoup profits from the relatively high R&D costs they incurred. They would no longer produce, develop, or improve their seeds if a limited-monopoly power was not provided to them. The negative circumstances of the contract are expressly aggravated by producers who do not read, understand, or seek proper legal counsel before aligning their business with a GM-seed producer. They can mitigate their risk by implementing the guidelines that the company requires (Monsanto Technology Guide) to ensure a decreased liability if seed failure occurs.

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Increasing Student Retention Among College Students

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Abstract

Retention among college students is one of the biggest challenges facing colleges today. This research combines mixed qualitative and quantitative methods to determine factors that might allow colleges to better retain students. I find early risk indicators of students dropping out of college, and also some factors which serve as signals that can lead to retaining a student. Using statistics from a medium-sized Midwestern state institution, and combining them with student interviews, I find that academic support mechanisms, student GPA, and scholarships are the major factors affecting student retention.

Introduction & Literature Review

Student retention is one of the biggest and most important challenges facing colleges today. There are still a surprising number of students that do not return for their second year at college. There have been many studies in the area of student retention, and in many ways this study will support existing findings, while applying them to a new sample and some unique institutional factors. I use mixed qualitative and quantitative analyses to answer the specific question of why students drop out of college, and how policies and programs might be improved to better retain them in the future.

College degrees help our whole society, from reducing unemployment rates to reducing levels of criminal activity (Singell, Waddell 2010, Mbuva 2011). Students obtaining college degrees will lower our unemployment rate in our nation, this is of vital importance. "Nationwide, 22% of first-year college students do not return for their sophomore year. Graduation and retention rates still remain low, even though enrollments are increasing," (Morrow, Ackermann 2012). With the current retention rates the

way they are, an update on research is needed to see if there is anything to add to the current data.

The first step in unlocking the secrets to student retention is finding out first why students leave. "Previous research has found that attrition and retention rates differ by educational level, age of the student, level of course, course subject, socio-economic group and institution" (Yorke 1999, Johnes & McNabb 2004 & Cameron, Roxburgh, Taylor & Lauder 2010). Students can leave a university for a variety of other reasons as well: academic difficulty, adjustment problems, uncertain goals, lack of commitment, inadequate finances, lack of student involvement in campus activities, and generally a poor fit to the institution (Morrow, Ackermann 2012, Adams 2011). Some of the main variables that can lead to retaining a student involve their pre-entry attributes and what their goals are when they reach college. Having a strong academic pathway that is clear and concise to students will likely cause them to want to stay at the institution (Mbuva 2011, Cerezo, McWhirter 2012).

Despite the variety of factors that have been identified as leading to the retention or non-retention of students, there are three common themes in the existing research. One of these is the idea that peer involvement is a major factor in who stayed in a program. The relationships between students are a very important attribute in who is retained at a certain institution. (Cameron, Roxburgh, Taylor and Lauder 2010). This concept was brought up in most of the literature as a significant contribution in a student's decision to stay at an institution for another year. It likely means that having peer involvement and friends throughout college allows the student to feel more involved and comfortable in college.

Another common theme is the area of academic support. "Students who are the happiest and academically the most successful have developed a solid relationship with an academic advisor, a faculty member or an administrator who can help them navigate the academic and social shoals of the academy," (Drake 2011). The paper stated that it was hard to determine whether or not there was some measure to define "solid academic advising," nevertheless, this is an important factor in student success.

Finally, the idea of having a healthy environment comes into account when thinking about retaining a student. Atmosphere

is a big component to bring more support to the students directly (Cameron, Roxburgh, Taylor and Lauder 2010). There are many reasons why a student would stay in the residence hall the following year, including the ability to have a decent dining plan, where the dorm was located on campus, the ability to choose what dorm you want to live in, and the different utilities that a student can get while living in the dorm. Some negatives that would drive students away from living in a dorm were the inability to cook meals, the length of the housing contract, the inability to have a private bathroom, parking accommodations, and the ability to live with or near a friend. (Li, Sheely, Whalen 2005).

Academic support, peer support and a healthy atmosphere are the main variables that will enable a student to succeed not only in the classroom but outside as well. One question to ask is how do colleges address these factors to ensure that they will have high retention rates? Another is how do students view these three main themes the literature pointed out and did they really have any contribution to their leaving the institution?

Some other methods have been used to increase student retention, including higher academic entry qualifications have been one of those changes (Cameron, Roxburgh, Taylor and Lauder 2010). Students are more likely to succeed and be retained when they are also the ones who work hard and earn good grades. College, therefore, are increasingly looking at increasing the rigor of admissions criteria to increase their student retention.

"It seems essential for universities to maximize the links and supports that already exist on campuses and to do so in more consistent and systematic ways for all incoming students, especially students traditionally underrepresented on college campuses" (Cerzo, McWhirter 2012). For students to truly succeed on a campus, college administrators must take the steps to assist the students. That doesn't necessarily mean creating programs that will just give the student more work, but helping the student build a community both academically and socially. As the literature has illustrated, student retention is a problem that doesn't seem be going away, and attrition is still alarmingly high among college freshmen. The sooner the problem is fixed the better our future as a society can become as fewer resources will be wasted and a more efficient path through college can be

achieved. It is up to the institutions to take the necessary steps to ensure that the environment they come into as freshmen is one that is welcoming and that their admitted classes are a good fit with the strengths and weaknesses of a given program.

This project seeks not only to show aggregate trends in major contributing factors that lead to student retention, as well as warning signals for potential non-retention, but also to find individual level factors from students themselves and discover what they feel was a significant point that caused them to leave. Was it one of the three main points that the literature covered or was there another reason why these students transferred or dropped out? In my literature research, the voice from the students themselves was often missing, and that is one key contribution provided by this study. This will hopefully allow a richer understanding of the issues beyond the broad demographic trends. For instance, if professors are a factor which causes a student to stay or leave, the goal with my research is to find out what they feel could be done better by the professors, or administration to help them stay at their current institution.

Methodology & Results

This research is a mixed-methods study including both quantitative and qualitative approaches. Northern State University provided data about all incoming freshman from 2006-2011 and followed them through their college years. The data had an array of information including GPA, ACT scores, high school GPA, etc. All names were removed and replaced with random identification numbers. Regression analysis was conducted to examine significant factors that would show why a student left an institution.

I also conducted interviews, and found my initial interview subjects through connections made via professors. I then used a snowball sampling method to expand my pool of interviewees. My interview questions revolved around issues of academic support, peer support, and the college environment. All interviews were transcribed and coded to find any common themes.

Table:1

OLS Regression on Student Attrition with Dependent variable: Student left institution

	B	Significance
Scholarship recipient	-.099	.041(**)
NSU GPA	-.177	.000(***)
ACT Composition	.017	.017(**)
Distance	.045	.018(**)

Table 1 shows my main regression results exploring the factors affecting a student's retention. The dependent variable was a binary indicator for students who were not retained at the institution. The stars represent the significance level in the data. One star (*) being significant at the ten percent level, two stars (**) being significant at the five percent level, and three stars (***) being significant at the one percent level. The results show that College GPA is estimated to be a negative but significant factor in student attrition. The higher the GPA the more likely a student will be retained at the institution. Scholarships in general are significant and gaining a scholarship will increase the likelihood of retention. Distance from home is significant, and positive, meaning the farther away from home a student is, the less likely he or she will be retained.

These data findings are important since they show what an institution can keep in mind when a student enters college. If a student has a lower GPA in high school, this student would need more help in college to bump up their grades and be retained. If a student has trouble with financial support, then more scholarships could help their retention. Along with this, extra support can be given to students with lower ACT scores and students who live farther away from home, to all improve retention rates.

In my interviews several themes emerged that further supported the literature, including academic support, peer support, and a comfortable environment. Students felt that academic support is important in a college. Students leave for a variety of reasons that the school can't control: Money, sick, or the college doesn't have the major. One problem some of my

interviewees stated were not having a major, or they lost interest in the ones current ones they had. At the same time, they felt that certain aspects of a school were important and would have kept them at the institution. Academic support is a huge factor in why a student would not feel welcome or comfortable at a college, or return to a college if they had the ability to return. Students want to be more than just a face in the crowd. They are looking for a sense of belonging at the institution. Through their academic support, that sense of belonging can be established. The relationships with the professors and advisors could potentially create an environment that makes the student feel like they belong at the school, and equally as important makes them want to try much harder.

One student commented in particular highlights this idea that students want to be guided more by an adviser.

"She would send out an e-mail to however many advisees cause I didn't declare a major. Which might have been different if you would have declared, maybe there wouldn't have been as many students but she had a lot of advisees. And so…she would send out this mass email. That would be like you can come meet with me but I would prefer to meet via email. And I was like ok…sure you know. I ended up taking a math class because I didn't know what my major was going be so I was going to take the minimum requirements and taking a class that didn't even count towards generals. It was below that, it was super easy but I registered without anyone helping me."

The ability to have clear guidance is something that students find very important in their institution. Having that advisor there for help, makes students feel like they are on the right path, and that they will leave college alright in the end. Students want to try when they are surrounded by professors and advisors that care.

Looking at another example of how there was a problem with the sense of belonging on campus, one student reflected how they went to class of 300-400 students, and the teacher never took attendance. All there would be is a swipe of their campus card, and a throw-away quiz question. That was their attendance for that day. The professor didn't even need to know the name of the student. It stripped all identity from the student and made them only a face in a crowd full of students, which none of my interviewees felt was a good learning environment.

In addition to academic support in the form of personalized advising and personal relationships with professors, peer support is also another factor that leads student to actually want to stay at an institution. Most of my interviewees had no problems meeting friends. They had groups they were a part of, and with these groups it made the decision even harder to leave an institution. These groups can be created in an academic setting, or in a non-academic setting. Having the ability to work with a student inside a class room is probably one of the easiest ways that a student can get involved with his classmates, plus, students actually don't mind working on homework in class together. Some pointed out the case can arise they had an easier time leaving an institution if they didn't have any friends, and couldn't find any sense of belonging in both the peer and academic support.

On the other hand, not finding a group of friends might make it easier for a student to decide to leave. If you don't find your group of friends or that clique, they may find it easier to leave the college in search for another institution, or find it easier to say that they wouldn't go back if they left for some other reason that wasn't the direct result of anything lacking in the institution. For example, one interviewee stated that the school was really "cliquey", and that caused her not to meet a lot of friends. In one of my interviews, the subject stated that since they never formed a clique they and enhanced by never being satisfied with where they were with the program, therefore, they never felt the need to stay at the college.

The students I interviewed had mostly positive things to say about the environment the university created for them. The significant factors for students were the location and the proximity of the campus to home. Some of them stated that it was an added bonus that the campus was close to home, which supports my quantitative data. At the same time, no one said that distance from home was a significant reason for them to leave. The location of the campus was important, however. One student in particular did not want to feel trapped on a campus and the ability to move on and off campus was very important for them as a student. They even mentioned that the closest thing to the campus was a gas station, seven miles from campus so there was not much to do. It created an environment that was less welcoming and more boring.

Conclusion

Using both quantitative and qualitative approaches provides a very different and more complete picture of why a student leaves a particular institution. My quantitative results can show what a university can do *before* a student enters college, and my qualitative results can show what a student can do *currently* when they are at college. If a student's home is far away from the campus, half way across the country for example, they should be provided more academic support and advisement to increase the likelihood of retention. Also, if a student had a lower GPA in high school, or a lower ACT comp score, they should be provided more academic support as well. Students should be helped as much as possible to find a major, so not only do they have a sense of where they are going, but so that they can also meet peers that have the same interests. Students should be told about all the scholarships that the university provides through their advisement, and should be pushed to take these scholarships to help them out financially.

Keeping students in college is important. It helps out our society as a whole, and it can change a student's life for the better. Leaving everything you know to take a risk at a college is not an easy step, which is why it is so important for the college to do all they can to make the student feel like they belong at the school, to make them feel at home. If we, as a society, can crack that code, retention of students will change for the better.

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Metallurgical Characterization of Inconel-625 and Waspaloy Joints Brazed using Five Ag, Cu and Ni-Base Active Braze Alloys

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Abstract

Many industrial components such as heat exchangers and gas turbines are fabricated by joining a number of simpler units into complex structures. This demands development and demonstration of robust joining technology applicable to a wide variety of materials including alloys that can withstand very high temperatures that are encountered in jet engines, furnaces, combustion cans, and other systems. This research characterized brazed joints of two high-temperature nickel-based alloys for microstructure, composition, and hardness. The purpose was to evaluate the effectiveness of selected brazes and joining conditions to form integral joints that could be further characterized prior to pilot-scale testing and evaluation. Inconel-625 and Waspaloy[1] were vacuum brazed using two Ni-base amorphous brazes (MBF[2] -20 and MBF-30), two Ti containing Ag-Cu base brazes (Cusil-ABA and Ticusil), and a Cu-base active braze (Cu-ABA) with brazing temperatures in the range 1108-1348 K. All five brazes formed well-bonded metallurgically-sound joints. MBF-20, MBF-30, Ticusil-ABA and Copper-ABA exhibited substantial diffusion and prominent interaction zones whose thickness increased with increasing braze liquidus temperature.

[1] High-performance alloys; also referred to in industry as superalloys. These alloys have exceptional resistance to deformation and corrosion at elevated temperatures usually encountered in gas turbines and marine turbines.

[2] MBF stands for metallic glass braze foil. MBF is trademark of Metglas Solutions Inc. The company was bought by Allied-Signal/Honeywell in 1999, and in 2003, by Hitachi Metals Ltd.

Cusil-ABA with the lowest temperature (1108 K) had the smallest reaction layer whereas MBF-30, with the highest temperature (1348 K) had the thickest reaction layer. The interaction zones in Cusil-ABA and Ticusil joints were enriched in titanium and accompanied by Ti depletion and low hardness within braze matrix. The MBF-30 joints revealed the most prominent and most complex reaction layer of all brazes consisting of at least four different regions identified by their Knoop hardness.

Introduction

Inconel-625[3] is a versatile nickel-based alloy with excellent strength, ductility, and corrosion and oxidation resistance over a wide range of service temperatures, from cryogenic to about 982°C. Applications of Inconel-625 include propeller blades and exhaust ducts, submarine propulsion motors, steam-line bellows, heat-exchanger tubing, wire rope for mooring cables, and plasma confinement equipment in nuclear reactors. Some superalloy components can be formed by a single-step casting process but in many applications these alloys must be joined to themselves and to other materials to create parts. For example, a high pressure turbine nozzle assembly may be structurally supported by a nozzle support assembly formed by brazing a number of individual superalloy members. Brazing process parameters need to be controlled to avoid part cracking that may result from thermal stresses. These stresses develop when structural elements with different dimensions are joined together.

Although many superalloys are weldable[4], they often contain titanium and aluminum, which make the alloys susceptible to heat affected zone cracking during welding [Arafin et al, 2007]. High-temperature brazing with nickel-base filler alloys, containing boron and silicon as melting point depressants, has evolved as an effective alternative to welding to join superalloys. There are, however, a number of key metallurgical issues that must be addressed to realize the full benefit of brazing. For example, while the addition of boron to the filler metal is effective in depressing the alloy liquidus[5], boron has high grain

[3] INCONEL is a trademark of INCO Alloys, Huntington, WV

[4] Welding involves melting and fusion of the work-pieces whereas brazing involves melting and spreading of a low-melting point filler metal between work-pieces.

[5] The liquidus temperature is the temperature above which an alloy is completely liquid. Likewise, the solidus temperature is the temperature below which an alloy is completely solid. Between its solidus and the liquidus, an alloy is mushy (solid plus liquid). For a pure substance, solidus and liquidus temperatures are identical and equal the melting point of the substance.

boundary diffusivity at elevated temperatures. This causes boron to diffuse away from the joint before reaching the brazing temperature thus preventing complete braze melting and bond formation. In addition, Ti, Al, Fe and Nb are added to most superalloys including Inconel-625 to strengthen the alloys and enhance their oxidation resistance by forming tenacious metallic oxides. Unfortunately, these non-wettable protective oxides hinder braze spreading and flow, restrict surface coverage, and impair the bond quality. Thus, brazing of superalloys involves issues that require careful metallurgical evaluation of joints brazed using different type of filler metals.

The purpose of the study was to compare and contrast the microstructure, composition and microhardness of two vacuum-brazed nickel-base superalloys, Inconel-625 and Waspaloy. These alloys were joined using five different commercial braze alloys. : two Ni-base amorphous brazes, two Ti containing Ag-base brazes, and a Cu-base active braze. The research had the dual objectives: (i) investigate how the process of brazing modifies the composition of a given braze and the metallurgical structure of the braze and the substrate in the vicinity of the joint via diffusion and reactions and, (ii) evaluate how different braze alloys modulate the metallurgical structure, composition and hardness in and around superalloy joints. An evaluation of the basic metallurgical characteristics of Inconel 625 and Waspaloy joined using multiple Ag, Cu and Ni-base braze alloys should permit screening of potentially promising systems for a detailed future investigation.

Both Inconel-625 and Waspaloy retain high strength to elevated temperatures (870-980°C). They are used use under extreme heat and pressure environments such as those in gas turbines, combustors, and turbocharger rotors. Inconel-625 is an oxidation and corrosion-resistant austenitic Ni-based superalloy. Waspaloy is an age-hardenable, nickel-based superalloy with excellent strength properties. Generally, welding Ni-base superalloys is difficult due to cracking and microstructural segregation of alloying elements in the heat affected zone. Brazing such alloys works better than welding. Certain welding techniques can, however, be used with superalloys. Additionally, diffusion bonding [Ahmad et al, 2008], diffusion brazing [Ojo et al, 2004; Laux et al, 2010], transient liquid phase bonding [Egbewande et al, 2008; Ojo et al, 2004], and liquid infiltration

[Zhuang and Eagar, 1997] can also be used. Brazing is attractive to join superalloys because of its relative simplicity and cost-effectiveness.

Experimental Procedure

Inconel-625 and Waspaloy from Inco Specialty Metals were vacuum brazed to themselves using five active braze alloys with brazing temperatures in the range 1108-1348 K. These braze alloys were: Cusil-ABA, Ticusil, Cu-ABA, MBF-20 and MBF-30. The braze alloys Cusil-ABA, Ticusil and Cu-ABA were obtained from Morgan Advanced Ceramics, Inc., and MBF-20 and MBF-30 were obtained from Honeywell Corp. The compositions of Inconel 625 and Waspaloy are shown in Table 1. The composition and selected properties of the brazes are shown in Table 2. The joints created and characterized in the study, and the joining temperatures are shown in Table 3.

Table 1. Nominal Composition of Ni-base Superalloys used in the Study (in wt%)

Alloy	Cr	Co	Mo	Nb+Ta	Al	Ti	Fe	C	B	Zr	Si
Inconel 625	20-23	1.0	8-10	3.15-4.15	0.4	0.40	5	0.1	--	--	0.50
Waspaloy	18-21	12-15	3.5-5.0	--	1.0-1.5	2.6-3.25	2	0.08	0.008	0.02-0.12	0.75

The Inconel-625 substrates were cut into 2.54 cm x 1.25 cm pieces using a ceramic blade on a high-speed precision saw. The substrates and braze foils were ultrasonically cleaned in acetone for 15 minutes. Braze foils listed in Table 2 were sandwiched between the substrates, and a load of 150 g was applied normal to the joint during brazing. The assembly was heated in a furnace to the brazing temperature under high vacuum[6] (~10^{-6} torr), isothermally held for 5 min. at the brazing temperature, and furnace-cooled to room temperature. The brazed joints were mounted in epoxy and prepared for metallurgical examination, using grinding and polishing on a Buehler automatic polishing machine. The polished joints were examined using optical microscopy (OM), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS), and subjected to the Knoop microhardness test under 200 g load and a loading time of 10 seconds. Multiple hardness scans were accessed across representative regions of joined samples, and average values were reported.

[6] Conventional brazing requires use of fluxes that contain toxic and corrosive chemicals (e.g., hydrogen fluoride, potassium bifluoride, potassium fluoride). These fluxes release fumes and gases (HF and BF3) that cause irritation of eye and respiratory system, and sclerosis of the bone. Vacuum brazing permits extremely clean, high-strength, flux-free braze joints to form without release of toxic or corrosive effluents. Work-piece heats up uniformly under vacuum (less residual stress), and heat-treating could be combined with brazing in a single furnace cycle.

Table 2. Composition, and Physical and Mechanical Properties of Braze Alloys used in the Study

Braze	Comp., wt%	T_L, K	T_S, K	E, GPa	YS, MPa	CTE, x10^{-6} K^{-1}	K, W/m.K	%El
MBF-30[b]	Ni-4.61Si-2.8B-0.02Fe-0.02Co	1327	1257	--	--	--	--	--
MBF-20[b]	Ni-6.48Cr-3.13Fe-4.38Si-3.13B	1297	1242	--	--	--	--	--
Ticusil[a]	Ag-26.7Cu-4.5Ti	1173	1053	85	292	18.5	219	28
Cusil-ABA[a]	Ag-35.3Cu-1.75Ti	1088	1053	83	271	18.5	180	42
Copper-ABA	Cu-3Si-2Al-2.25Ti	1297	1231	96	279	19.5	38	42

[a]Morgan Advanced Ceramics; [b]Honeywell, Inc., T_L: liquidus temperature, T_S: solidus temperature, E: Young's modulus, YS: yield strength, CTE: coefficient of thermal expansion, K: thermal conductivity, %El: percent elongation.

Table 3. Vacuum Brazed Joints Evaluated in the Study

Substrates	Braze alloy	Brazing Temperature, K
Inconel/Inconel	Cusil-ABA	1108
Inconel/Inconel	Ticusil	1193
Inconel/Inconel	Cu-ABA	1318
Inconel/Inconel	MBF-20	1318
Inconel/Inconel	MBF-30	1348
Waspaloy/Waspaloy	MBF-20	1318

Results and Discussion

Figure 1 shows a montage of low-magnification photomicrographs of a complete joint between two bonded Inconel 625 substrates together with the solidified braze layer and the interaction zone that formed during high-temperature brazing from inter-diffusion of alloying elements. The microstructure, composition and representative microhardness of the joints evaluated in the study are displayed in Figs. 2 through 7 and discussed below.

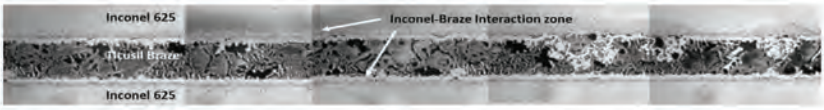

Fig. 1 A montage of optical photomicrographs of a complete Inconel/Ticusil/inconel joint showing the Inconel 625 substrates, the solidified braze layer, and Inconel-braze interaction zone

Figures 2 and 3 show the Inconel joints made using the two Ag-base active braze alloys, Cusil-ABA (Fig. 2) and Ticusil (Fig. 3). The braze region (Figs. 2(a) & (b)) shows the characteristic two-phase eutectic structure (Fig. 2a & b) of the solidified alloy. In joints made using Cusil-ABA, the braze/Inconel interaction zone was too thin to conduct micro-indentation test directly onto the interaction layer.

The Cusil-ABA interlayer has the lowest hardness (87 HK[7]) among the four brazes. However, in both Cusil-ABA and Ticusil joints, the Inconel matrix farther from the joint has slightly higher average hardness (335 HK) than the Inconel matrix in joints made using the two Ni-base metallic glass braze alloys (Figs. 4-6) discussed later. The high hardness of Inconel-625 is known to result from carbides of the type MC and M6C (rich in Ni, Nb, and Mo) as well as carbides of the type M23C6, which is a chromium-rich carbide.

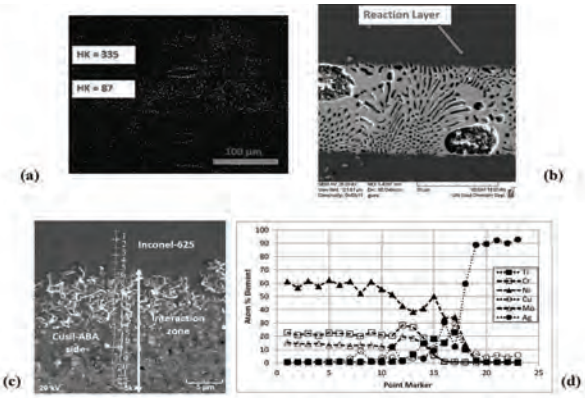

Fig. 2 An Inconel/Inconel joint made using Cusil-ABA braze: (a) overall view showing the average Knoop hardness, (b) SEM image of the joint showing the two-phase eutectic structure of Cusil-ABA, (c) a higher mag SEM view of the interaction zone/Inconel interface, and (d) relative atomic percentages of elements at point markers in (c) based on energy dispersive spectroscopy (EDS).

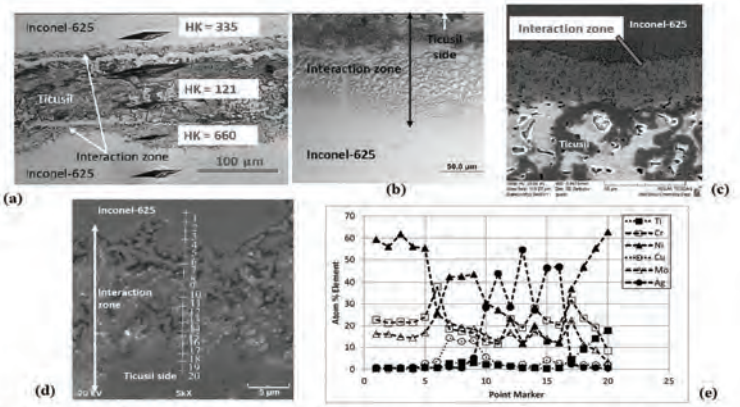

Fig. 3 An Inconel/Inconel joint made using Ticusil braze: (a) overall view showing average hardness of different regions, (b) interaction zone/Inconel-625 interface, (c) & (d) higher magnification secondary electron SEM images of the interaction zone, and (e) atomic percentages of elements at point markers in (d) from energy dispersive spectroscopy (EDS).

The energy dispersive spectroscopy (EDS) results for the Cusil-ABA joints (Figs. 2c & d) revealed Ti enrichment inside the interaction zone (point markers 13 through 18) where a

[7] HK denotes Knoop hardness.

peak concentration of 18 atom % titanium was attained. The EDS results also show Ti depletion within the braze region where the titanium concentration drops to near-zero values and causes the braze hardness to drop to low (87 HK) values. The Cr and Mo concentrations drop precipitously to near-zero value within the interaction zone indicating sluggish diffusion of these solutes at the brazing temperature.

In Inconel joints made using Ticusil (Fig. 3), a prominent interaction zone of high (660 HK) hardness developed. The high hardness was caused by the diffusion of titanium atoms toward the interaction zone which is confirmed from the Ti enrichment noted in Figs. 3d & e (point markers 17-20). However, even with a partial loss of Ti, the Ticusil braze retains higher hardness (121 HK) than Cusil-ABA (87 HK). This was because of a higher initial titanium concentration (4.5 wt%) in Ticusil than in Cusil-ABA (1.75 wt%). Precipitation of secondary phases in the interaction zone is revealed in Figs. 3(b-d). The EDS scans across the Ticusil joints also show that regions of high Mo and Cr concentrations correspond to low Ti concentration regions and vice versa. It appears that the microstructure of the Ticusil/Inconel interface consisted of an interaction zone[8] extending from the brazed region into the Inconel substrate along the Inconel's grain boundaries. The interaction zone was much harder than the braze region or Inconel substrate. In contrast to the Ticusil-ABA braze, the Cusil-ABA braze formed a very thin interaction zone, which is barely visible under an optical microscope. Compared to Ticusil, the smaller concentration (1.75 wt%) of the reactive titanium and lower liquidus temperature (1088 K) of Cusil-ABA were responsible for the thinner interaction zone in Cusil-ABA joints.

[8] *Research on phase analysis of the interaction zone was not attempted within the constraints of the project*

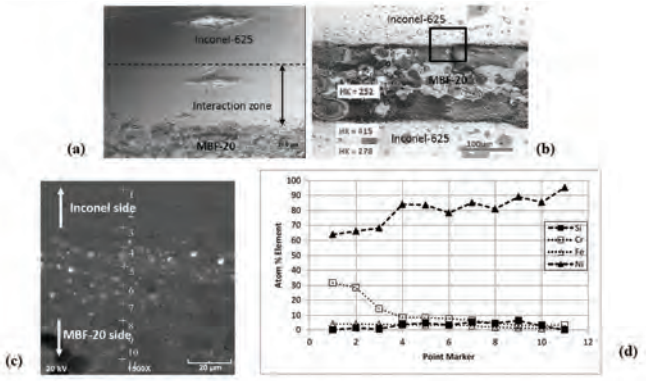

Fig. 4 An Inconel/Inconel joint made using MBF-20 amorphous braze filler: (a) Inconel/braze interface showing interaction zone, (b) average Knoop hardness values in braze, interface, and Inconel matrix, (c) SEM image of the interaction zone, and (d) relative atomic percentages of Si, Cr, Fe and Ni at point markers in (c).

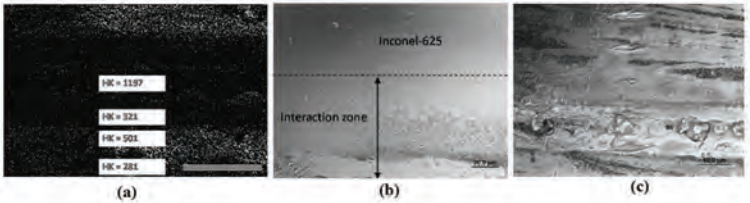

Fig. 5 An Inconel/Inconel joint made using MBF-30 amorphous braze filler: (a) overall view with average Knoop hardness of different regions, (b) Inconel/braze interface showing the Ni grain structure revealed by secondary phase precipitation at grain boundaries near the interface, and (c) overall view showing hardness indentation marks.

Although the brazing time (5 min.) was relatively short, Cu and Ag from Ticusil diffused along the Inconel grain boundaries to measureable distances forming a prominent interaction layer at the interface (Figs. 3(b-d)). This observation is consistent with the strong chemical affinity between Ag and Ni and between Cu and Ni that aided elemental diffusion along Inconel grain boundaries and facilitated bond formation upon solidification. Diffusion occurred in the solid state during heating to the brazing temperature and during cooling at the conclusion of brazing. Because excessive diffusion and solute segregation of the low melting point metals Ag and Cu may deteriorate the elevated temperature properties of Inconel-625, it is necessary to optimize the brazing temperature and time to develop a strong interfacial bond without causing degradation of the mechanical properties of the joined Inconel substrates. Such an optimization

was not attempted in the present study.

Amorphous Ni-base brazing foils MBF-20 and MBF-30 (Table 2) have been developed using rapid solidification technology [Rabinkin, 2004] and used to join alloys including Inconel [Rabinkin, 2004; Wu, 2000; Miyazawa and Ariga, 1992]. The Inconel joints made using MBF-20 (Fig. 4) show a distinct interaction zone (Figs. 4a & b) of higher average hardness (Knoop hardness: 415 HK) than either the braze region (252 HK) or the Inconel matrix (278 HK). The EDS results (Fig. 4 c & d) across the interaction zone/Inconel boundary showed the presence of small (6-7 atom %) concentrations of Si and Fe in the interaction zone; the high Fe concentration regions overlap the low Si regions. Silicon and boron were added as melting point depressants to the amorphous filler metal. The chromium content continuously decreased from 30 atom % on the Inconel side (point markers 1 & 2, Figs. 4c & d) to about 4-8 atom % in the interaction zone (point markers 4-10). The Ni content increased gradually from 62 atom % (point marker 1) in Inconel to nearly 95 atom % (point marker 11) in the interaction zone. The element boron could not be detected in the interaction zone using the EDS; however, it is known [Grushko and Weiss, 1984] that appreciably faster diffusion of boron compared to that of Cr and Si could lead to large penetration distances of boron and formation of hard and brittle boride phases (e.g., Ni3B and CrB2 [Jalilian et al, 2006; Pouranvari, 2009]) especially after long brazing times and at high temperatures. The relatively short (5 min.) brazing times used in the present study may have limited the boron diffusion to near-interface regions where possible formation of hard boride phases could have led to higher hardness. Absence of any observable changes in the microhardness of the Inconel substrate far from the interface region was consistent with the presumed lack of long-range diffusion of boron during brazing.

An Inconel 625 joint made using MBF-30 amorphous braze is shown in Fig. 5. Of all brazes examined in the study, MBF-30 led to the most prominent and most complex reaction layer consisting of at least four different regions identified by their Knoop hardness values. The hardness of the braze region averaged 1197 HK and was the highest value observed. The region closest to MBF-30 had a hardness of 321 HK whereas the hardness farther out toward the Inconel boundary was 501 HK.

The Inconel matrix far from the joint had a hardness of 281 HK similar to the value (278 HK) for MBF-20 (Fig. 4). The formation and distribution of brittle borides of Cr and Ni are responsible for the increase of micro-hardness. Solute diffusion and segregation along the matrix grain boundaries, together with the precipitation of secondary phases (e.g., carbide and boride), are seen to have decorated the Inconel grain boundaries that are visible in the un-etched sample of Fig. 5b.

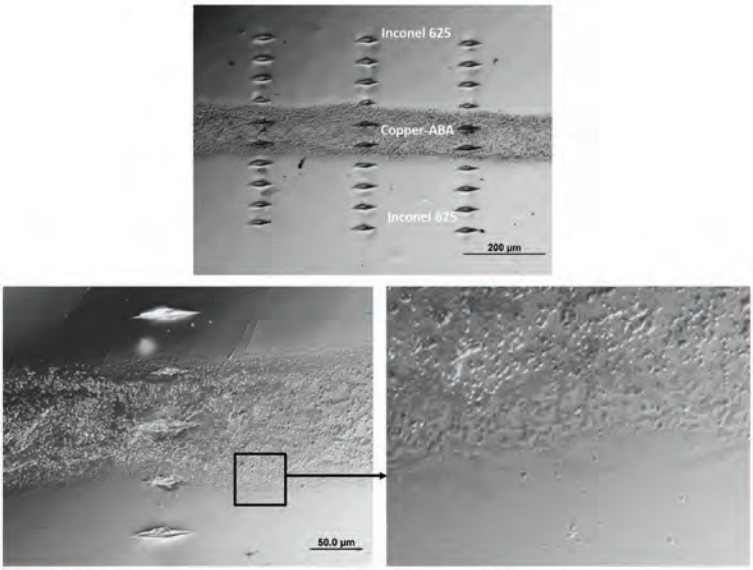

Fig. 6 (a)-(c) An Inconel/Inconel joint brazed using Copper-ABA braze showing a defect-free interaction zone and hardness indentation marks across the joint.

An Inconel joint made using Copper-ABA braze is shown in Figure Fig. 6 (a-c). The joint was defect-free and exhibited a distinct interaction zone. A detailed chemical and metallurgical characterization of the joint using the SEM and EDS was not attempted. The dark phase with round morphology in the braze matrix had been reported [Arafin et al, 2007] to be a Cu phase rich in Si and Ti. The HK in the center of the Cu-ABA braze is 673 HK whereas the reported HK of as-received Cu-ABA per the supplier is 112 kgf.mm-2 (1100 MPa). This hardness increase following brazing is believed to result from the inter-diffusion of alloying elements. The HK of the prominent interaction zone (Fig. 6c) was even greater as evidenced by the smaller size of the

indentation (Fig. 6b). Figure 7 shows a Waspaloy/Waspaloy joint vacuum brazed using MBF-20 braze. The joint was sound and defect-free, and exhibited smaller hardness indentation marks within the braze than Waspaloy.

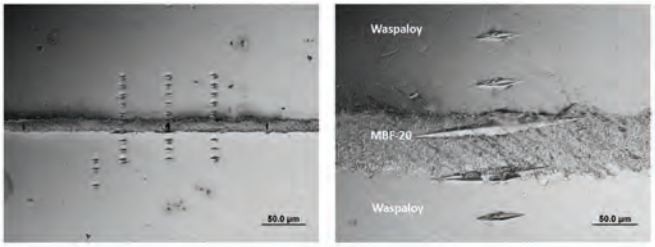

Fig. 7 (a)-(c) An Waspaloy/Waspaloy joint vacuum brazed using MBF-20 braze showing (a) overall view and (b) Knoop indentation marks in braze and waspaloy regions.

Four of the five brazes examined, MBF-20, MBF-30, Ticusil-ABA and Copper-ABA, exhibited substantial diffusion of alloying elements along the braze/Inconel interface, as reflected in the formation of prominent reaction layers. The thickness of the reaction layers showed a correlation with the braze liquidus temperature, which was consistent with enhanced diffusion at elevated temperatures. Cusil-ABA with the lowest liquidus temperature had the smallest reaction layer of all braze alloys whereas MBF-30 with the highest liquidus temperature had the thickest reaction layer. Both very thin and very thick reaction layers are deleterious to bond quality; thin layers provide insufficient bond strength whereas thick layers form excessive brittle reaction products that weaken the joint. An optimum reaction layer thickness can be empirically established for complex multicomponent alloy systems such as those examined here, and related to the joint strength and toughness characteristics.

Conclusion

The purpose of the study was to evaluate the effectiveness of several high-temperature commercial brazes to form metallurgically-sound joints in two industrial nickel-base superalloys. Although the study did not focus on a specific product such as propeller blades, exhaust ducts or combustion cans where such alloys are currently used, the research outcomes offered insights into engineering development of a simple and

environment-friendly flux-less joining technology applicable to such components.

The research characterized vacuum brazed joints of Inconel-625 and Waspaloy for microstructure, composition, and hardness. The joints were made using five different commercial braze alloys with brazing temperatures of 1108-1348 K: two Ni-base amorphous brazes, two Ti containing Ag-base brazes, and a Cu-base active braze. All five brazes formed metallurgically sound joints. Four of the five brazes examined, MBF-20, MBF-30, Ticusil-ABA and Copper-ABA, exhibited substantial inter-diffusion and prominent interaction zones. The thickness of the interaction zones showed a correlation with the braze liquidus temperature due to faster diffusion at elevated temperatures. Cusil-ABA with the lowest temperature (1108 K) had the smallest interaction zone whereas MBF-30, with the highest temperature (1348 K) had the thickest interaction zone. The interaction zones in Cusil-ABA and Ticusil joints were enriched in titanium and accompanied by Ti depletion (and low hardness) within the braze. Even with partial loss of Ti in the interaction zone, the Ticusil braze retained higher hardness (121 HK) than Cusil-ABA (87 HK). The MBF-30 joints revealed the most prominent and most complex reaction layer of all brazes consisting of at least four different regions identified by their Knoop hardness.

As excessive diffusion and segregation may degrade joint properties, it is necessary to optimize the joining conditions (e.g., temperature and time) to develop a strong interfacial bond without deteriorating the joint- and substrate properties. Such an optimization was not attempted in the present study, and it represents an area for future study. The optimized joining conditions and the most promising braze alloys identified by further study could then be subjected to pilot-scale testing and evaluation.

In summary, the research provided an understanding about (i) how brazing process modifies the braze composition because of chemical interactions with the substrate, and (ii) the metallurgical structure and hardness of the braze and the substrate in the vicinity of the joint. The study offered an opportunity for in-depth research and exploration of an important manufacturing technology.

Acknowledgement: Vacuum brazing, scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS) were done at the NASA Glenn Research Center, Cleveland, OH, by Dr. Rajiv Asthana. Metallurgical preparation, optical microscopy, and hardness testing were done at UW-Stout.

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A Minnesota Prairie Style: John Howe and the Menomonie Public Library

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Abstract

This paper highlights and analyzes architect John H. Howe's 1986 design for the Menomonie Public Library, and the preliminary designs leading up to its completion. A prolific Midwest architect in his later career; Howe was Frank Lloyd Wright's chief draftsman for 27 years. He was known for his speed and proficiency at architectural drawings, which illustrated the profound integration of Wright's buildings into the landscape. He closely followed Wright's philosophies and later adapted Prairie School architecture for Minnesota's unique climate. The Menomonie Public Library illustrates the primary elements found in Howe's designs. It is based upon a geometric structure and is tailored to suit the characteristic of the site and the needs of the client. Carefully selected natural and modern building materials as well as the surrounding landscape serve as the inspiration for the design. The Menomonie Public library is a unique and functionally beautiful example of organic architecture in the Midwest.

Keywords: John H. Howe, organic architecture, architecture, Frank Lloyd Wright, Menomonie Public Library, Minnesota Prairie School

Architect John H. Howe was retained in 1981 to design a new public library in Menomonie, Wisconsin. This commission was gained near the end of a long and distinguished career. Howe's primary influence was that of his mentor, the founder of organic architecture, Frank Lloyd Wright. Though he was draftsman for Wright's most famous projects, Howe's work is relatively unknown. The Menomonie Public Library is functional and elegant, carefully integrated into the lakeshore landscape; it is the result of an extensive process of design iteration. While it shares similarities with Wright's work, the building is an example

*Diana is a McNair Scholar (Ed.)

of Howe's unique design method, which he called the Minnesota Prairie Style.

John Howe realized over 80 buildings in the Twin Cities area of Minneapolis and Saint Paul, Minnesota, including the First Church of Christ, Scientist, in New Brighton, Minnesota and the public library in Menomonie, Wisconsin. Homes located in western Twin Cities suburbs comprise the majority of his built designs. The houses are not readily visible because they are so carefully worked into the landscape.[1] This defining aspect of organic architecture becomes increasingly vital as development takes over wild places in the urban environment. Organic buildings take into consideration both the physical and spiritual needs of their occupants. The designs are simple, honest and functional, with formal elements based upon abstraction of natural forms. Howe's buildings include some of the best examples of organic architecture in the Midwest.[2]

The Menomonie Public Library rests on the shore of lake Menomin, in the university town of Menomonie, Wisconsin, which is located about an hour from Minneapolis, Minnesota (Image 1). The building is subtly earth sheltered. It has a hipped roof, brick exterior walls,

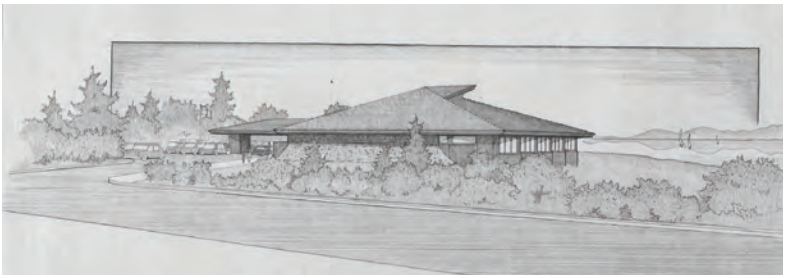

Image 1. Howe, J. H.. Menomonie Public Library II View from the Southwest. [Colored pencil on blueline]. John Howe Collection (N14). University of Minnesota Libraries, Minneapolis, MN.

and is oriented to face away from the road toward the lake. The final design of the library was completed after an extensive process of re-design, aligning Howe's architectural ideals with the practical requirements and budget provided by the community.

[1] *Linda Mack, 2000. Living in a Howe house: Wright's draftsman also built a lot. Star Tribune. Retrieved 3/24/12:1. http://www.startribune.com/lifestyle/11478911.html?refer=y*

[2] *Ibid.*

John Howe and Frank Lloyd Wright

John Henry Howe was born on May 17, 1913 and was raised in Evanston, Illinois, an affluent Chicago suburb. He lived in a neighborhood with a number of houses designed by Frank Lloyd Wright and his draftsman, Walter Burley Griffin. When Howe was a child he aspired to become an architect and hoped to work with Frank Lloyd Wright. He said that he had happy childhood memories of bicycling in Oak Park and Chicago's North Shore to visit Wright's buildings.[3]

In 1932, one week after graduating from high school in Evanston, he joined the first class of students in the Taliesin Fellowship, an apprenticeship program under Frank Lloyd Wright, later to become the Frank Lloyd Wright School of Architecture. Wright and his wife Olgivanna Lloyd Wright founded the Fellowship that same year in Spring Green, Wisconsin. Living and working at Taliesin was a formative experience for Howe. He said that Frank Lloyd Wright taught him how to live. The apprentices worked alongside Wright in all things, sharing the tasks of everyday living. During the Great Depression everyone at Taliesin, including Wright, worked at subsistence farming. Howe learned the joy of hard work and the appreciation of music. Frank Lloyd Wright taught a fundamental work ethic, believing the words of a hymn they would sing at Taliesin, "Joy in work is man's desiring."[4]

A man of remarkable integrity and social conscience, John Howe was arrested at Taliesin in 1942 for refusing conscription into the army during WWII. In 1943 he was put on trial and sentenced to prison. He spent nearly three years in the Federal Correctional Institution at Sandstone, Minnesota.[5] The facility was minimum security and Howe continued to work, creating a number of designs for buildings and futuristic objects, like a motor home for Frank Lloyd Wright. He also taught drafting to fellow inmates, many of whom were imprisoned for the same reason.[6]

From the beginning of his apprenticeship, Howe distinguished himself through his excellent skill in drawing and drafting. In 1935 he became chief draftsman and senior

[3] Richard L. Kronick, The Pencil in Frank Lloyd Wright's Hand, Journal of the Taliesin Fellows - Issue 23. Summer (1998): 4-17. Los Angeles:Taliesin Fellows, 7.

[4] Richard Kronick, 1998, The Pencil in Frank Lloyd Wright's Hand, 15.

[5] MIA, John Howe in Minnesota: The Prairie School Legacy of Frank Lloyd Wright, September 2, 2000-January 7, 2001. Contributors: Minneapolis Institute of Arts, Frank Lloyd Wright Building Conservancy. Minneapolis: Minneapolis Institute of Arts, 2000, 1.

[6] Jane. K. Hession, & Tim Quigley, 26 no. 4 (Sept./Oct. 2000). The future imagined : John Howe in Sandstone. Architecture Minnesota, 42.

apprentice in charge of the Taliesin drafting studios. He rendered the ideas that Wright created, supervised the work of the apprentices and traveled to oversee various building sites. Howe worked so closely with his mentor that his desk was adjacent to Wright's and they often shared drafting tables, taking turns working on the same drawing. He learned to work very quickly in order to keep up with Wright. It is said he could create finished drawings more quickly than drawings can be created with computer assistance today.[7] John Howe produced many of the beautiful drawings associated with Frank Lloyd Wright's architecture. He worked with Wright on hundreds of projects, including the senior architect's most famous and influential works. Howe was the draftsman for Wright's masterpiece, Fallingwater (1934) in Mill Run, Pennsylvania, the Johnson Wax Building (1936) in Racine, Wisconsin, and the Guggenheim Museum in New York City (1943).

Frank Lloyd Wright was an excellent draftsman and taught Howe the style and drawing technique that Wright had perfected under his teacher Louis Sullivan, an influential architect known as the "father of modernism". With Wright's guidance, Howe refined his skill at producing pencil and ink plans and perspectives. Howe created two sets of hand colored drawings for each project, often drawn directly onto the blue-line drawings. His hallmark technique involved many perfectly rendered parallel lines, illustrating planes in color. Howe was known for his unique, stylized way of rendering vegetation, showing the integration of the design into the site, a cornerstone of organic architecture.[8] These drawings distinguished Howe throughout his career. The excellence and speed at which he could render was truly remarkable. This skill undoubtedly aided him in the second chapter of his career, his architecture practice in Minneapolis, Minnesota.

John Howe's Life After Taliesin

In April of 1959, at the age of 91, Frank Lloyd Wright passed away while undergoing surgery in Phoenix, Arizona. Howe continued to work at Taliesin, helping to complete projects that were in progress and starting new commissions, running the Taliesin studio along with Wes Peters, Wright's engineer and son-in-law. They completed projects that were started under Frank

[7] *Myron A. Marty & Shirley L. Marty, 1999, Frank Lloyd Wright's Taliesin Fellowship. Kirksville, Mo.: Truman State University Press.*

[8] *Jane King Hession & Tim Quigley, The future imagined: John Howe in Sandstone, 42.*

Lloyd Wright such as the Marin County Civic Center and the Guggenheim Museum in New York City. At this time, most of the senior apprentices remained at Taliesin. Howe and Peters, along with about ten senior apprentices eventually formed the group the Taliesin Associated Architects.

In 1964 John Howe left Taliesin to join the San Francisco office of Aaron Green, the West Coast representative of the Frank Lloyd Wright Foundation. Howe wanted to start an architecture office in Santa Cruz, California, but was getting requests for work in Minneapolis, Minnesota. He had designed three houses in Minneapolis while he was at Taliesin. In August of 1967, he opened an office on Wayzata Boulevard in Minneapolis.

John Howe's Philosophy

After years of developing his architecture practice, Howe found in his mid-career that he was a regional architect with a philosophy adapted specifically to the Midwest. He observed that the Minnesota area called for a unique form of architecture. Flat roofs could not withstand severe winters. Windows must be oriented to the south. Integration of passive solar building design,the use of a building's site, and materials to minimize energy use, was necessary for buildings to be comfortable through severe winters. About this Howe said, "I have developed a Minnesota Prairie School architecture… I also confess to following somewhat in the footsteps of Purcell and Elmslie who were here first and did wonderful work."[9]

William Gray Purcell and George Grant Elmslie, like Frank Lloyd Wright were practitioners of Prairie School architecture, a style beginning in the late 19th century. They described their work as 'organic', referring to a philosophy of integration and intentional reference to natural forms. The style aspired to qualities of honesty and democracy, called for the design of the building and its contents to be integrated and for functional form to be the basis of the design.[10] Organic architecture grew out of ideas of both the Prairie Style and the late 19th century Arts and Crafts movement, promoted by John Ruskin and William Morris. This philosophy embraced ideals of honesty in materials, hand crafted production and exceptional design of every day objects.

[9] Richard Kronick, 1998, The Pencil in Frank Lloyd Wright's Hand, 6.

[10] David Gebhard, 2006, Purcell & Elmslie: Prairie Progressive Architects, Gibbs Smith, Salt Lake City, 21-22.

John Howe's Design Method

John Howe's designs originated with the inherent characteristics of the site and drew inspiration from carefully chosen building materials. He embraced the principles of organic architecture, the most important being "the land is the beginning of architecture."[11] Once he had visited a site and become familiar with it, Howe became inspired to create a design based upon the landscape and the needs of the people who would live there. He would start with a topographical map, then orient the house to the compass points and surrounding views. He carefully considered the role of light and shadow, the orientation of the morning sun and details such as where the rain falls from the roof.[12] He kept intact certain aspects of the site, beautiful rocks and trees.

Elements of organic architecture include interiors that are divided into zones that were based upon the intended function of the space. The plans were very open; the shared areas of the house such as living and dining rooms were often delineated by a change in the height and construction of the ceiling. Walls were used to separate private portions of the house such as bathrooms, bedrooms and the kitchen. Terraces, balconies and banks of windows intentionally brought nature inside, blurring the boundary between the building and the outdoor environment.[13] Howe's buildings have a unique spatial composition based upon an underlying geometric structure. Each architectural element within the library's plan fits within this matrix.

The structure is more involved and considered than a simple grid pattern or rule of proportion. Naturally inspired geometric forms determine the building's structure. Each architectural component 'grows' from that structure. The design for the Menomonie Public Library began as a deliberate matrix of lines that is similar to tree branches, or perhaps molecular system of units. This method helps to create a sense of order and aesthetic unity in the space.

In keeping with the Prairie School, John Howe created objects that were integrated into the architecture of a building, including stained glass, furniture, built-in cabinets and light fixtures. He used very limited ornament in his buildings; often

[11] *John H. Howe & M. Tanigawa, 1975, John H. Howe, Architect/visiting professor, Nihon University. Dept. of Architecture, College of Engineering, Nihon University, 1.*

[12] *Linda Mack, 2000, Living in a Howe house: Wright's draftsman also built a lot, 1.*

[13] *Koning, H. & Eizenberg, J. (1981). The language of the prairie: Frank Lloyd Wright's prairie houses. Environment and Planning B. 313.*

limiting architectural ornamentation to perforated or hinged boards around the soffit, a feature seen in the Menomonie Public Library. Ornamentation was minimal, and an integrated part of the whole, "as flowers on the tree", something more profound than surface decoration.[14] These characteristics of simplicity and integration are illustrated in the series of design drawings leading to its completion.

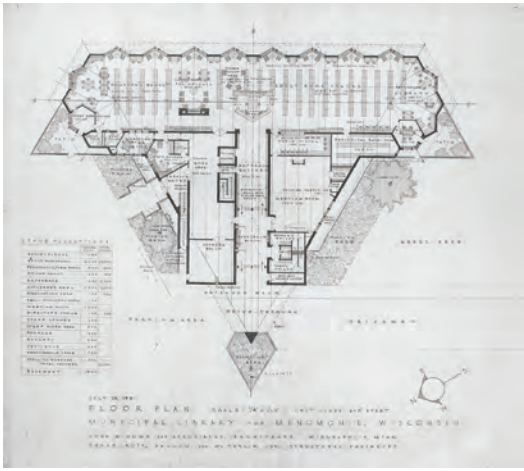

Image 2. Howe, J. H. (Date, Month). *Menomonie Public Library II Floor Plan.* [Colored pencil on blueline]. John Howe Collection (N14). University of Minnesota Libraries, Minneapolis, MN.

The Creation of the Menomonie Public Library

Plans for the new library in Menomonie, Wisconsin were considered for nearly ten years before the building was finally realized. Plans were stalled by political, financial and practical challenges. In 1977 a Menomonie City council vote to created a Municipal Library Board, consisting of nine members. In 1979 the City Council approved funds to purchase or develop a library building or site along with construction costs. There was a great deal of community interest in locating the library downtown. A few architects were selected to compete for the project. Library Board member Bob Willow and his wife Jan approached John Howe for the project. Howe, in the tradition of Wright generally did not participate in competitions. The Willows commissioned Howe to do a series of preliminary drawings for the downtown

14. John H. Howe, The land is the beginning of Architecture – Lecture by John H. Howe given in Japan, John Howe Collection (N14). Minneapolis: University of Minnesota Libraries, 1975.

site that were later presented to the library board.[15]

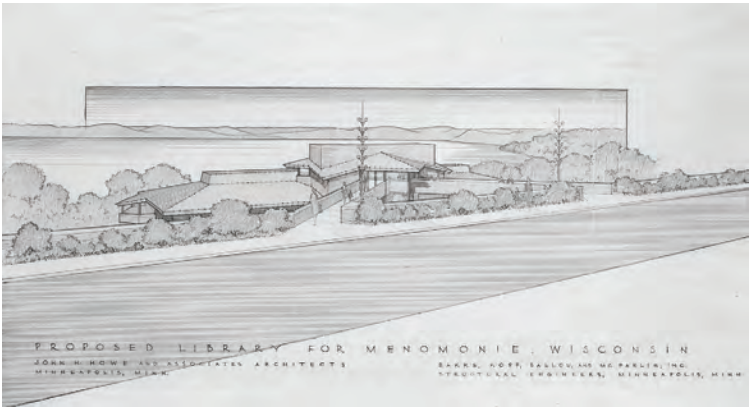

Image 3. Howe, J. H.. *Menomonie Public Library I Exterior Perspective*. [Colored pencil on blueline]. John Howe Collection (N14). University of Minnesota Libraries, Minneapolis, MN.

These drawings describe a building located on Third Street and Crescent Avenue, which was never built (Image 3). The preliminary drawings illustrate a design that combines elements of organic influence and futuristic idealism. A horizontal, hipped roofline, in which the four sides slope gently downward, mirrors the shape of distant hills. Three central flat rooftops integrate with those of the downtown buildings. The structure was to be dramatically cantilevered over the hillside, supported by precast concrete pilings, the overall form reminiscent of the trees that would surround the building. Dual diagonal walkways would have approached a wide building that was dynamically stacked upon the steep lakeshore. The building's vertical orientation allowed for more light to enter the interior and efficient use of space within the small lot. The plan featured a sheltered drive that met a lower level entrance and underground parking. Despite, or perhaps because of its dramatic and visionary nature, this plan was later rejected in favor of a larger site.

In 1980 the Municipal Library Board purchased, a two-acre plot of land acquired from the Myrtle Werth Medical Corporation for the amount of $70,000. The location, just north of the downtown area, would provide space for a large building with a wide view of Lake Menomin. John Howe felt the new lakeside site was excellent and imagined that it would take

[15] *Bob Willow, & Jan Willow, 2013, Interview conducted by Diana Witcher.*

about seven months to construct the building. He wanted to create a structure of timeless character and distinction, naturally integrated into the landscape. The Library Board was somewhat concerned about his age (68), but chose him for his design ideas and excellent references.[16] Howe was formally chosen as architect for the Menomonie Public Library on March 24 of 1981.

Designing the Library

In August of that year Mr. Howe presented a preliminary design for the building. The drawings called for another forward-looking plan (Image 4). The building was to be earth sheltered and roughly triangular in shape, the south and east sides dominated by windows. A series of triangular skylights would bring light into the interior and a 180-foot long entrance hall would house an art gallery. A future addition would create a mezzanine, a half story including clerestory windows.

Image 4. Howe, J. H.. Menomonie Public Library II Interior Perspective. [Colored pencil on blueline]. John Howe Collection (N14). University of Minnesota Libraries, Minneapolis, MN.

In October of 1981 the library board reviewed the proposed plans and suggested a number of changes. These included removing a large fireplace from the children's area for safety reasons, shortening the entrance hall and reshaping the front of the building.[17] In December of 1981, Howe presented revised site plans and a summary of construction costs, which totaled $1,137,020. The board suggested that Howe "pull back the

[16] *K. Barnard, K. Building the Menomonie Public Library: An inside view. Menomonie Public Library, 1986.*
[17] *K. Barnard, K. Building the Menomonie Public Library: An inside view. Menomonie Public Library, 1986.*

perimeter by one foot in order to stay within the budget."[18] The revised plan maintains some of the original structure, but the building folds in upon itself, a triangle becomes a pentagon and the building has an even more open and compact plan. Despite a series of significant changes by the client, in the end Howe created a space that is beautiful, unique and functional.

Protests Over Proposed Library

Local opposition to the new library was to some extent based upon affection for the library that was going to be replaced. Up until this time the library in Menomonie was housed in the historic Mabel Tainter Memorial Building, a Richardsonian Romanesque building located in the downtown area. Established by Senator James H. Stout, it was one of the first public libraries in the state of Wisconsin. In the 1980s the books were still housed in tall bookshelves, accessible only to the staff. A patron would request a specific book and a librarian would ascend a tall ladder to retrieve it.[19] A number of community members fought to preserve the Tainter Library and after this option proved impractical, pushed to maintain a downtown location for the library. In June of 1982 a petition was circulated protesting the construction of the new library. In October of the same year, the Library board was served with an injunction prohibiting them from proceeding with the building. In November 1982, an advisory referendum, which would allow the library board to move forward with plans for the library, was defeated. A local developer proposed a hotel on the property if plans for the library were not realized.[23] After this setback, the library construction was delayed for another three, as the project awaited funding and local government approval.

In 1985 the plan for the new library finally gained the necessary momentum for completion. In April the City Council permitted an application for a 125,000 grant, which was approved in July by the Department of Public Instruction. The Library Board now had nearly all the funding required to proceed. As previously agreed the City Council provided the additional $350,000 needed to complete the project. All aspects of the plan for the library had finally gained approval and construction of the building soon commenced.

[18] Barnard, K. (1986). Building the Menomonie Public Library: An inside view. Menomonie Public Library.

[19] Bob Willow, & Jan Willow, 2013, Interview conducted by Diana Witcher.

[23] K. Barnard, 1986, Building the Menomonie Public Library: An inside view, 1986.

The groundbreaking ceremony for the Menomonie Public Library was held on Saturday October 5, 1985. John Howe attended the ceremony. Community opposition persisted; individuals who opposed the building picketed that day reportedly with signs that read "This is Russia" and "Don't Ask the County."[24] On August 6, 1986 the Mabel Tainter Library was officially closed. On September 2, after nine years of planning, the Menomonie Public Library opened to the public.

The library dedication was held on September 21, 1986. John Howe and Public Library Board president Dwight Agnew attended. First Lady Barbara Bush presided over the ceremony; at the time Mrs. Bush was working on a campaign to eradicate illiteracy. A group of fifteen to twenty people picketed the dedication, but the event was well attended.[25]

At the dedication Howe said, "I won't say much… The library says what I have to say...Within these walls the citizens of Menomonie will discover new horizons. For as we know, there is no frigate like a book to take you miles away. The library offers limitless expansion and growth." There is a handwritten note on a newspaper clipping from Howe's business files in the Northwest Architectural Archives correcting a misquote from "there is no thrill" to "there is no frigate."[26]

The Library as Built

The library features a low sheltering roof and covered entrance on the north (Image 5). The building is pentagonal in shape. Energy efficient walls enfold a series of windows on the east and south, which afford lake views and collect passive solar energy. The circulation desk is centrally located, providing ease of observation and service, near rows of bookshelves for 36,000 books. A large public meeting room, paneled entirely in red oak, is adjacent to the main entrance allowing for use when the library is closed. A centrally located audiovisual section is situated near the children's area on the south, along with space for computer terminals. A story-hour discussion room is positioned between the children's library and the meeting room. An elevator provides access to a 4,800 square foot basement, which holds workshop and storage space. The completed building is 12,000 square feet and cost 1.2 million dollars.

[24] *K. Barnard, 1986, Building the Menomonie Public Library: An inside view, 1986.*

[25] *Chuck Backus, 2011, 1986: Menomonie dedicates new public library. Dunn County News. Retrieved 3/24/12: http://chippewa.com/dunnconnect/news/local/history/menomonie-dedicates-new-public-library/article_87ecac7a-e3a8-11e0-a8e2-001cc4c03286.html*

[26] *a small warship or archaic sailboat*

John Howe chose materials for the library that are beautiful, modest and readily available in the Upper Midwest. The walls and roof supports are made of brick or burnished concrete masonry on all exposed faces, both inside and outside. The colors are warm and inviting. The exterior brick is reminiscent of the local sandy-colored limestone bedrock. The partitions on the interior are steel framed and finished with paneling made of red oak. Red oak and cedar are used throughout the building. Both trees are often found growing wild in the Menomonie area. The bookshelves, carrels, tables and chairs are also red oak.

Image 5. Howe, J. H. (Date, Month). Menomonie Public Library II View from the Southwest. [Colored pencil on blueline]. John Howe Collection (N14). University of Minnesota Libraries, Minneapolis, MN.

In the tradition of organic architecture, transitions in the ceiling delineate areas of function within the building. The central information area is a primary focus, housed by a stained glass ceiling. The areas that hold the library materials have ten-foot high ceilings, with long vertical lines of florescent light and acoustical tile; these aspects encourage movement. The reading areas on the perimeter of the building are situated near the windows. A lower eight-foot ceiling made of cedar designates them as areas of quiet and repose. The combination of lowered ceilings and natural light from the windows creates a feeling of stillness and intimacy. In this perimeter there is a series of tables

and chairs, centered on windows that create cozy semi-private areas to read and research. The building has a sense of dignity and tranquility. It is remarkable how quiet it is in the back of the library. There is no noticeable noise from the street and one can concentrate on work or enjoy the beautiful view of the lake.

John Howe's design for the Menomonie Public Library was his own, but he drew inspiration from the work of Frank Lloyd Wright. The central ceiling of the library is pentagonal in shape and backlit, functioning as stained glass (Image 6). The structure is reminiscent of the ceiling in the living room of the Coonley House (1908) by Frank Lloyd Wright, located in Riverside, Illinois. The radial form is similar, as are the secondary crosspieces. Howe's design has more symmetry and a more conventional treatment of negative space. Howe's version is also functional, providing light to the room below.

Image 6. Witcher, D. (2013, May). *Menomonie Public Library Ceiling* [Photograph]. Menomonie, Wisconsin.

The ceiling originally provided natural light through a light well that originated in the winged portion of the library roof. Because the light was too dim, fluorescent lights were later installed. The geometric shape houses five inner triangles, divided into five sections by red oak styles, which hold vertical

pieces of colored glazing. This element brings an openness and elegance to the center of the library. As a focal point it is a visual cue to the use of the space, sheltering the information and circulation desks, areas of primary interactions between library staff and patrons.

Conclusion

John H. Howe was a prolific architect who made an important contribution to American architecture. His work evolved into what he called a Minnesota Prairie Style, which originated in organic architecture and the philosophies developed by Frank Lloyd Wright. Howe's work had an elegant pragmatism that was uniquely his own. His designs centered on the characteristics of the site and the needs of the client. Inspiration for each design began with the landscape and the nature of the materials at hand. His designs are complex and elegant, grounded in the concepts of organic architecture. Howe's buildings offer myriad opportunities for research and historical restoration. Though will first be remembered Wright's draftsman and senior apprentice of the Taliesin architecture studio, his architectural designs are a significant contribution to organic architecture. His built structures should be preserved and cherished both for their historical value and their inherent quality of intelligent, understated beauty.

The Menomonie public library is an unknown historical gem, a unique community space designed by a quietly influential Prairie School architect. John Howe intended the Menomonie Public Library to be a building that was profoundly integrated into its natural surroundings. It combines beauty with function, serving as a place of discovery and learning, a space for community members to gather. John Howe's design for the library serves as a model for architecture that is quiet and stable transcending passing trends by combining elegance and integrated function.

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Music and Memory: Effects of Listening to Music While Studying in College Students

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Abstract

Thirty-nine college students participated in an experiment that tested their memory for a text that they studied while in one of the three different auditory settings. Participants were randomly assigned to study a text in silence or while listening to either popular music or classical music. Previous studies have shown mixed performance effects of listening to music while studying a text. The current experiment focused on how college students enrolled at the University of Wisconsin-Stout performed on a test of memory after studying a text in varying auditory environments. The results demonstrated that college students recall more content after listening to pop music or silence during study when compared to classical music.

Effects of Listening to Music While Studying in College Students

Studying is a common activity for college students. Students have an enormous variety of study spaces and situations to choose from, ranging from quiet study rooms to noisy coffee houses. For many students, studying informational materials typically involves some type of background noise, such as television or music. A variety of studies has investigated exactly how music affects learning and memory; with their results pointing to the notion that there are many different factors associated with how music influences how people remember information. The current paper seeks to examine this common and important issue, as listening to music while studying is a

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prevalent behavior for college students.

Researchers have recently examined how background music influences the important cognitive processes involved in reading. Cauchard, Cane, and Weger (2012) investigated the effects on background speech and music on the speed of the participants' reading times via an eye tracking methodology. Specifically, they were interested in whether music or background speech would interrupt important comprehension processes while of reading as indicated by eye movements. The researchers had thirty-two University of Kent students between the ages of 18-29 years old participate in this study. Their eye movement was tracked while they read, and at random points the reading session, participants were interrupted by background speech and music. Despite the fact that some participants were interrupted during reading, most participants only slowed down and re-read the sentences that were interrupted during the noise stimulus. It was also found that there was no deleterious effects, meaning that no information was lost, during the interrupting settings. Moreover, that comprehension of materials read after the interruption was actually better compared to those results from participants that had no interruption at all.

While music can be a distractor for some individuals during performance, it may also provide some benefits. In an office study, Schlittmeier and Hellbruck (2009) investigated the potential for different types of music to block outside noise and increase performance. The authors first examined the detrimental effects of office noise on performance, as well as whether performance could be increased by having music playing. Participants were asked to learn and recall a set of numbers, first in silence, and then while listening to legato music, staccato music, continuous music, or normal office noise. Normal office noise was found to significantly hinder digital recall. In addition, legato music and staccato music superimposed with the office noise also hindered the performance of the participants on the digital recall compared to silence. However, it was also demonstrated that continuous music did help reduce the detrimental effects of office noise on recall of digits.

In addition, Schlittmeier and Hellbruck (2009) asked participants about their musical preferences afterwards and how disrupting the music and noise was as well as their preferences for working while exposed to music or noise. Participants

responded that, generally, they preferred to work in silence in the office rather than with outside noise or music.

In a second study, Schlittmeier and Hellbruck's (2009) also sought ways to reduce the disturbance of office noise in isolation from the noise they introduced rather than superimposed with the office. Results showed that only legato music showed any difference in how it affected test performance in the isolation situation, and it did reduce the disturbance of the office noise.

With regard to learning, a study by de Groot (2006) investigated the ability and speed of learning a language while in an environment of music or silence. Thirty-six participants, all of whom were first year psychology students at the University of Amsterdam, were randomly assigned to one of the two environmental settings, music or silence. They were then taught a number of words of a foreign language in silence or while music played. Participants completed three total word-learning sessions, and were brought back in one week later to be retested on the language materials they had learned. Interestingly, participants actually learned foreign language words better while there was music playing compared to silence.

In contrast to the studies summarized above, other studies have found detriments to studying while listening to music. One such study investigated the effects of multi-tasking and performance. Variables that were looked at included; listening to music while writing a work report or any other tasks, or other stimuli physical or visual, around the main task that interrupt the main task. The study found that there was a correlation between multi-tasking and impaired performance on the main task (Konig, Buhner & Murling, 2005). This study shows a further correlation between playing music and poor performance.

In a study done on the self-reported perception of the impact on memory from playing music while studying, Kotsopoulou and Hallam (2010) found that participants in their study chose not to listen to music while studying. This observation appeared to be due to the fact that students perceived that listening to music while studying would impair their ability to study. A study conducted by Furnham and Bradley (1997) appeared to validate this self-reported claim, in that cognitive test performances for both extraverts and introverts was marginally lowered in the presence of music.

In a follow up research study to Furnham and Bradley (1997),

Dobbs, Furnham, and McClelland (2011) investigated whether the previously observed difference was due to the task or the presence of background music versus background noise. One hundred and eighteen female schoolchildren between the ages of 11-18 years old participated. Participants were assigned to one of the three sound settings: Silence, background music, and background noise. Participants were then asked to perform a cognitive task, based on their abilities, as measured using Raven's progressive matrices, the Wonderlic personnel test, and a verbal reasoning test. Generally, participants performed better in silence on these cognitive tasks than with music. However, participants in the music setting did notably better than those that were in the background noise setting. The study also showed that there was a positive correlation between extraversion and task performance in the presence of noise of either type of setting, background noise and background music.

Silverman (2007) did a study that looked at the effects of pitch, rhythm, and speech on the abilities of 120 undergraduate college students to perform well on a digital recall test. In essence, it was asking whether students recalled things better if they were simply spoken, or if they were better at remembering things at certain pitches while being spoken. They also wanted to know if there was any effect on the numbers being sung to the participant in rhythm rather than just spoken. The participants were asked to try to remember numbers that were presented to them in four different ways. The first form of stimuli was spoken numbers that they were asked to recall later; the second was spoken numbers paired with a pitch only; the third was spoken numbers paired with rhythm, and finally spoken numbers paired with pitch and rhythm. They were asked to write down the numbers afterwards in the sequence that they were presented. There was no significance between any of the different scenarios and it was suggested that the primacy and recency effect both had something to do with that as well as exhaustion since all participants were subjected to all four stimuli types. While there was no significance, some of the data suggested that there might have been some extra difficulty for students to recall information in the rhythm and pitch mixture stimuli.

The results of this body of research seem to suggest that extraneous sound, including music, has a negative effect on academic performance. Other experiments with regard to

memory and music studied the effects of playing a certain type of music while studying. These experiments looked at whether the information could be more efficiently recalled when the same music was played during testing on the studied material. It also was looking at whether it was the tempo, or the musical selection that had the effect on the ability of the participants to recall the studied material. The results were that the recall score was unchanged when the musical selection was changed as long as the tempo remained the same. Conversely, when the tempo was changed, there was a diminished recall score (Balch & Lewis, 1996). The similarities in results across all previously mentioned studies suggest that listening to music while studying has a potentially detrimental effect on academic performance. Yet, these studies appear to either stand in contrast to those examined earlier, in which music did not interfere with or actually enhanced learning: (Alley & Greene, 2008, Cauchard, Cane, &Weger, 2012, De Groot, 2006, Dobbs, Furnham, & McClelland, 2011, Furnham & Bradley, 1997, Konig, Buhner, & Murling, 2005, Kotsopoulou & Hallam, 2010, Schlittmeier & Hellbruck, 2009, and Silverman, 2007).

The present experiment sought to expand on the previous body of research using a sample of students who were probably adept at studying while listening to music. One potential issue with the previous studies is that students potentially did not have much experience studying and learning while listening to music. Specifically the current experiment sought to investigate the performance of University of Wisconsin-Stout undergraduate students on a learning task while listening to music popular music, classical music, or silence.

We hypothesized that students who listened to music while studying a text would recall less information and that students who studied in silence would recall the most information. In addition, we hypothesized that students who listened to pop music while studying a text would recall the least amount of information and that the students who studied in silence would recall the most. We based these expectations on the observation that the popular music contained verbal lyrics, potentially causing the most distraction for the participants during reading. We also hypothesized that classical music would similarly prove distracting to readers compared to the silence condition, but not to the extent as the popular music, due to the lack of lyrics.

Method

Participants

Thirty-nine undergraduate students from the University of Wisconsin-Stout participated in the experiment for course credit. Participants ranged in age from 18 to 22 years old (M = 20.00, SD = 1.95) and 26 were females, 13 were males. Participants were recruited into the study through the University of Wisconsin-Stout internet based participation pool.

Materials

Participants received a packet that contained a short informational text on phosphorus, adapted from Bill Bryson's (2003) book, *A Short History of Nearly Everything*. The text was a single page, and was 530 words in length. In addition, the text packet contained math problems for a distractor task and a recall sheet that contained 10 comprehension questions (see Appendix A and Appendix B). For participants in the popular music condition, the song, Born This Way (Lady Gaga, 2011, track 2) was played during the five-minute reading period. For participants in the classical music condition, Piano Sonata No. 11 in A major (Mozart, 1783) was played during the five-minute period. In the control setting participants read in a silent room.

Procedure

Upon arrival at the laboratory, participants were randomly assigned to either the popular music, classical music, or control (i.e., silence) condition. Participants were seated at a table, given the text packet, and were instructed to read the passage carefully. For participants in the popular and classical music conditions the appropriate music was played at a reasonable volume once participants began reading .Participants in the control condition heard no music or noise during the five-minute reading period.

After the five-minute reading period, the music was stopped and the participants were instructed to turn to the math problem section of the packet. Once participants had completed the math problems, they were instructed to complete the 10 comprehension questions without looking back at the text.

Results

Participant answers on the comprehension questions were assigned one point for a correct answer and zero points for an incorrect answer. Means were first calculated for participants who were exposed to any type of sound during reading and participants who were exposed to silence. Means were then also calculated for each type of noise condition, and all means were then subjected to a one-way Analysis of Variance.

A marginal main effect of sound was observed, in that participants assigned to read the text in the Silence Condition (M = 6.46, SD = 3.95) produced slightly more correct answers after reading, compared to the Music Conditions (M = 4.46, SD = 3.11, marginal, F (1,37) = 2.99, p = .09)(see figure 1). This observation was followed by an analysis to determine an omnibus effect between the three conditions, in which significance was not obtained for Pop Music (M = 5.08, SD = 3.86), Classical Music (M=3.85, SD = 2.11), or Silence Conditions (M = 6.46, SD = 3.95, F < 1.9).

Finally, post-hoc comparisons were conducted between the pairs of the three conditions. Interestingly, participants in the Silence Condition produced significantly more correct answers, Compared to participants in the Classical Condition, F(1,24) = 4.43, p = .05. No other comparisons were significant (all Fs < 1.0). No main effect was observed for average reading scores between the pop music (M = 5.08, SD = 3.86), classical music (M=3.85, SD = 2.11), and silence conditions (M = 6.46, SD = 3.95, F < 1.9) (see Figure 2).

Discussion

We hypothesized that students who listened to music while studying a text would recall less information and that students who studied in silence would recall the most information. The results from the study were moderately significant when comparing silence and music lending to support our first hypothesis. However, the results comparing pop music, classical music, and silence were not significant and indicated the opposite of what our hypothesis stated, which was that that pop music would damage comprehension of a text during study. These results suggest that the auditory environment has potentially limited influence on college student's ability to study a text. Although participants who studied the test in silence

appeared to score slightly higher on the comprehension test compared to both popular and classical music, the findings indicated that silence did better than classical music. These findings would seem to suggest that, for students at the University of Wisconsin-Stout, studying for a test while listening to music may cause little to no detriment to comprehension. Obviously, the simplest explanation for this effect would be that college students are generally better, or at least adept at, studying or performing tasks while listening to music. Indeed, as demonstrated by de Groot (2006), students may learn languages better with music.

However, a variety of outside factors may have also influenced the results of this study. It is possible that many participants were not motivated to participate in the experiment. As the experiment was not part of a class grade, participants may not have put in their full effort to read and understand the text. In addition, it may also be the case that five minutes of reading time was not sufficient for full comprehension of the text. In future experiments, allowing additional or unlimited time to read the test might enable participants to fully comprehend and remember the test.

It is also a possibility that the music was simply not distracting for the participants. Unlike previous experiments that did so (e.g., Cauchard, Cane, & Weger, 2012), the music in this study was not intended to provide a disruption of the study processes used by participants. Participants may have simply not found the provided music samples distracting to their study of the tests. In addition, participants did not listen to the music through headphones, but instead through laptop speakers. The possibility exists that, if participants had been allowed to adjust the music volume, they may have increased the volume level to the point the music caused distraction and damaged performance.

Comments made by some of the participants after completion of the study suggested the popular perception that performance would be harmed by studying while listening to music; an observation mirrored by previous research on college student's perceptions of effective studying (Kotsopoulou & Hallam, 2010). While the perception of performance was not specifically tested in this experiment, the results suggest that reader's belief that listening to music while studying may either

harm or help comprehension would potentially correlate with actual performance in an experimental situation.

The findings of this study should be taken with some caution, however. One potential extraneous factor that may have had an impact on performance is that of personal taste in music. For instance, if a participant disliked classical music it may have impaired their ability to focus on the reading task. Another problem is that there are many different types of popular music enjoyed by students at the University of Wisconsin-Stout. For instance, R&B, country, and soft rock are popular music forms enjoyed by students, and the current study did not consider which type of music might cause the most damage to comprehension nor did we include these genres in the current investigation.

In conclusion, although the experiment data yielded only a small significance between the music and no music comparison, when the results were tested breaking the conditions down to pop music, classical music, and silence, there was no overall effect. This was because pop music and classical music cancel each other out. What was observed does matter, a larger sample sized might have yielded significance, though more importantly, the observations reflected that University of Wisconsin-Stout students performed almost equally as well between the silence condition, and the popular music condition. What this may mean for the research is that University of Wisconsin-Stout students are adept at listening to music with lyrics.

On the other hand, classical music may have been more disorienting, simply because it was unfamiliar to the students. If this was the case, then with these results in mind, further study on the effects genre familiarity might have on students' ability to tune out music while performing demanding cognitive tasks may be of interest to educational researchers (e.g., Dobbs, Furnham & McClelland, 2011). Considering the popularity of studying while listening to music, future research should consider this and other important factors that might help better explain the circumstances under which music can enhance or harm learning in college students.

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Appendix A

1. When is chemistry said to date from?
2. Robert Boyle of Oxford published the Sceptical Chymist, the first work to distinguish what?
3. What was the name of the man who thought gold could be distilled from human urine and in what year?
4. How many buckets of urine did the chemist collect and where did he collect them?
5. At first, who was called on to provide the raw material to make phosphorus?
6. What was the full name of the chemist that devised a way to manufacture phosphorus in bulk without the slop or smell of urine? And in what year?
7. Name as many of the elements that the poor chemist discovered as you can.
8. Name as many compounds as you can that the same chemist discovered.
9. At what age did this poor chemist die?
10. How did this chemist die?

Appendix B

Chemistry as an earnest and respectable science is often said to date from 1661, when Robert Boyle of Oxford published The Sceptical Chymist —the first work to distinguish between chemists and alchemists—but it was a slow and often erratic transition. Into the eighteenth century scholars could feel oddly comfortable in both camps—like the German Johann Becher, who produced an unexceptionable work on mineralogy called Physica Subterranea, but who also was certain that, given the right materials, he could make himself invisible.

Perhaps nothing better typifies the strange and often accidental nature of chemical science in its early days than a discovery made by a German named Hennig Brand in 1675. Brand became convinced that gold could somehow be distilled from human urine. (The similarity of color seems to have been a factor in his conclusion.) He assembled fifty buckets of human urine, which he kept for months in his cellar. By various recondite

processes, he converted the urine first into a noxious paste and then into a translucent waxy substance. None of it yielded gold, of course, but a strange and interesting thing did happen. After a time, the substance began to glow. Moreover, when exposed to air, it often spontaneously burst into flame.

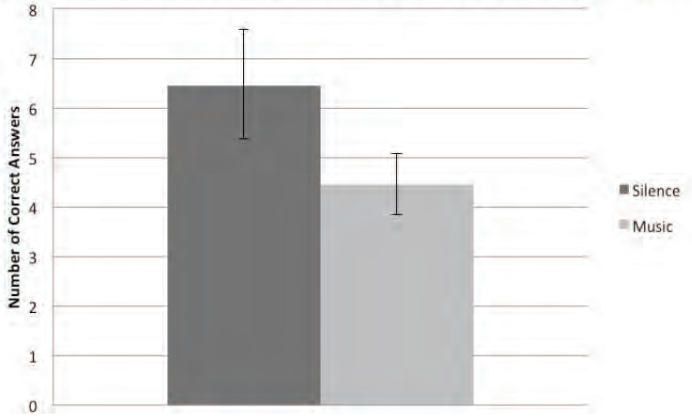
The commercial potential for the stuff—which soon became known as phosphorus, from Greek and Latin roots meaning "light bearing"—was not lost on eager businesspeople, but the difficulties of manufacture made it too costly to exploit. An ounce of phosphorus retailed for six guineas—perhaps five hundred dollars in today's money—or more than gold.

At first, soldiers were called on to provide the raw material, but such an arrangement was hardly conducive to industrial-scale production. In the 1750s a Swedish chemist named Karl (or Carl) Scheele devised a way to manufacture phosphorus in bulk without the slop or smell of urine. It was largely because of this mastery of phosphorus that Sweden became, and remains, a leading producer of matches.

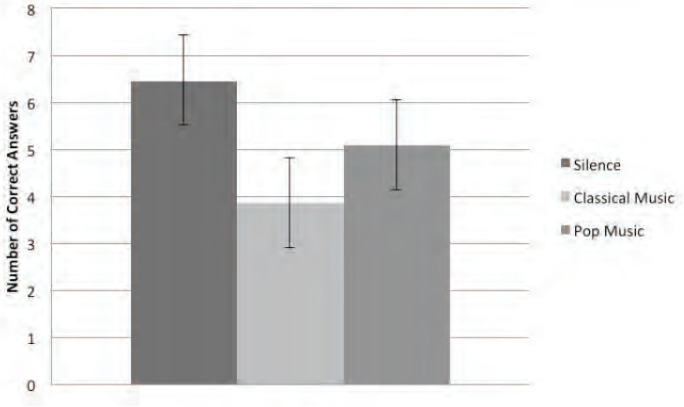
Scheele was both an extraordinary and extraordinarily luckless fellow. A poor pharmacist with little in the way of advanced apparatus, he discovered eight elements—chlorine, fluorine, manganese, barium, molybdenum, tungsten, nitrogen, and oxygen—and got credit for none of them. In every case, his finds were either overlooked or made it into publication after someone else had made the same discovery independently. He also discovered many useful compounds, among them ammonia, glycerin, and tannic acid, and was the first to see the commercial potential of chlorine as a bleach—all breakthroughs that made other people extremely wealthy.

Scheele's one notable shortcoming was a curious insistence on tasting a little of everything he worked with, including such notoriously disagreeable substances as mercury, prussic acid (another of his discoveries), and hydrocyanic acid—a compound so famously poisonous that 150 years later Erwin Schrödinger chose it as his toxin of choice in a famous thought experiment. Scheele's rashness eventually caught up with him. In 1786, aged just forty-three, he was found dead at his workbench surrounded by an array of toxic chemicals, any one of which could have accounted for the stunned and terminal look on his face.

Number of Correct Answers Based on Noise Compared to Silence During Reading



Number of Correct Answers Based on Noise Condition During Reading



Optimal Realignment of Athletic Conferences

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Abstract

This article presents a mathematical analysis of the current realignment plan for men's, Division I, college hockey. Comparisons are made between existing alignments, proposed alignments, random alignments, and optimal alignments, with respect to various measures. It is shown how proposed alignments do not minimize travel distance nor maximize attendance. It is shown also how a non deterministic clustering procedure can be expected to outperform the proposed alignments, with respect to these measures. Although this clustering procedure is not almost surely optimal, it is shown in our hockey setting to be an effective approximation, being nearly optimal and easily computable. R programs are provided in the appendix.
Keywords: athletic conferences, optimization, k-means clustering

Introduction

The Western Collegiate Hockey Association (WCHA) and the Central Collegiate Hockey Association (CCHA) are two established, men's Division I college hockey conferences, whose teams have claimed a combined 48 national championships [4]. The conferences are facing significant challenges, extinction in the case of the CCHA and significant alteration in the case of the WCHA. This is due to the emergence of the Big Ten ice hockey conference [1] and resulting realignment [5].

There are those who vehemently disagree with the premise that the realignment plans benefit college hockey generally (see [10],[5],[11] or [6]). To give a sense of the associated controversy, a quote from a storied veteran of college hockey seems appropriate. Former player and current coach Dean Blais has said, "We (the college hockey community) didn't decide on this....I don't think it was for the good of hockey [10]." He insinuates, perhaps, that the Big Ten Network is behind the

sudden changes to the college hockey landscape.

While some commentators have pointed out certain benefits of the proposed realignment (see [9] or [12]), it seems premature to form an opinion on the matter based mostly on the rhetoric of columnists. Here, in order to contribute to the debate, we present a mathematical analysis of how best to group teams into conferences. Our logical approach assumes the desirability of alignments that minimize total travel distance and maximize attendance. We focus mainly on teams located in the Midwest.

The Teams

As of 2013 there are 59 teams in men's, Division I, college hockey [13]. Since most of the conference realignment involves teams from the WCHA and CCHA, we focus on the Midwest region. We exclude the Alaska teams from our analysis. Since Notre Dame has joined Hockey East [13], we exclude them as well. 21 teams remain, as mapped in Figure 1. The latitude and longitude coordinates were obtained through a Google search, and plotted using "Map-It" [16].

We speak of the traditional alignment into WCHA and CCHA teams as the WCHA-CCHA alignment. We speak of the proposed realignment as the Big Ten alignment. See Table 2.1 for details.

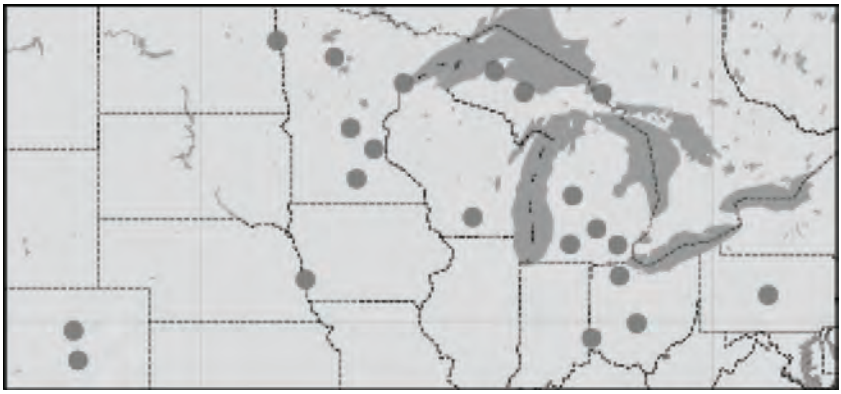

Figure 1: Locations of the universities under consideration

Table 2.1: Proposed realignment of teams [13]. NCHC stands for the newly created National Collegiate Hockey Conference.

University	2012 Conference	2013 Conference
Bowling Green State University	CCHA	WCHA
Ferris State University	CCHA	WCHA
Lake Superior State University	CCHA	WCHA
Miami University	CCHA	NCHC
University of Michigan	CCHA	Big Ten
Michigan State University	CCHA	Big Ten
Northern Michigan University	CCHA	WCHA
Ohio State University	CCHA	Big Ten
Western Michigan University	CCHA	NCHC
Bemidji State University	WCHA	WCHA
Colorado College	WCHA	NCHC
University of Denver	WCHA	NCHC
Michigan Technological University	WCHA	WCHA
University of Minnesota	WCHA	Big Ten
University of Minnesota–Duluth	WCHA	NCHC
Minnesota State University	WCHA	WCHA
University of Nebraska–Omaha	WCHA	NCHC
University of North Dakota	WCHA	NCHC
Saint Cloud State University	WCHA	NCHC
University of Wisconsin	WCHA	Big Ten
Pennsylvania State University	N.A.	Big Ten

Minimizing Travel Distance

In this section we select the alignment that minimizes travel distance between teams. Road distances between universities have been determined using Google Maps.

Definition 3.1. The **distance matrix** is defined to be the 21 by 21 matrix D where D[*i, j*] is the distance between the hometown of team *i* and the hometown of team *j*.

Before using these data we should define precisely what is meant by an alignment.

Definition 3.2. An **alignment** is a vector *x*, of length 21, whose entries take a finite set of values that indicate conference membership.

History guides us to only consider alignments into two or three conferences; that is vectors whose entries take only two or three values. For each conference, indexed by l, of an alignment into k conferences, there is an associated submatrix of D, that we denote with D_l. It is an n_l by n_l matrix with entries indexed by i and j. With such notation the following definition is possible.

Definition 3.3. For an alignment of teams into k conferences, each indexed by l and containing nl teams, define the **travel distance** to be

$$d(\mathbf{x}) = \sum_{l=1}^{k} \frac{\sum_{i=1}^{n_l} \sum_{j=1}^{n_l} D_l[i,j]}{2(n_l - 1)}.$$

The $2(n_l - 1)$ terms are included so that the travel distance gives an approximate measure of the average, weekly, distance traveled by all teams in all conferences over the course of the entire season.

We would like to minimize d over all possible alignments. This was initially accomplished by computing d for every possible alignment. (For a more elegant but less certain approach see Section 5 on clustering.) We programmed R (see [14]) to count in both base two and base three, and after adding zeros for place holders and recognizing that each number represents an alignment, we then computed the travel distance d for all possible alignments. This took approximately six days of computing time. The associated R program is included in the appendix.

The results indicate that the Big Ten alignment was definitely not chosen to minimize travel distance. Indeed, the travel distance for the Big Ten alignment is not much better than what we would expect from a random alignment. For a comparison of the travel distances for random alignments, the existing alignment, the Big Ten alignment, and the optimal alignment see Figure 2. A map of the optimal alignment that minimizes travel distance is displayed in the fourth plot of Figure 4.

Maximizing Attendance

In this section we select the alignment that maximizes attendance. The starting point toward a rigorous measure of attendance across alignments is a matrix of attendance data.

Definition 4.1. The **attendance matrix** is defined to be the 21 by 21 matrix *A* where *A[i, j]* is an estimate for the average historical attendance when team *i* hosts team *j*.

A limitation of our analysis is that we were only able to obtain attendance data for the 2011–2012 season. Data were obtained from box scores stored online [15]. If a row team hosted a column team multiple times then an average attendance was entered. If a row team did not host a column team during the 2011–2012 season we left the corresponding entry blank.

Definition 4.2. With M_i denoting the average of the entries in row *i* of *A*, define the standardized attendance matrix, A^-, to be the 21 by 21 matrix with entries determined by

$$\bar{A}[i,j] = \frac{A[i,j] - M_i}{M_i}.$$

In case of lacking data we set $A^-[i, j] = 0$. We can now define a measure of attendance for alignments. In the following definition the $2(n_l - 1)$ factors are used mainly to allow for adequate comparison of alignments that utilize conferences of differing sizes.

Definition 4.3. For an alignment, *x*, of teams into *k* conferences, each indexed by *l* and containing n_l teams, define the **attendance score** to be

$$a(\mathbf{x}) = \sum_{l=1}^{k} \frac{\sum_{i=1}^{n_l} \sum_{j=1}^{n_l} \bar{A}_l[i,j]}{2(n_l - 1)}.$$

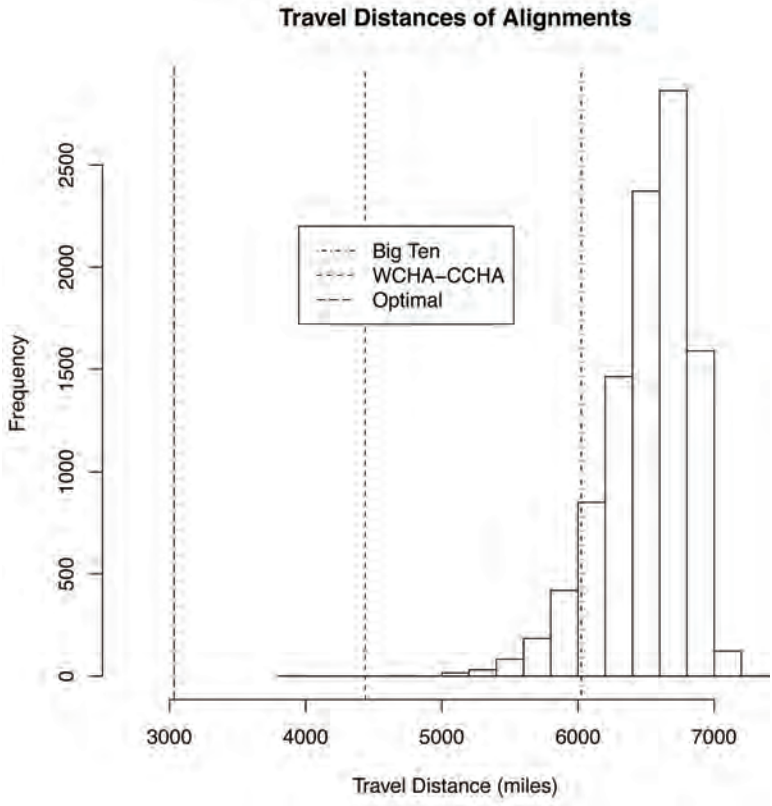

Figure 2: Distances were computed for each of ten thousand, randomly selected alignments, and then plotted in a histogram so as to provide a reference background upon which to compare the distances associated with three different alignments of interest.

As in Section 3, we seek to find an optimal alignment, where this time we are searching for an alignment that maximizes the attendance score *a*. Analogous techniques are used (see the appendix for the R commands). The results are displayed in Figure 3.

Clustering Teams

Here we proceed without pointed objectives such as minimizing travel distance or maximizing attendance. Our aim is to select promising alignments by clustering teams into groups based on a heuristic method. The method is known as k-means clustering, and the mathematical details can be accessed within

Johnson and Wichern's Applied Multivariate Statistical Analysis [8]. All that is required here, however, is a basic understanding of the method. For simplicity we set k equal to 3 so our objective is to suitably cluster the 21 teams (as viewed on a map) into 3 groups.

We start by assigning coordinates to each of the teams hometowns, and for this purpose we employ latitude as the y coordinate and a transformed version of longitude as the *x* coordinate. We store this information in a 21 by 2 matrix, with the x coordinates in the first column and the y coordinates in the second column. We denote the matrix with *C* and its entries with *C[i, j]*.

While it might be argued that within this section the distances between the hometown's of pairs of teams should be measured along geodesics (great circles of the Earth), we instead simply utilize a Euclidean approximation, since the patch of the Earth under consideration is not too large. Remember, we have excluded the Alaskan teams from our analysis. Also, precise attention to detail is not overwhelmingly important here, as our clustering method is heuristic and not even deterministic, as we shall see.

Once x and y coordinates have been assigned to each of the teams, we randomly select three pairs of coordinates to serve as three initial centers for conferences. Teams are then assigned to the conference (center) that is closest—as measured with Euclidean distance in the plane—to their hometown's coordinates. After such assignment is complete, updated centers are computed—for each conference a new center is established as the geometric mean of the coordinates of its (previous) teams. All the teams are then reassigned, resulting in a new alignment. This process is then repeated until repeated iteration no longer changes the selected alignment.

We found through experimentation that ten iterations is typically sufficient to obtain results. We ran thirty iterations just to make sure, and we did this for each of seventy triplets of initial centers, each randomly chosen. The results were eleven attractive clusters of teams into alignments, each of which revealed unforeseen possibilities for possible conference realignment. Some associated plots are on display in Figure 4.

For each of the eleven results of our clustering procedure it is possible to compute an associated travel distance

and attendance score. Such vectors of data, and their standardizations can be seen in Table 6.1. The ideal alignment possesses both a low travel distance and a high attendance score. However, in order to select the "best" alignment, some subjectivity is required.

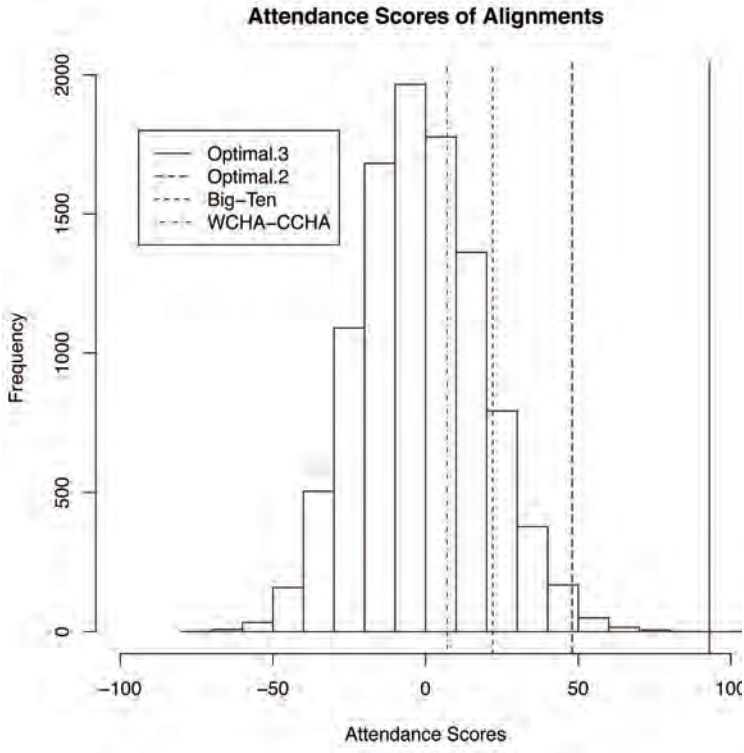

Figure 3: Attendance scores were computed for each of ten thousand, randomly selected, three-conference alignments, and then plotted so as to provide a reference background upon which to compare the the attendance scores associated with various alignments of interest. For $k = 2, 3$, "Optimal.k" refers to optimal alignment into k conferences.

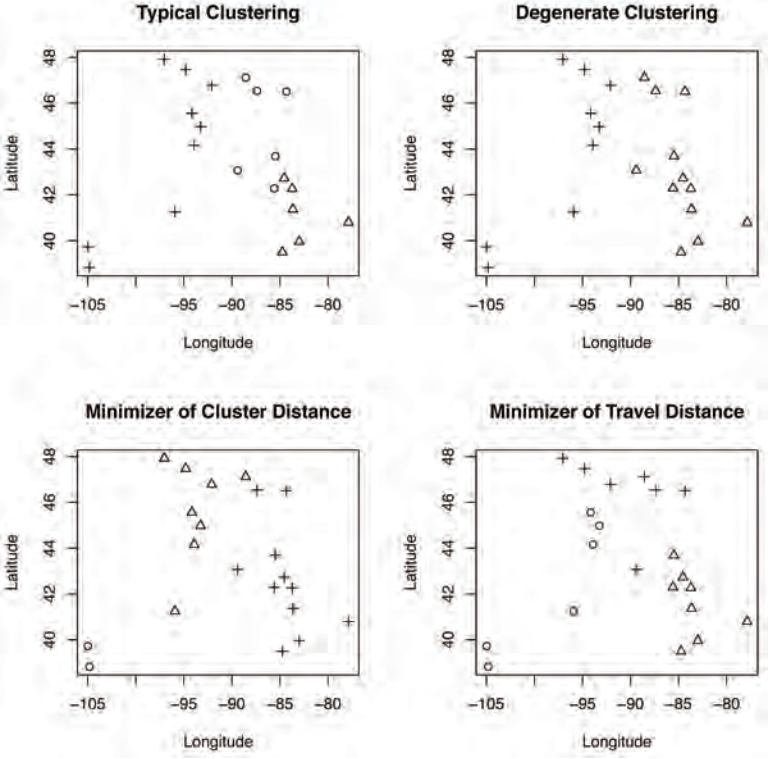

Figure 4: The non deterministic nature of the clustering algorithm is displayed in the top two graphics—different, randomly selected triplets of initial centers give rise to different clusters. After running the algorithm for 70 different randomly selected triplets of initial centers it was possible to select from the 11 different observed outcomes an empirical minimizer of cluster distance. This minimizer is on display above. It is important to note that none of the seventy trials was successful in selecting our previously determined minimizer of travel distance, that is also on display above for comparison.

Conclusions

Based on our investigations, it is clear that the Big Ten alignment was not proposed in order to minimize distance traveled. The evidence for this is overwhelming. Clustering picked out eight separate alignments with travel distances less than 4000 miles, while the Big Ten alignment has a travel distance of more than 6000 miles. Even randomly selected alignments can be expected to outperform the Big Ten alignment with respect to travel distance.

Might the Big Ten alignment have been proposed to maximize attendance? The answer seems to be no. Simple clustering leads quickly to an alignment with a better attendance

score than the Big Ten alignment, and the optimal alignment with respect to attendance has a score more than four times that of the Big Ten alignment.

We thus conclude that the new alignment plan was not designed with these aims (minimizing travel distance nor maximizing attendance) in mind. Our study leads to more general conclusions, with regards to the general problem of seperating teams into conferences, as well. Our methodology applies not only to college hockey but other sports and other situations. We have the following suggestions.

When aligning teams into conferences, and searching for an optimal alignment, a combination of objective analysis and subjective personal judgement is recommended. First, clustering should be used to select ten to twenty alignments of interest. These should then be mapped. Next, judgement or optimization theory should be used to shorten this list of alignments to a list of only a select few, optimal alignments. This short list of finalists can then be compared to existing or proposed alignments, and perhaps a clear distinction will become apparent, leading to a single, best alignment.

In closing we make a final comment regarding the speed of calculations. Checking all alignments in a search for an optimal alignment with respect to some attribute such as travel distance or attendance is a time consuming task. Even with our landscape of 21 teams the computations required approximately six days to complete. Clustering on the other hand is a simple procedure that can be carried out in seconds. While it won't necessarily lead to the absolute optimal solution, the evidence that we have presented here indicates that it can be expected to come very close. Since the attributes defining what is optimal are subjective anyway, we conclude that clustering should be the first tool employed in any analysis of the realignment of athletic conferences.

Table 6.1: Clustering resulted in the selection of 11 separate alignments that can be compared based on the criteria of travel distance and attendance.

Alignment Number	Travel Distance (miles)	Attendance Score	Travel Distance (standardized)	Attendance Score (standardized)
1	3079	9.1	-1.19	-0.34
2	3937	16.1	0.49	0.30
3	3168	9.1	-1.02	-0.34
4	3013	11.7	-1.32	-0.10
5	3733	2.0	0.09	-1.01
6	3930	18.8	0.48	0.55
7	4438	9.1	1.49	-0.34
8	4047	8.6	0.71	-0.39
9	4200	3.8	1.01	-0.84
10	3100	11.1	-1.15	-0.16
11	3884	41.8	0.39	2.7

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Perceptions of Middle School Teachers on Teacher Bullying

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Abstract

Many individuals experience bullying; however, over 42% of college students surveyed reported that their worst experience of bullying in primary through high school was perpetrated by a teacher (Pottinger & Stair, 2009). Informed by current literature and Symbolic Interactionism Theory, we hypothesized that teachers would acknowledge traditional student-student bullying in their school but would lack awareness of specific occurrences of teacher bullying. Strong support was found for this hypothesis. This non-random pilot study surveyed the attitudes of middle school teachers about other teachers who exhibit bully-like behavior towards students. Data was analyzed using the following descriptive statistics: frequencies, mean comparisons, correlations, and Cronbach's alpha reliability analysis. The implications of this study are to provide awareness of teacher bullying and to promote future research of this under-studied type of bullying. Future research recommendations include a larger and random national sample using mixed methods for capturing the lived experience of the teachers in addition to survey data.

Keywords: Teachers as bullies, Bullying prevention, School bullying

Bullying may occur in many forms, but some ways are more detrimental for students than others. For example, just over 42% of college students surveyed believed that their worst experience of bullying in primary through high school was perpetrated by a teacher, most commonly through humiliation and embarrassment (Pottinger & Stair, 2009). A teacher bully is defined as someone who controls and manipulates their students beyond what administration deems an acceptable method (Twemlow & Fonagy, 2006). Most often, teacher bullies

target victims who they are familiar with and spend time with on a regular basis in close surroundings (Beaty, 2008). Over time, being bullied may create increased oppositional conduct in students (Pottinger, 2009). Due to the growing awareness of teacher bullying and its effects on students, there is an increased need for research.

Literature Review

To explore the relationship between teachers and bullying of students, a review of the literature was conducted through the search engine Ebscohost using the key words school bullying, teachers as bullies, and bullying prevention. The search was also limited to studies conducted since the year 2003 to the present, in order to ensure up-to-date data. The literature suggested that overall teachers were unaware of current bullying trends, including teachers who bully students. The literature also indicated that there is a significant relationship between being bullied as a student and later exhibiting bully-like behaviors as a teacher. We defined teacher bullying as "someone who controls and manipulates their students beyond what the school administration deems an acceptable method" (Twemlow, p. 10, 2006). It is also important to know that bullies most often choose victims who they are familiar with and spend time with on a regular basis in close surroundings (Beaty, 2008). Therefore, teachers are more likely to bully the students they see regularly and less likely to bully students they have limited contact with.

As their years of experience increase, teachers are more likely to overlook common incidents of bullying, such as name calling, due to slight acclimatization from handling the same occurrences for a number of years (Beaty, 2008). The same research also found that teachers were generally less aware of bullying incidents than their students. This supports the concept that while teachers are aware of various bullying types, they are less likely to recognize conceptual examples within their classroom. This is also suggested in Kennedy's (2012) study, which found that 70% of students reported being affected by bullying, but only 15-18% of teachers reported that they intervened after observing bullying.

Glasner's (2010) research looked at how teachers observe and identify different types of bullying. The results from this study showed that 61% of teachers recognized bullying due to

training they had previously received. However, 70% of the same teachers only recognized bullying because a student directly reported the incident to them. Forrester (2012) recommends that teachers should know all forms, signs, and effects of bullying, including teacher bullying. Being able to identify the types and severity of bullying is important when teachers face the decision to intervene. Zerillo and Osterman (2011) found that a teacher's choice to intervene was not based on the type of bullying. Instead, the choice whether or not to intervene is generally determined by the severity of the situation.

In 2006, Twemlow et al conducted a quantitative interview protocol regarding teachers' perceptions of bullying. In this study they defined a bullying teacher as someone who controls and manipulates their students beyond what the school administration deems an acceptable method. The research found a significant relationship between how often a teacher was bullied when they were a student and their likelihood to bully their students now. Furthermore, 45% of the teachers surveyed reported that they had bullied a student at least one time in the past. The teachers who claimed to be frequent bullies also reported they felt a lack of support from administration, which was a factor in why they bully. Other factors that contributed to teacher bullying were large class sizes, lack of disciplinary training, and job burnout. Regardless of their own behavior, the teachers agreed that colleagues who bully create a hostile environment in both the classroom and between coworkers.

Research has shown that teachers who had autonomy over their educational methods report increased job satisfaction and less job stress. This is supported by Twemlow (2005), who examined the prevalence of teachers who bully students in comparison to the rate of student suspension in their respective schools. Included in this study were 214 teachers from 15 different schools. There were significant differences between the schools depending on the levels of suspensions. Teachers who worked in schools with high suspension rates reported that they observed or participated in teacher bullying. The opposite was true in low level suspension schools; there were fewer instances of teacher bullying. This suggests that a reported stressful work environment can increase the likelihood of teacher bullying (Twemlow, 2005). Skaalvik and Skaalvik (2007) looked at different strain factors: perceived teacher efficacy and job burnout.

They found a strong correlation between the perception of teaching efficacy and burnout rates. Teachers who felt they were effectively teaching and dealing with students were less likely to experience burnout. This suggests that both positive attitudes and support from administration can help prevent teacher strain, which has been correlated with teacher-to-student bullying. One recommendation that may deter teacher bullying is to promote a positive classroom by teaching students positive self-concepts, anger management strategies, and conflict resolution skills (Forrester, 2012).

Current literature has shown the impacts of bullying on students from both peer and teacher bullying. Literature has also shown the ability to identify and prevent student-to-student bullying, but there is limited research regarding teachers' abilities to identify and prevent teacher-to-student bullying. There is limited research about teachers' attitudes towards teacher bullying and also limited research on the harmful psychological effects that teacher-to-student bullying can create for students. (Duong et al, 2013; Kennedy et al, 2012; McCarra et al, 2012; Zerillo 2011; Glasner, 2010; Pottinger, 2009; Beaty, 2008; Skaalvik, 2007; Twemlow et al, 2006; Twemlow, 2005). The purpose of this pilot study was to explore the attitudes of teachers in relation to teachers who exhibit bully-like behavior in hopes to promote further research on preventing teacher bullying.

Theoretical Framework

The theory used to form the foundation of this study was Symbolic Interactionism Theory. This theory argues that people develop their perspectives based on personal experiences, personal interactions, and self-perception (Ingoldsby, Smith and Miller, 2003). Symbolic Interactionism Theory is one of the most broadly used theories in family studies and therefore has many different interpretations. These interpretations vary based on the researcher and the type of research being conducted; however, there are commonalities among all definitions. First, people react only to things that have meaning to them and how they define its meaning. Second, the way we view ourselves and the way we desire the world to see ourselves both influence personal behavior. Finally, societal views also have an impact on an individual's perception of the self and the perception of meaning

(Ingoldsby, 2003).

When applied to our study, Symbolic Interactionism Theory would assume that teachers expect interactions between themselves and students to be socially normal within their role as a teacher in any given situation (Ingoldsby, 2003). According to Kennedy, Russom, and Kevorkian (2012), approximately 90% of teachers believed that part of their role as a teacher is to prevent bullying. Current bullying prevention programs almost entirely focus on student-to-student bullying and lack significant information on bullying that occurs between a teacher and student (Sylvester, 2011). Based on Symbolic Interactionism Theory, we predicted teachers' observations of other teachers who exhibit bully-like behavior towards students would be of low frequency.

Hypothesis

The central research question in this study was: "What are the perceptions of middle school teachers on teachers who bully?" We hypothesized that teachers would acknowledge bullying in their school but would lack awareness of specific occurrences of teacher bullying. Because teachers view themselves as participants in bullying prevention programs that focus on student-to-student bullying, they will not actively look for other teachers who exhibit bullying behaviors. This assumption is based on Symbolic Interactionism Theory, which suggests that because their roles generally do not include the tolerance of bullying, teachers assume that teacher bullying does not occur (Ingoldsby et al, 2003).

Method

Participants

This study was conducted at a rural Wisconsin middle school. The participants included five female middle school teachers. Please see demographics below.

Gender	Age	Years Teaching
Female = 5	20-30 years = 1	6-10 years = 1
	31-40 years = 2	11-15 years = 1
	41-50 years = 1	16-20 years = 3
	51-60 years = 1	

Research Design

The purpose of this non-random survey research was to evaluate teachers' perceptions of middle school teachers who bully students. We used a cross-sectional research design in order to examine the attitudes of the participants towards teacher bullying at one point in time. Paper survey questionnaires were used to collect the data. The justification for using this method was that paper questionnaires were requested by the school's principal and for convenience purposes.

The sampling design used in our study was non-random, purposive and snowball. We had a "purpose" in identifying a specific middle school to access its teachers and their perceptions of teacher bullying. Additionally, the study utilized a snowball sampling design. We secured collaboration for sampling through both researchers' past experiences as volunteer tutors in the school knowing that without this connection we were unlikely to gain collaboration given the controversial nature of the research question. This study was approved by the Institutional Review Board (IRB). The ethical protection of human subjects was provided through completion of the IRB's Human Subjects training.

Data Collection Instrument

The survey was designed to examine teachers' perspectives of teacher bullying. The survey included a brief description of the study, definition of terms not commonly known, risks, benefits, time commitment, confidentiality, voluntary

participation, our contact information as well as our supervisor's contact information, and instructions for completing the survey. Statements and questions for the survey were developed by reviewing literature and by applying Symbolic Interactionism Theory.

Procedure

The process began when we emailed the principal of a rural Wisconsin middle school to explain our research and asked if the school would be willing to collaborate. The principal responded to our email with permission to survey the teachers if she could review the survey prior to distribution. The survey questionnaire was hand-delivered to the school and was administered to the teachers by the principal, who followed specific protocol that was provided by the researchers. The implied consent form was attached to the survey. We did not attempt to randomize our sample because the population was inaccessible and every participant was crucial to data collection. Data collection began March 25, 2013 and ended March 28, 2013.

Data Analysis Plan

The survey data was first collected, cleaned, and checked for missing data. The cleaned surveys were then coded using acronyms. Demographics were given a three-letter acronym: Gender of the participants (GEN); Age of the participants (AGE); and Number of years teaching (TTT); All survey statements were also given a three-letter acronym: I believe that there are teachers who bully students at this school (TOP); I have noticed that other teachers have disparaging labels for some students. These may include but are not limited to labels such as dumb, stupid, incompetent, trouble, behind or a handful (IND); I have observed teachers being disrespectful towards students. For example, making sarcastic remarks, being discouraged, or being rude toward students (DIS); I am aware of at least one situation in the past month where a teacher bullied a student (PMO); I am aware of at least one situation in the past year where a teacher bullied a student (PYR); I am aware of other teachers who show favoritism in their interactions with students such as accepting late work for some while rejecting others (STE); I am aware of other teachers who use humiliation to stop classroom disruption by using personal put downs, sarcasm, or isolation of students (HUM); I feel that teachers should have a significant role in

addressing teachers who bully students (INT); Our school has policies and procedures in place to address teachers who bully students (POL); If I were to observe another teacher bullying a student I would know how to intervene in the best interest of that student (ITC).

The data was analyzed using the computer program *Statistical Package for the Social Sciences (SPSS)*. Groups were not compared during this study. The methods of data analysis used included frequencies, mean comparisons, and correlations. Cronbach's alpha reliability was also conducted as a means of analysis for this study. All variables were subjected to frequency distribution analysis. Results indicated that there was no missing data.

Results

We hypothesized that we would find a higher level of response from teachers regarding their awareness of teacher bullying (TOP), but also that teachers would be unable to point out specific occurrences of teacher bullying (PMO). The data supported our hypothesis in that 100% of teachers either slightly agreed or agreed that there was a prevalence of teacher bullying within their school (TOP). Sixty percent of teachers reported slightly agreeing or agreeing that they had seen a teacher bullying a student in the past month (PMO). Support is provided in the Frequency Distribution, Table 1. See A for full Frequency Distribution.

Variable

	SD	D	SLD	SLA	A	SA	Total
TOP	0.0%	0.0%	0.0%	60.0%	40.0%	0.0%	100.0%
IND	0.0%	20.0%	0.0%	40.0%	40.0%	0.0%	100.0%
PMO	40.0%	0.0%	0.0%	40.0%	20.0%	0.0%	100.0%
PYR	40.0%	0.0%	0.0%	0.0%	40.0%	20.0%	100.0%

We did not run Correlations due to having an N<10. Cronbach's Alpha reliability in this analysis was 0.925. This value indicated that the survey questions were a reliable measure of the major concept (teacher bullying). Qualitative comments were not received at the end of any of our surveys.

Discussion

Support was found for both parts of our hypothesis. In our study, 100% of teachers reported awareness of teacher-to-student bullying, but only 60% reported awareness of a specific incident of teacher bullying. Findings for our hypothesis were supported by theory and literature. The Symbolic Interactionism Theory suggests that because teacher roles do not tolerate bullying, they will assume that bullying by teachers does not occur (Ingoldsby et al, 2003).

This study's frequency distribution demonstrated that participants unanimously reported that they either slightly agreed or agreed that there were teachers at the school who bully. There was also support that teachers lack awareness of specific occurrences of teacher bullying. Forty percent of respondents strongly disagreed that they were aware of a specific occurrence of teacher bullying within the past month. Forty percent of respondents also strongly disagreed that they were aware of a specific occurrence of teacher bullying within the past year. This supports our hypothesis that teachers believed there was a prevalence of teacher bullying in their school, but were unable to pinpoint specific occurrences of bullying.

Forty-two percent of college students have reported that their worst experience of bullying from a teacher in primary through high school was most often due to embarrassment or humiliation (Pottinger & Stair, 2009). This statement is supported in our results as 80% of the participants slightly agreed or agreed that teachers have labels such as dumb, stupid, incompetent, trouble, behind, or "a handful," that they gave to certain students. It is important to understand that these labels for students are used to mask or deflect teacher bullying behaviors (Sylvester, 2010).

Limitations

Some limitations of this non-random pilot study are its small sample size, lack of demographic diversity, and time allotted for survey completion. This study included only five participants; therefore the results cannot be generalized to the larger population. Surveys were only distributed for four days, which limited the number of surveys completed and returned. Implications for Practitioners The implications of this study will be helpful to professionals working in educational fields in regards to preventing and acknowledging teacher bullying. The

data indicated that 100% of the participants believed there were teachers at their school who bully. Administration should provide training to staff and students on recognizing, preventing, and intervening on teacher bullying. Policies that specifically address teacher bullying should be considered as part of standard bullying policies already in place.

Implications for Future Research

Recommendations for future research would include a larger and random national sample to be able to generalize findings. Also, extending time for survey completion would allow for higher return rates. Students, administration, and other working staff at educational institutions should also be included for a more complete perspective on teacher bullying. If this survey is used again, we suggest additional questions on perceived bullying actions mixed with qualitative interviews to investigate the perceptions and experience of teachers and students. As it was successful in Doung's study (2013), we also suggest utilizing an online survey administered by someone who is not affiliated with participants' employment so that they can be less concerned about repercussions for their participation. We believe that utilizing a web-based survey would allow more accessibility for more participants.

Conclusion

This study examined teachers' awareness of other teachers who bully students. As stated in current literature, just over 42% of college students surveyed believed that their worst experience of bullying in primary through high school was perpetrated by a teacher, most commonly through humiliation and embarrassment (Pottinger & Stair, 2009). Our research found that 100% of teachers overall were in agreement that teachers are bullying students. Previous research has found that being bullied over time creates the potential for increased oppositional conduct in students. Some examples of oppositional conduct include noncompliance, irritability, and a lack of respect for authority (Pottinger, 2009). Because being bullied by a teacher can have lasting effects on a student, it is important to continue researching the topic of teaching bullying.

Additionally, the literature suggested that overall teachers were unaware of current bullying trends, including a lack of

awareness about teacher bullying. Since many students have reported that their worst experience of bullying was perpetrated by a teacher, it is important to include teacher-to-student bullying when discussing bullying. It is also important to include teacher bullying in the formation and implementation of policies in order to protect students from this type of abuse (Pottinger & Stair, 2009).

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Appendix A

Frequency Distribution

Variable

	SD	D	SLD	SLA	A	SA	Total
TOP	0.0%	0.0%	0.0%	60.0%	40.0%	0.0%	100.0%
IND	0.0%	20.0%	0.0%	40.0%	40.0%	0.0%	100.0%
DIS	0.0%	0.0%	40.0%	40.0%	20.0%	0.0%	100.0%
PMO	40.0%	0.0%	0.0%	40.0%	20.0%	0.0%	100.0%
PYR	40.0%	0.0%	0.0%	0.0%	40.0%	20.0%	100.0%
STE	40.0%	40.0%	0.0%	0.0%	20.0%	0.0%	100.0%
HUM	20.0%	0.0%	20.0%	40.0%	20.0%	0.0%	100.0%
INT	0.0%	0.0%	0.0%	20.0%	40.0%	40.0%	100.0%
POL	20.0%	0.0%	20.0%	20.0%	40.0%	0.0%	100.0%
ITC	20.0%	0.0%	20.0%	20.0%	20.0%	20.0%	100.0%

Note. I believe that there are teachers who bully students at this school (TOP); I have noticed that other teachers have disparaging labels for some students. These may include but are not limited to labels such as dumb, stupid, incompetent, trouble, behind or a handful (IND); I have observed teachers being disrespectful towards students. For example, making sarcastic remarks, being discouraged, or being rude toward students (DIS); I am aware of at least one situation in the past month where a teacher bullied a student (PMO); I am aware of at least one situation in the past year where a teacher bullied a student (PYR); I am aware of other teachers who show favoritism in their interactions with students such as accepting late work for some while rejecting others (STE); I am aware of other teachers who use humiliation to stop classroom disruption by using personal put downs, sarcasm, or isolation of students (HUM); I feel that teachers should have a significant role in addressing teachers who bully students (INT); Our school has policies and procedures in place to address teachers who bully students (POL); If I were to observe another teacher bullying a student I would know how to intervene in the best interest of that student (ITC).

Appendix B

Compare Means

	TOP	IND	DIS	PMO	PYR	STE	HUM	INT	POL	ITC
Mean	4.40	4.00	3.80	3.00	3.20	2.20	3.40	5.20	3.60	3.00
SD	0.55	1.22	0.84	1.87	2.05	1.64	1.52	0.84	1.67	1.58
Range	1.00	3.00	2.00	4.00	4.00	4.00	4.00	2.00	4.00	4.00

Note. I believe that there are teachers who bully students at this school (TOP); I have noticed that other teachers have disparaging labels for some students. These may include but are not limited to labels such as dumb, stupid, incompetent, trouble, behind or a handful (IND); I have observed teachers being disrespectful towards students. For example, making sarcastic remarks, being discouraged, or being rude toward students (DIS); I am aware of at least one situation in the past month where a teacher bullied a student (PMO); I am aware of at least one situation in the past year where a teacher bullied a student (PYR); I am aware of other teachers who show favoritism in their interactions with students such as accepting late work for some while rejecting others (STE); I am aware of other teachers who use humiliation to stop classroom disruption by using personal put downs, sarcasm, or isolation of students (HUM); I feel that teachers should have a significant role in addressing teachers who bully students (INT); Our school has policies and procedures in place to address teachers who bully students (POL); If I were to observe another teacher bullying a student I would know how to intervene in the best interest of that student (ITC).

A Proactive Approach to the Application of Quality Cost Data

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Abstract

Philip Crosby established the widespread 'Quality Costs' accounting system. It allows management to track the prevention, appraisal, internal, and external failure costs of an organization. The trend information is invaluable to assure the organization's efforts in its continual improvement and profit maximization. Often missing from the endeavor is the related prioritization and corrective action model. In addition 'hidden costs' are often overlooked. A literature search has exposed the pros and cons of the existing 'Quality Cost' approach. Based on the literature findings, this paper presents elements of a model for a more proactive utilization of data and discussion of total actual costs.

Keywords: appraisal, costs, failure, prevention, quality

Introduction

The cost of quality categories (prevention, appraisal, internal failure, and external failure) are widely known and generally credited to Phillip Crosby (Crosby, 1979, pg 124). The trend information is invaluable to assure the organization's efforts in its continual improvement and profit maximization. Unfortunately, often missing from the endeavor is the related prioritization and corrective action. In the effort to be thorough in capturing costs for all of the required categories, the energy can all focus on calculating the totals, rather than concentrating on corrective action. A literature search exposed the pros and cons of the existing 'Quality Cost' approach. Based on the literature findings, this paper presents elements of a model for a more proactive utilization of the data. Hopefully, the model elements, based on literature findings will lead to favorable outcomes for 'Quality Costs' reductions.

Literature Review

Approaches in the Development of Quality Costs

An initial step in quality costs is determining what to measure (Jaju & Lakhe, 2009, pg 948). An approach is to provide questionnaires to employees in different departments to determine their general overview of cost. Employees then determine their individual quality costs and how they affect their department. Each department is then studied in detail to determine all the quality costs within the departments. An analysis prioritizes the data. A key tool is the plotting of trends. Investment in prevention costs drives down appraisal and failure costs. Increasing training and quality programs raises prevention costs but results in lower appraisal and failure costs.

Ittner (1996) presents the hypothesis that conformance expenditures must continue to be increased to achieve ongoing reductions in nonconformance costs (Pg. 571). The researcher uses a sample survey data analysis, conducted from a selection of 49 manufacturing units from 21 companies resulting in a foundational understanding of key definitions of quality costs and a breakdown of how these definitions and concepts are classified. Two competing models illustrate a hypothesis of the contrast between conformance and non-conformance expenditures. The hypothesis is as follows: "Conformance expenditures must be increasing over time to achieve ongoing reductions in nonconformance costs." versus "Ongoing reductions in nonconformance costs can be achieved over time, while maintaining or even reducing existing conformance expenditure." The results derived from exploring the hypothesis demonstrate that the empirical evidence on the quality cost behavior exists in spite of the implicated contradicting allocation of resources to quality improvement activities illustrated from the traditional models. It becomes a challenge differentiating the two competing approaches. Ittner reverts to a more liberal proposition whereby firms demonstrate a reduction of nonconformance costs while simultaneously maintaining or ensuring the reduction of existing conformance expenditures. Ittner also looked at the changes over the life of a quality program that result in an average reduction in nonconformance costs of the plants and a "relatively fixed level of prevention expenditures, not the increasing conformance expenditures."

Finally, a plant-specific time series behavior of reported quality cost analysis was carried out. The results illustrate a conflicting analysis to the hypothesis which portrays an accelerating pattern that attains a reduction in conformance costs.

White (1996) provides a handbook on categorizing performance measures and exposes the significance of these measures in each category (pg. 48).

Four major objectives are outlined:
1. Coordinated literature related to measurement performance with respect to manufacturing within the parameters of competitive strategy.
2. Construction of a personalized taxonomy relevant to the measurement of manufacturing performance.
3. Use of the taxonomy to classify and categorize each performance measure found in a literature survey.
4. The presentation of a common standard structure illustrating the mechanism by which strategy-related performance measures are chosen. Thereby an accurate measure of manufacturing performance is provided in relation to a firm's competitive strategy or to serve as a reliable reference for researchers evaluating manufacturing performance, who can then incorporate it into their strategic research.

Additionally, White (1996) summarizes a literature survey that took place in 1993, and then elaborates by providing us with a guide for selecting measures and in turn develops a classification scheme (pg 49). White does this by answering two major questions:
1) What will be measured
2) How will it be measured

The first question is answered by placing emphasis on competitive strategies related to strategic manufacturing.

The second question is answered through the assessment of four different factors with respect to the required information for improving competitive performance. These factors are:
a) " The possible sources of data " (External or Internal)
b) "The type of data collected" - (Subjective or Objective)
c) "The reference base used and (Benchmark or self-reference)
d) "The collection of measurement" (Location of measurement)

White's research proposed that 125 strategy related measures should be categorized according to:

a) Competitive Priority
b) Data source
c) Type of measure
d) Measure reference
e) Process orientation

The following discoveries were made:

1. Competitive priority of flexibility held the majority number of proposed measures in contrast to delivery reliability which has the lowest number of proposed measures.
2. Subjective benchmark measures are mostly used in academic research as compared to self-referenced ones. The academic researchers also aimed at achieving more objective measures from external data sources.
3. Subjective type measures appeared to be the preferred choice for most firms as compared to external data sources.

Practitioners appeared to exclusively depend on process outcome measures. White (1996) recommends that consideration be given for more process input measures (pg 50). It appears that there is a consensus that the measurement of delivery reliability performance should be based on "a function of due–date adherence," since almost all measures focus on the due date in one way or another. However it appears that due to the multi-dimensional nature of flexibility and quality performance, a consensus has not been found. White hoped that this attempt of taxonomy could 'provide a basis for future work in developing or refining performance measures for manufacturing.'

Improving quality in the service industry is much harder than that of production (Radovic & Camilovic, 2012, pg 610). The reason it is harder is that it is tough to measure. Not much research is performed in quality management in the service industry. An important aspect for improving service quality is providing an accurate mission and vision. This gives the customer a better idea of what to expect. A hurdle some service companies encounter is customer expectations straying away from the actual service product. Like the production industry, it is important for service companies to find a way to measure performance. Focusing on training will improve standardization

of service. Standardizing service will help discover flaws or defects in your service.

Hidden Costs

Rodchua (2009) performed a comparative analysis of quality costs and organization sizes in the manufacturing environment (pg 36). A company's failure to improve cost of quality is one of the many factors that cause it to lose money. The study of categorized costs is between both small and large organizations. The approach is the prevention, appraisal, and failure (PAF) cost model.

The findings suggested that total quality costs were on an average eight to ten percent of manufacturing expenses, or up to four percent of sales revenues. The failure costs result in the major expenses and ranged from seventy percent to eighty percent of total quality costs. The primary problems in quality cost program implementation are culturally related in favor of correction over prevention, human mistakes, insufficient processes, and lack of proper information. 'A quality cost program is an effective tool used to contribute to customer satisfaction and profits. Today, more and more enterprises - small, medium, and large - are spelling out quality cost requirements, from the collection of scrap and rework costs to the most sophisticated quality cost program.'

The study attempts to identify problems and solutions that quality professionals experience in their quality cost program implementation efforts. The findings of this study may further help industrial and quality professionals measure the success of their quality costs program or assist businesses in setting up a system of quality cost implementation.

Yang's traditional categories for quality cost (PAF) are broken down further to add extra resultant cost and estimated hidden cost (2008, pg 180). The main goal is to capture all the quality cost data in a company. Most companies believe their quality costs to be three to seven percent of sales while in actuality it is around thirty percent. This revolves around companies not recording all of their quality costs. Some of these hidden costs they proposed include loss of reputation costs, and costs of the product not meeting the customer expectations. It is suggested that these could constitute up to ten percent of actual production costs. Some researchers also estimated that the

hidden quality costs are more than three times that of the visible costs.

Through research Mr. Yang constructed a list of hidden costs companies incur. One important hidden cost is if a product fails and has to be re-worked; those costs are incurred in the internal failure category but what about time lost and possible damage to other parts? Those are to be considered hidden costs. Another example of hidden cost is the cost incurred when there is a delay of a new product due to design change.

Kendirli and Tuna (2009) note that measurable costs are less than actual costs (Kendirli & Tuna, pg 24). They use the iceberg representation. It is important that management understands the importance of quality costs and makes it a top priority in their organization. Top managers need to lead the way and teach their middle and lower managers the importance of quality management.

Furthermore, Revelle (2013) defines the "hidden factory" as the portion of personnel, equipment, material and facility that is devoted to various non-productive activities, such as rework or obsolete storage (pg 50). He estimates that it occupies fifteen to forty percent of otherwise productive use. Revelle notes, "Do you even know how to obtain the information?" This is a quality cost that is "hidden."

Quality Cost Correlations

Having a good quality costs system in place helps each project group be more effective. (Chopra & Garg, 2011, pg 513). The conclusion is that there is a strong negative correlation between prevention costs and internal failure costs. They found that after a year of implementing a new system, it slowly gets worse over the following years, which is a key issue of control. A quality team can change an organization's procedures and improve quality but if employees slowly deviate from the process things will go back to normal. "On analyzing these quality costs, it has been found that there is a strong negative co-relation between prevention costs and internal failure costs. This implies that we should direct more efforts towards prevention activities so as to reduce internal failure costs. However the co-relation between prevention costs and external failure costs is less negative (Chopra & Garg, 2011, pg 515)."

Different measuring practices and improvements that can

be made are discussed (White, 1996, pg 49). Companies can put more of an emphasis on measuring external data sources. Measuring this data can be more difficult since you are not in control. It is important for companies to work closely with their suppliers and their customers. By maintaining a good relationship and communication the company is able to design quality products that the customers desire. White (1996) also believes that the way to measure data needs to shift away from current measures and shift toward strategy related manufacturing performance (pg 50).

Proactive Quality Cost Approaches

The ultimate objective is action and not just data collection. There are two interesting hypothesis. The first hypothesis is that average quality increases over time. The other is that both internal and external failure costs decrease over time. There are a lot of other variables. It would be necessary to keep the same employees and the exact same process. The assumption is that as defects decrease over time so do appraisal costs. Although White discusses how costs can decrease over time, it does not mention ways of corrective action or other methods of reducing costs. Knowing costs decrease over time can be important, but there do not seem to be many variables to help improve decreasing costs over time.

Kendirli and Tuna (2009) emphasize the importance of top management leading the way for quality management. Although logical, it is important that top management is clear and able to put reports together that workers will be able to understand. It is important to break down quality tasks into projects. By breaking up quality into different projects, they are able to look more in-depth and thus improving quality as a whole.

Mandal & Shah (2002) note that in improving quality, it is helpful to educate the workforce and cement the 'do it right the first time' attitude (pg 176). If employees are educated and fully trained there is a significant reduction in scrap. Other key areas in improving quality costs are in-process rejection of scrap. This is important because it keeps external failure costs down. If failed products get out to the customers not only is the company reputation hit but the company has to pay for replacing the product and responding to the customer complaints. These costs can be kept down by not allowing flawed parts out

the door. Mandal & Shah, (2002) state, "…quality education programs are highly correlated with controlling rework as the education helps in changing the attitudes of the employers and in creating the concept of 'do it right the 1st time' amongst employees" (Mandal & Shah, 2002, pg 177).

Soltani, (2011) explains that as globalization continues to grow, interlinking supply chain and quality management is key (pg 278). While the supply chains are analyzed, it is important for quality to remain the top priority. This study also looked at the culture of the organizations. Soltani, (2011) found it to be a big factor as one company played the blame game. Instead of blaming themselves or the process they put blame in the workers. While the workers are not solely responsible they must be held accountable for their work. A key factor is the building up of supplier relations and working together to drive down costs while improving quality. One benefit of a strong relationship is the sharing of information, which is important for measuring quality.

In addition, Al-Khawaldeh (2007) asked companies about the culture and how they manage their quality (Al-Khawaldeh & Sloan, pg 325). One question was, "[do] individuals and groups use the organization's strategy and objectives to focus and prioritize their improvement activities?" The answer to this question received 54 disagrees and 14 strongly disagrees compared to 20 agrees and 10 strongly agree (Al-Khawaldeh & Sloan, 2007,pg 326). If employees do not follow procedures it makes improvement nearly impossible. When discussing improvement activities, companies said the two biggest challenges they faced were not having enough time and not having a supportive culture.

The supply chain focuses on supplier assessment, strategic long-term relationships, and logistics integration that correlate with quality, delivery, flexibility and cost (Prajogo & Chowdhury, 2012, pg 125). Supplier assessment is positively related to the firm's quality performance. The key finding is the importance of sharing data back and forth with the suppliers. By improving communication up and down the supply chain, there is an increase in the quality of the product.

Khasawneh, AL-Hashem, and Al-Zoubi (2012) noted that it is our responsibility in the United States and other more developed nations to teach less developed countries about

quality management and the importance of measuring quality (Khasawneh & AL-Hashem & Al-Zoubi, pg 19). They created a list of recommendations that include: "Increase employees' participation and empowerment for preparing plans to develop quality requirements," "Increase interest and attention by enterprises towards making clear plans about quality with specific goals set by management," "Establishment should show more interest towards developing annual training plans to develop employees' skills and abilities," and "Increase interest and attention by enterprises to use scientific styles and tools for improving quality." It would be easy for Americans (or any other more developed country) to look at this list and say "we've been doing that for years", but it is important to be reminded of the basics. The authors note that too many companies implement these ideas yet they end up either getting lost or taking a back seat to something else.

Aziz & Taleghani & Esmaielpoor discussed the role of quality costing in total quality management, reaching the following conclusions: The analytical tools, ANOVA, and Duncan Tests, identified a major disparity between the optimum execution of Total Quality Management (TQM) and the quality costing system, a contrast between low, medium, and high levels of specifying the quality costing system in optimum execution of TQM and the greater impact of increased levels of quality (pg 23). Quality and costs are compliments of each other and the quality cost system demonstrates their relevance in an organization, by facilitating informed managerial decisions and controls. Finally, as the effect of quality costing system on the optimum execution of TQM is determined in accordance with each of the PAF model variables, the results show that higher levels of specifying each one of the said components would result in an improved implementation of TQM.

Industries that use the quality cost approach (however, the same approach is effective in the service industry)

Jaju & Lakhe (2009), tracing quality cost in a luggage manufacturing industry, focuses on discovering the most effective and efficient means of applying quality cost in a luggage manufacturing industry (pg 952). The main vehicle for deriving information about quality cost in the luggage industry

is departmental interviews and questionnaires as well as quality cost checklists, which include a list of cost elements.

More so, Munro (2003) illustrates the major challenge for managers in the automobile business correlating and understanding the application of quality cost concepts to their daily operations, their inability to learn from past mistakes on the instability of the automobile industry (pg 51). The author highlights the distinctive communication problem between management and the original equipment manufacturer (OEMs). He addresses the history of the automobile industry to emphasis the need to draw lessons from past mistakes. He further elaborates on the status-quo dilemma between ISO 9001:2008 and ISO/TS16949 and the need for '…the five US based manuals used to supplement QS-9000:2008 and ISO/TS 16949' to be understood by registration auditors and suppliers. Other setbacks that hinder the application of quality costs include endless debates on definitions of the words 'continual' and continuous improvements.'

Munro concludes with recommendations citing examples of how Peter Drucker and Peter Senge have attempted to work with managers in various organizations. He points out that the Wall Street marketing scheme does not encourage employees to give managers the right information to make informed decisions and better corrections on their mistakes. He recommends that the industry act independently regardless of criticism from the outside business world.

Mandal & Shah's (2002) analysis of quality costs in Australian manufacturing firms (pg 179) adds to the justification of sound analysis. Statistical analysis is used by the researcher to address major quality data cost reports used by Australian manufacturing firms that result in the formulation of improved quality strategies. It is obvious from the article that the application or inclusion of quality cost analysis is highly neglected by many firms. This analysis is conducted through a questionnaire survey that seeks to marry the application of Total Quality Management cost concepts and operations in quality cost management. The researcher notes that there are no precise methods for prevention, internal appraisal and external failure cost elements. Measurements for total quality cost exist; such as percentage of sales turnover, total material costs, total manufacturing costs and labour costs. Frequency distribution, cross-tabulation, chi-square

test and discriminant analysis are the major analytical instruments used to analyze the cost. He illustrates that the Australian firm responds positively to its customers' feedback needs in respect to product requirements via its own technical tools and controls of quality cost. This forms a solid foundation for the reduction of customer complaints. The results of the discriminant analysis illustrate that quality education is more effective in controlling total rework/scrap and customer complaints compared with any other strategies. This finding allows a manufacturer to increase its rate of learning and thereby lower its quality assurance costs below its previous level.

Analysis

Several lessons about quality costs were uncovered and in the literature searched and categorized as:

Data Collection Methodology

1. Quality cost were discovered via enterprise wide department questionnaires (Jaju & Lakhe, 2009, pg 950)
2. A strong supplier/customer relationship includes the sharing of information which is important for measuring quality. As globalization continues to grow, interlinking supply chain and quality management is key. (Soltani, 2011,pg 281)
3. The main vehicle for deriving information about quality cost is departmental interviews and questionnaires as well as quality cost checklists which included a list of cost elements (Jaju & Lakhe, 2009,pg 948)
4. Marketing schemes do not encourage employees to give managers the right information to make informed decisions and better corrections on their mistakes. (Munro, 2003,pg 51)

Hidden Costs Difficulties

5. The "hidden factory" is the portion of a personnel, equipment, material and facility that is devoted to various non-productive activities, such as rework or obsolete storage. It comprises fifteen to forty percent of otherwise productive use. We do not even know how to obtain the information. This a quality cost that is "hidden."
(Revelle, 2013,pg 50)
6. Total quality costs are on an average eight to ten percent of manufacturing expenses, or two point six to four percent of sales

revenues. The failure costs are the major expenses and ranged from seventy percent to eighty percent of total quality costs. (Rodchua, 2009,pg 37)

7. After one year after a new system is implemented, it slowly gets worse, a key issue of control (Chopra & Garg, 2011,pg 512)
8. Most companies believe their quality costs are three to seven percent of sales while in actuality they are around thirty percent due to not recording all of the costs. Some of the hidden costs are loss of reputation costs, and costs of the product not meeting the customer expectations. This could constitute up to ten percent of actual production costs. (Yang, 2008,pg 180)
9. Companies must put more of an emphasis on measuring external data sources. Measuring data can be more difficult since you aren't in control. It is important for companies to work closely with their suppliers and their customers (White, 1996,pg 59)
10. Measurable costs are less than actual costs--they are the iceberg representation (Foster & Wallin & Ogden, 2011, pg 2289)

Investment Costs

11. Learning is a function of proactive investments in quality improvement, autonomous learning-by-doing, and is more effective than simple proactive investment in quality improvement. (Ittner & Nagar & Rajan, 2001, pg 119)
12. Quality education programs are highly correlated with controlling rework as education helps in changing the attitudes of the employers and in creating the concept of `do it right the first time' amongst employees. (Mandal & Shah, 2002,pg 178)
13. Relative to improvement activities companies said the two biggest challenges they faced was not having enough time and their culture not being supportive (Al-Khawaldeh & Sloan, 2007,pg 325)
14. Exhibit more interest towards developing annual training plans to develop employees' skills and abilities. Increase interest and attention by enterprises use of scientific styles and tools for improving quality (Khasawneh & AL-Hashem & Al-Zoubi, 2012,pg 5)
15. Quality education is more effective in controlling total rework/scrap and customer complaints compared with any other strategies. (Mandal & Shah, 2002,pg 180)

Focus

16. Enterprises demonstrate a reduction of nonconformance costs while simultaneously maintaining or ensuring the reduction of existing conformance expenditures (Ittner, 1996, pg 565)
17. Both academic and corporate researchers appear to exclusively depend on process outcome measures for classifying quality costs. (White, 1996,pg 58)
18. The effect of quality costing systems on the optimum execution of TQM was determined, in accordance with each of the PAF model variables. The results showed that higher levels of specifying each one of the said components would result in an improved implementation of TQM. (Aziz & Taleghani & Esmaielpoor, 2010,pg 21)
19. Improving quality in the service industry is much harder than that of production--the reason is it harder to measure. Standardizing service will help discover flaws or defects in your service. (Radovic & Camilovic, 2012,pg 610)

Information Dissemination

20. By improving information and, quality up and down the supply chain, there is an increase in the quality of your product. (Prajogo & Chowdhury, 2012,pg 127)
21. It is important that top management is able to put reports together that workers will be able to understand. Quality tasks must be delegated to projects. (Kendirli & Tuna, 2009, pg 29)
22. A company's failure to improve cost of quality is one of the many factors that cause it to lose money (Rodchua, 2009,pg36)

Discussion

Literature reviews are invaluable in gathering the industry's experience about quality costs.

Based on the principle that experiential information is good, however, but action is better, the following considerations are proposed as additions to the current models:

The Crosby four cost model is valuable, but may be upgraded for on-going performance improvement for the following reasons:

1. Pareto analysis of each of the four categories is generally lacking
2. Project assignments must be generated for near term and

long term follow-up
3. There is generally a lack of information generation with suppliers and customers
4. Hidden cost estimates are required to express the true quality failure percentage as a function of sales.
These four elements may be modeled for an action oriented approach.

Conclusion

Literature searches provide valuable information on the state of the art and are a form of benchmarking for a firm's TQM continual improvement efforts.

The culture of quality improvement is not always rapid and the discussion points above cannot be all accomplished at once. Each management team must decide their strategic approach to achieve the ultimate quality advantages.

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The Relationship Between Facebook and Body Esteem Comparing College Women

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Human Development and Family Studies

Abstract

As of March 2013, Facebook recorded having 1.11 billion active members worldwide (Associated Press, 2013). Research reveals a staggering amount of college students are users of Facebook. Considering Facebook's prevalence in the lives of young people, it is essential to understand how Facebook affects our society. The purpose of this study was to examine the relationship between Facebook and body esteem and compare this relationship between college freshmen and senior women. This nonrandom pilot study surveyed 106 college women at a west-central Wisconsin university. The method used was a cross-sectional research design. We predicted that Facebook would negatively affect body esteem in young women when users utilized the site for social comparison among Facebook friends. We also predicted that there would not be a difference between college freshmen and senior women when looking at the relationship between Facebook and body esteem. Due to our research comparing college women based on academic status, survey data was statistically analyzed using cross-tabulations, mean comparisons, independent t-tests, and a Cronbach's Alpha reliability analysis. Results showed mixed support for both hypotheses. Implications for those working with college women include raising awareness on possible effects of Facebook on body esteem, and providing tips for healthy usage of Facebook. Future research would benefit from a large, randomized national and global sample, and qualitative interviews to capture the lived experience of those surveyed.

Keywords: Facebook, body esteem, college women, Social Comparison Theory

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With technology becoming more and more integrated into our society, so too are social networking sites, the most popular being Facebook. As of March 2013, Facebook recorded having 1.11 billion active members worldwide (Associated Press, 2013). Research sampling mostly U.S. college students revealed that 90% used social networking sites, and of those students, 97% visited Facebook daily (Smith & Caruso, 2010 as cited in Junco, 2011). Considering the prevalence of Facebook in the lives of young people, it is essential to understand how Facebook affects our society.

Current research has revealed that Facebook could be a cause for stress, particularly in women, and could lead users to believe that their friends are living happier, more enjoyable lives than themselves (Thompson, & Lougheed, 2012; Chou, & Edge, 2012). The connection between Facebook and body esteem- how we perceive our body and our appearance- is just beginning to be explored (Mendelson, Mendelson, & White, 2010). A poll looking at this relationship found that Facebook users who viewed photos of themselves and Facebook friends were more conscious of their body and weight. This poll further revealed statistics that correlated Facebook use with comparing one's body to others (The Center for Eating Disorders at Sheppard Pratt, 2012). The features available on Facebook offer users the ideal instrument for social comparison processes.

Social comparison is the process of an individual comparing him/herself to others as a way of better understanding one's own attitudes, abilities, and opinions (Festinger, 1954; Goodman, 2005, as cited in Sheldon, 2010). Research on social comparison and body esteem found that women often suffer from poor body esteem as a result of social comparison (Franzoi, Vasquez, Sparapani, Frost, Martin, & Aebly, 2011). Although connections between Facebook and body esteem have already been identified, there is scant research examining the changes in body esteem in connection with Facebook throughout a young women's college career. This study examined the relationship between Facebook and body esteem comparing college freshmen and senior women.

Literature Review

A literature review was conducted to investigate the relationship between Facebook usage and body esteem in

college women using Ebscohost. Key words used included: *Facebook, body esteem, college, women, social networking, and social comparison.* Literature from the past 5 years was utilized.

Current research on social networking sites (SNS) has examined the effects of Facebook on users' body image and overall wellbeing. A survey conducted by The Center for Eating Disorders at Sheppard Pratt (2012) found that 80% of respondents- both male and female, logged onto Facebook at least once daily and of those respondents, 61% logged in several times a day. About half of all users reported that they compared their life to others when viewing photos or reading statuses posted by friends, and 32% of respondents felt sad when comparing photos. A study by Thompson and Lougheed (2012) revealed that compared to males, females were more likely to report feeling stressed due to Facebook use, and feel anxious or upset if unable to access Facebook.

Research by Franzoi and Klaiber (2007) revealed that most college students in the study were more likely to compare themselves to other college students than professional athletes or models. This implied that students preferred to use a reference group of those who use their bodies in a similar manner when utilizing social comparison. Later research by Franzoi et al. (2011) found that women were more likely to compare their face and body shape to women whom they perceived as having similar or better physical qualities than themselves. These findings suggested that women were more likely to use similar or upward comparisons rather than downward comparison. Additionally, females have been shown to be especially prone to using the standards of peers to measure their own appearance, particularly during adolescence and early adulthood (Davidson & McCabe, 2005; Morrison, Kalin, & Morrison, 2004, as cited in Linder, Hughes, & Fahy, 2008).

Haferkamp and Krämer's (2011) research found that individuals who viewed photos of attractive SNS users were in a less positive emotional state afterwards. These individuals also reported a higher level of difference when comparing their build and an ideal build, and were less satisfied with their body compared to participants who looked at photos of less attractive SNS users. Chou and Edge's (2012) research found that the longer an individual used Facebook, the stronger they believed that others were living happier lives than they were and the less

likely they agreed that life is fair.

Sheldon's (2010) findings showed that both peers and family influenced women's body esteem; however, family influence subsided when women were attending college and peers were the most influential factor contributing to body esteem. Other findings show that women in emerging adulthood value their peers' opinions and acceptance regarding appearance. Messages about appearance from peers have been shown to be paramount in a young woman's self-concept (Gillen, 2007, as cited in Linder et al., 2008)

Krcmar et al.'s (2008) research revealed that interpersonal norms, including those of peers and parents, and mediated norms had a negative correlation to a young woman's appearance and body esteem. Social comparison and interpersonal norms were shown to either negate or reinforce mediated norms that force beauty and thin-ideals on women. This finding showed that support for thin-ideals within the social environment reinforced mediate norms that promoted the same beauty ideals. Linder et al. (2008) posits that as young people enter adulthood and form their self-concept, they use social comparison to develop their identity while also trying to fit in.

Current literature has established that women tend to have low body esteem and are heavily influenced by interpersonal norms and perceptions. The literature examining social networking sites indicated that Facebook can be utilized for social comparison and may have more adverse effects on women. The current literature does not adequately address if the influence of Facebook on body esteem changes with age. This study served as a way to better understand if this relationship changes as women goes through college.

Theoretical Framework

Social Comparison Theory was used to inform this study. This theory assumes that individuals compare themselves to others to better understand their own attitudes, abilities, and opinions as these concepts are difficult to assess individually (Festinger, 1954; Goodman, 2005, as cited in Sheldon, 2010). There are two types of social comparison: upward social comparison- comparison to someone considered "better off", and downward social comparison- comparison to someone considered "worse off" (Wilson & Ross, 2000 as cited in Franzoi et al., 2011). Typically,

individuals prefer to compare themselves to others they view as similar to themselves. Upward social comparison is often utilized to motivate self-improvement; however research shows that this frequently leads to low self-esteem, especially when the comparison is to someone with unrealistic and unattainable standards (Collins, 1996 as cited in Franzoi et al., 2011).

As applied to our study, Social Comparison Theory would predict that women who use Facebook as a tool for social comparison and perceive their Facebook friends as better looking than they would have poorer body esteem, as upward social comparison has been shown to negatively affect body esteem (Franzoi et al., 2011). In Western social standards, women's bodies are perceived as beauty objects and are modeled to body types with physical standards difficult to attain. Thus, women typically rely on upward social comparison when evaluating their own body which can lead to more body dissatisfaction (Collins, 1996; Krahe´ & Krause, 2010; Tiggemann & Polivy, 2010, all as cited in Franzoi et al., 2011).

Purpose Statement

The purpose of this study was threefold: 1) to examine the relationship between Facebook and body esteem and compare this relationship between college freshmen and senior women; 2) to develop a reliable survey instrument which measures college freshmen and senior women's attitudes towards Facebook and body esteem, and, 3) to increase awareness on the issue of Facebook and body esteem so programs can be further developed to build positive body esteem in young women.

The question central to this study was: "What is the relationship between Facebook and body esteem comparing college freshmen and senior women?" We predicted that Facebook would negatively affect body esteem in young women when users utilized the site for social comparison among Facebook friends. We also predicted that there would not be a difference between college freshmen and senior women when looking at the relationship between Facebook and body esteem. These hypotheses were based upon evidence from literature and theory.

Method

Participants

This study was conducted at a west-central Wisconsin university. One hundred and eighty-nine surveys were distributed to students in seven classes; 106 were included in our sample based on our demographic criteria. All of the participants were female, had a Facebook profile, and were students enrolled in the university. Fifty-four were freshmen and 52 were seniors; see Table 1 for age.

FAC

YER	SD	D	U	A	SA	Total
Freshmen	7.4%	16.7%	61.1%	14.8%	0.0%	100.0%
Senior	13.5%	32.7%	48.1%	5.8%	0.0%	100.0%

AWA

YER	SD	D	U	A	SA	Total
Freshmen	5.6%	13.0%	33.3%	40.7%	7.4%	100.0%
Senior	5.8%	13.5%	28.8%	40.4%	11.5%	100.0%

Note. (YER) = Year in college; (COM) –I often compare myself to the photos of others on Facebook; (ACC) = After viewing photos of myself on Facebook I am more accepti appearance; (MOR) = I tend to compare myself to people I perceive as more attractive myself; (LES) = I tend to compare myself to people I perceive as less attractive than m (PRI) = I am proud of my body and appearance; (PER) = I care about how others perce appearance; (WEI) = I am happy with my weight; (EST) = My body esteem has improv past 4 years; (FAC) = I believe Facebook positively influences my body esteem; (AWA Facebook makes me more aware of my body and appearance

Research Design

The purpose of this non-random survey research was to investigate the relationship between Facebook and body esteem and compare this relationship between college freshmen and senior women. A cross-sectional research design was utilized to evaluate this relationship among college freshmen and senior women at one point in time. Self-administered surveys were utilized, and were considered the most time and cost effective option as it allowed us to gather information quickly and reach our demographic population easily.

The population was college students at a west-central Wisconsin university that attended courses containing predominantly college freshmen and senior women. The sample consisted of 54 college freshmen and 52 senior women who had Facebook profiles. The study used a non-random, purposive sampling design. Our method was nonrandom as a way of being inclusive when sampling in classrooms. This study was approved by the Institutional Review Board (IRB). The ethical protection

of human subjects was provided through the completion of the IRB's Human Subjects training.

Data Collection Instrument

The survey was designed to investigate the relationship between Facebook usage and body esteem in college freshmen and senior women. The survey included a brief description of the study, definitions of terms not commonly known, risks and benefits, time commitment, confidentiality, voluntary participation, our contact information and that of our supervisor, and instructions for completing the survey.

The survey consisted of seven demographic questions regarding gender, age, year in college, if they had a Facebook profile, number of daily Facebook log-ins, how often Facebook friends' photos and albums were looked at, and how often the participant uploaded photos on his/her Facebook account, as well as ten closed-ended statements based on based on a 5-point Likert scale, ranging from one (strongly disagree) to five (strongly agree). Statements and questions were informed by the literature on body esteem and Facebook and also the Social Comparison Theory.

The survey instrument had both face validity- logical correlation between the statements and the research question, and content validity- statements addressed the breadth of concepts from the literature reviewed. The survey statements and questions addressed Facebook usage and body esteem issues, and if there was a relationship between the two. Using feedback from our research supervisor, we refined and finalized our statements. The majority of our survey statements were informed by reliable survey instruments such as the Body Image Scale (BIS; Connor, Martin, Silverdale, & Grogan, 1996); thus, a pilot study was not conducted.

Procedure

The survey process began when we e-mailed professors that taught classes predominantly populated with freshmen or senior women. We explained the purpose of our research and asked for permission to survey their classes. After receiving permission from the professors we set up specific times to go into each classroom and survey our sample. Data collection began November 1, 2012 and ended November 12, 2012.

For each class surveyed, we introduced ourselves and gave basic information found in the Implied Content section on the questionnaire. We explained the purpose of our research and explained that data from freshmen and senior women who have a Facebook account would be analyzed. We invited those who did not fall into this category to participate and informed them that their responses would still be considered. Surveys were then passed out and we read the Implied Consent out loud, asking students to follow along. Students were able to ask questions about anything on the implied consent and were then asked to detach and keep the implied consent. To decrease any pressure to complete the survey, the two of us as well as the professor, stepped outside of the classroom while the students completed the questionnaires. When the students completed their questionnaires they placed them in a file folder which we collected once all participating students were finished completing the questionnaire. The questionnaires were then locked in a safe in one of our homes until data analysis.

Data Analysis Plan

The data was first "cleaned" and checked for missing data. The "cleaned" surveys were then "coded" using acronyms for each variable. Our independent variable was year in college (YER). All demographic questions were given a three letter acronym: Gender of participant *(GEN)*; age of the participant *(AGE)*; year in college *(YER)*; if the participant had a Facebook profile *(PRO)*; how many times the participant logged onto Facebook in a given day *(DAY)*; how often the participant looked at Facebook friends' photos and albums *(LOK)*; how often the participant uploaded photos on their Facebook account *(UPL)*. Our survey statements were the dependent variables and each statement was also given a three letter acronym: I often compare myself to the photos of others posted on Facebook *(COM)*; After viewing photos of myself of Facebook I am more accepting of my appearance *(ACC)*; I tend to compare myself to people I perceive as more attractive than myself *(MOR)*; I tend to compare myself to people I perceive as less attractive than myself *(LES)*; I am proud of my body and my appearance *(PRI)*; I care about how others perceive my appearance *(PER)*; I am happy with my weight *(WEI)*; My body esteem has improved in the past 4 years *(EST)*; I believe Facebook positively influences my body esteem *(FAC)*;

Facebook makes me more aware of my body and appearance (*AWA)*.

The data was analyzed using the computer program *Statistical Package for the Social Sciences (SPSS)*. The individual was used as the level of analysis. Since our groups were compared, the data analysis included: frequencies, cross-tabulations, mean comparisons, independent t-tests, and a reliability analysis. Additionally, a Cronbach's Alpha reliability analysis was conducted.

Results

All variables were subjected to frequency distribution analysis and no missing data was found. Only data from freshmen and senior women were analyzed, however any qualitative comments from students not in these groups were considered.

A reliability analysis was run to indicate if the variables were a reliable index to measure the major concept: The relationship between Facebook and body esteem comparing college freshmen and senior women. Cronbach's Alpha is a measure of reliability and in this analysis was 0.590, indicating that the survey statements were a moderately reliable measure of the major concept.

Results for our first hypothesis, predicting that Facebook would negatively influence body esteem, were mixed. For both groups, a large percentage of respondents were uncertain if Facebook positively influenced their body esteem (FAC). For the remaining respondents, there were more that disagreed than agreed with the statement. For the statement: Facebook makes me more aware of my body and appearance, both groups had approximately half of all respondents agreeing with the statement. This support is provided in the Cross-tabulations, Appendix A, Table 1.

Hypothesis #2, predicting that there would not be a difference between the two groups, also had mixed support as five out of ten variables between the two groups supported our hypothesis; these variables included: *I often compare myself to the photos of others posted on Facebook (COM); I tend to compare myself to people I perceive as more attractive than myself (MOR); I am proud of my body and appearance (PRI); My body esteem has improved in the past 4 years (EST); Facebook makes me more aware of my body and appearance (AWA)*. This

support is provided in the Cross-tabulations, Appendix A, Table 1. Results not supporting our hypothesis showed a significant mean difference between the two groups on the Independent T-test with a p-value of 0.017 for the variable *FAC*.

Discussion

We found mixed support for our hypothesis that Facebook would negatively affect body esteem in young women when users utilized the site for social comparison among Facebook friends. We also found mixed support for our hypothesis that there would not be a difference between college freshmen and senior women when looking at the relationship between Facebook and body esteem. Statistically significant mean differences were found among one variable that will be discussed later within this section. Variable analysis will focus on cross tabulations and contrast whether the results were supported by literature and/or by theory. Limitations to the study, implications for practitioners, implications for future research, and the conclusion will be discussed as well.

The Social Comparison Theory supported our hypothesis that Facebook would negatively affect body esteem in young women when users utilized the site for social comparison. According to this theory, when women utilize upward social comparison body esteem is impacted negatively (Collins, 1996; Krahe´ & Krause, 2010; Tiggemann & Polivy, 2010, all as cited in Franzoi et al., 2011). Given this theory and other research on the subject, our mixed support for this hypothesis was surprising. Both groups had a high percentage of uncertainty for the statement "I believe Facebook positively influences my body esteem", and the majority of the remaining students disagreed with this statement. This is consistent with a national survey that found that nearly one in three respondents felt sad when comparing photos of themselves to Facebook friends' photos (The Center for Eating Disorders at Sheppard Pratt, 2012). Nearly half of all respondents were also uncertain if they were more accepting of their appearance after viewing photos of themselves on Facebook. Mixed support was found in regards to whether respondents often compared themselves to the photos of others posted on Facebook. A high percentage of both groups believed that Facebook made them more aware of their body and appearance, and there was a reasonably high amount

of uncertain responses for this statement as well. Results from a national survey support these findings as it revealed that over half of respondents reported feeling more conscious of their body and weight after viewing photos of themselves and friends on Facebook (The Center for Eating Disorders at Sheppard Pratt, 2012). With the uncertainness of whether Facebook positively influences body esteem and the agreeableness from most participants that Facebook makes them more aware of their body and appearance, it could be suggested that students recognize that Facebook makes them aware of their body and appearance, yet they are unable to discern if this awareness affects them positively or negatively.

Our second hypothesis, predicting no difference between the two groups of women when looking at the relationship between Facebook and body esteem, showed mixed support. Half of our variable statements had similar results among the two groups. Within the literature it is stated that social comparison is part of human nature and as humans we cannot escape comparing ourselves to others (Musseweiler, Rüter, Epstude, 2006, as cited in Haferkamp & Krämer, 2011). Given that current literature typically compares genders but not ages of college students, we were curious to examine whether there was a difference among the two groups. The survey utilized in our literature review looked at the relationship between Facebook and body esteem but had a wide age range (18-40 years) and did not provide demographics of those sampled (The Center for Eating Disorders at Sheppard Pratt, 2012). Our results found that similarities between both groups related to Facebook and social comparison were how often students compared themselves to the photos of others posted on Facebook, comparing themselves to people they perceived as more attractive, if Facebook made them more aware of their body and appearance. Similarities between the two groups that related to body esteem were how proud they were of their body and appearance, and if their body-esteem had improved in the past 4 years.

The one statement that showed significant difference between the two groups on the Independent T-test (p-0.05) was "I believe Facebook positively influences my body esteem." Responses showed significantly more seniors than freshmen did not agree that Facebook positively influenced their body

esteem. This may suggest that seniors are affected more negatively than freshmen; or rather, seniors are more aware of the effects of Facebook on body esteem. Other differences showed that seniors cared more about how others perceived their appearance and were less happy with their weight compared to freshmen. This could suggest that senior women have lower body esteem than freshmen; however, results also revealed for both groups, students were mostly proud of their body and appearance. This presents a paradox in examining body esteem and differences among college women.

Limitations

One limitation identified was the small sample; which prevented us from generalizing our findings to the larger population. With large percentages of uncertain responses on various survey statements, other limitations we identified included a lack of time to accurately respond to our survey and limited variation on the 1-5 Likert scale. The limited variation of options for demographic questions was also identified as a limitation.

Implications for Practitioners

Bringing awareness to this topic should be addressed by health educators and licensed counselors on college campuses and in high schools. Support groups, posters on the issue with statistics, public service announcements, and additional resources for further information are all ways to spread awareness. Programs addressing eating disorders and body esteem issues could use this research to better consider the effects of social networking on body esteem. Such programs should consider strategies to make college students understand ways to utilize Facebook without negatively influencing their body esteem. Suggested healthy habits for using Facebook include: limiting daily usage, being aware of feelings that arise while on Facebook, not comparing photos, and keeping a realistic view of Facebook profiles and photos. Counselors, therapists, and psychologists will also find this research helpful as it puts forth the issue of Facebook and its effects on body esteem.

Implications for Future Research

It is recommended that future research would include a random, large, nation sample in order to generalize the findings nationwide. Other ways to gain a broader perspective could include a global sample, a wider age range, and including men in the study. It would also be beneficial to increase the variability for the demographic questions and survey statements using a 1-7 Likert scale. Furthermore, it is suggested that if quantitative research was done again on this topic, respondents should be allotted more time to complete the survey. A qualitative study on this topic would be beneficial in gaining deeper knowledge on this topic.

Conclusion

Our research shed light on the lack of awareness regarding how Facebook affects body esteem. The high number of uncertain responses and mixed support for our hypotheses leads us to believe that many young women have not considered how their online social life could be affecting how they feel about their body and appearance. Although similarities in the relationship between Facebook and body esteem were found between college freshmen and senior women, the differences that remained gave interesting insight. With somewhat contradictory findings, such as seniors women being less satisfied with their weight, but having the same rate of body pride as freshmen and believing that their body esteem has improved since freshmen year, the focus of scholarly conversation could shift to understanding how we personally define and perceive our body esteem and body pride as we mature. Our research questioned the role Facebook played in the relationship between body esteem and social comparison in college women. Based on our results, it would appear that there are many questions within this topic that remain unanswered.

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Appendix A

Cross-Tabulations

COM

YER	SD	D	U	A	SA	Total
Freshmen	9.3%	25.9%	24.1%	37.0%	3.7%	100.0%
Senior	11.5%	26.9%	28.8%	23.1%	9.6%	100.0%

ACC

YER	SD	D	U	A	SA	Total
Freshmen	1.9%	14.8%	59.3%	22.2%	1.9%	100.0%
Senior	9.6%	15.4%	46.2%	26.9%	1.9%	100.0%

MOR

YER	SD	D	U	A	SA	Total
Freshmen	5.6%	9.3%	27.8%	48.1%	9.3%	100.0%
Senior	9.6%	11.5%	19.2%	44.2%	15.4%	100.0%

LES

YER	SD	D	U	A	SA	Total
Freshmen	7.4%	13.0%	24.1%	48.1%	7.4%	100.0%
Senior	5.8%	17.3%	34.6%	32.7%	9.6%	100.0%

PRI

YER	SD	D	U	A	SA	Total
Freshmen	.0%	16.7%	33.3%	31.5%	18.5%	100.0%
Senior	7.7%	11.5%	28.8%	30.8%	21.2%	100.0%

PER

YER	SD	D	U	A	SA	Total
Freshmen	1.9%	7.4%	25.9%	48.1%	16.7%	100.0%
Senior	3.8%	5.8%	15.4%	53.8%	21.2%	100.0%

WEI

YER	SD	D	U	A	SA	Total
Freshmen	7.4%	27.8%	14.8%	22.2%	27.8%	100.0%
Senior	13.5%	28.8%	19.2%	25.0%	13.5%	100.0%

Reshoring: Impact on the U.S. Economy

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Abstract

After decades of loss in manufacturing jobs, the recent trend has revealed that some production facilities are shifting their operations back into the United States. Job growth has been the focus of recent political and policy debates. The debate has rather intensified at the aftermath of the recent financial crisis during which the official unemployment rate has reached a staggering 10% at the peak of the crisis. The objective of this paper is to analyze potential factors which have an impact on the manufacturing production index in the U.S., using data from 2000 to 2012. Such variables as productivity, educational attainment, globalization, and business cycle have been found to exert a statistically significant impact on the manufacturing production index.

To gain a better understanding of the business decision of shifting production facilities, industry professionals were interviewed. The information gathered from the interviews reflects the prominent impact of technology and the level of training given to employees on business decisions to move their production facilities, a viewpoint consistent with my empirical results.

Keywords: Growth, manufacturing, reshoring, U.S.

Introduction

About 30 years ago, the idea of globalization blew up; bringing the number of employees in the manufacturing sector from 19.2 million to roughly 11.6 million in the U.S. (Ensinger, 2010). Looking back upon the United States history, manufacturing played a major role in shaping our society and our economy. A manufacturing plant is where everyone in a small town and people from surrounding towns worked. There was a since of community in these plants and pride. Americans were creating products for other Americans. The three words

** Samantha is a McNair Scholar (Ed.).*

"Made in America" brought overwhelming pride to many folks. It was the robust manufacturing sector in the 30's that aided in pulling out the United States from the Great Depression.

However, after decades of loss in manufacturing jobs, the recent trend has revealed that some production facilities are shifting their operations back into the United States. This process of reversed outsourcing is referred to as reshoring. The topic has been the focus of recent political and policy debates. The debate has rather intensified at the aftermath of the recent financial crisis during which the official unemployment rate has reached a staggering 10% at the peak of the crisis. The recent moves of a few large manufactures, such as General Electric from China and Caterpillar from Japan to the U.S., has the media, politicians, and business people all wondering what reshoring entails for the country (*The Economist*, 2013). In line with that debate, President Barack Obama recently held a discussion with Harry Moser, to discuss his insourcing initiative to encourage U.S. companies to manufacture in the U.S. Moser told the president that the total cost to hold production overseas is greater than the costs many companies looked into, hence the shift of location back to the U.S. (Markowitz, 2013). Moser and other industry analysts† also state the gap in wages between the U.S. and China is depleting, leading to financial strains if the company were to continue hosting production overseas. These strains are pushing companies to reassess their Total Cost of Ownership (TCO) model. The TCO model is used to identify costs in all areas of the company. Examples include sourcing, production location, processing costs, and transportation of the finished goods (Markowitz, 2013). Other reasons for the shift of production location include proximity to customer, enhanced response times, lower complexity of supply chain, and lower transportation costs (Harrington, 2011).

The purpose of this study is to highlight the determinants of reshoring and the implications of the process to the U.S. economy.

The qualitative results indicate that through Total Cost of Ownership models, manufacturing true costs are being shown, exposing costs that seemed minor compared to the cost savings in wages when offshoring or outsourcing to another country. With the realization of added costs through additional taxes,

† *For example, Hohner, Sirkin and Zinser (2011) findings suggest that wages between U.S. and China have started to move toward equalization. Specifically, they conclude that the cost advantage of Chinese labor drop from 55 % to 39 %.*

tariffs, and lengthy lead times, companies are utilizing lean practices to cut costs, improve productivity, and reduce the overall cost of manufacturing.

The quantitative results indicate that reshoring has a positive impact on the United States economy through measures of globalization, productivity, and education. The economic model used in this study reflects how an increase in educational attainment, the productivity of plants, and international trade has a positive correlation with that of the manufacturing index.

The increase in productivity is in line with the results of globalization. As the plants in the U.S become more productive, they can increase the output of the plant, resulting in more goods to export.

Literature Review

Gross Domestic Product (GDP) as defined by the Bureau of Economic Analysis is "the output of goods and services produced by labor and property located in the United States" (U.S. Department of Commerce, 2013). Positive signs of improvement in the economy in terms of GDP would be an increase in exports and a decrease in imports. In 2012, $1.87 trillion was contributed to the economy due to increased manufacturing and $1.73 trillion in 2011 (National Association of Manufacturers). According to McMeekin & McMackin (2012), an estimated $100 Billion USD is expected to be added to the current GDP contribution from reshoring alone. A sign of this was reflected in a posting from the U.S. Census Bureau; it stated the national trade deficit in goods and services has decreased from $44.1 billion in May of 2013 to $34.2 billion in June as reported on August 6th (United States Census Bureau, 2013).

Manufacturers in the U.S. are actively enhancing current operations to win business from companies that are considering shifting production to the U.S. For example, Coating Excellence International invested in technology to enhance operations and give them a leg up on foreign competition (Katz, 2008). According to Acs and Audretsch (1990), small firms are able to compensate for their small capacity with the amount of innovation they contribute to the industry.

In order to boost the growth of manufacturing in the U.S., industry, labor, and political leaders believe imports would need to be limited through quotas, tariffs, domestic legislation or discriminatory preferences. However, many materials are

sourced from foreign suppliers for U.S. based manufacturers. Boeing, for example sources 30% of the components for their 787 Dreamliner from non U.S. suppliers. Kliesen and Tatom (2013) find a strong positive correlation between growth of manufacturing output and real good imports into the U.S.

The offshoring boom impacted sectors in which a majority, if not all positions, required minimal skill levels. Industries such as apparel knitting mills and textiles lost roughly 85% of their jobs (Wilkerson & Williams, 2012). By contrast, industries such as food processing, pharmaceutical manufacturing, machine shops, agriculture, construction , and energy machinery have been a few of the industries that have added jobs due to the higher skill set needed to be competent in the job as well as the need for resources to be in relative proximity of the production facility (Wilkerson & Williams, 2012).

How many jobs are coming back? According to the Bureau of Economic Analysis labor data, as cited in the National Association of Manufacturers, manufacturing supports 12 million jobs directly in manufacturing and 17.2 million jobs indirectly (National Association of Manufacturers, 2012). When taking into consideration the multiplier effect, which means that for every x job in one sector it contributes a y amount of jobs in another, there are 5.8 million professional service jobs such as accounting or consulting that depend on manufacturing positions (Manufacturing Institute).

According to the Manufacturing Institute, when companies were asked, in which employee segment do they experience the most shortages, 83% of companies said that they were facing a moderate-to-serious shortage in skilled production positions such as machinists, operations, craft workers, distributors, and technicians. Many manufacturing sector job openings are unfilled because of a greater skill requirement (Rich, 2010).

Methodology

Using a mixed method approach, this study analyzes the determinants of reshoring in the U.S. manufacturing sector.

In the qualitative portion of the paper, professionals in a management position were interviewed from three different companies located in the Midwest. Discussions were held about the manufacturing sector in general and the trends for the past five years. The interview questions are presented in the

appendix section.

To explain the change in manufacturing output in the U.S., the following model was developed:

Manufacturing Production Index=
a_0+a_1 *Globalization*$+a_2$ *Manufacturing productivity*$+a_3$ *education*$+a_4$ *manufacturing job growth rate*$+a_5$ *time*$+a_6$ *business cycle*$+\mu$

Where globalization equals the value of U.S. exports plus the value of U.S. imports divided by GDP; manufacturing productivity equals the value added to GDP by manufacturers divided by GDP; education equals the percentage of the United States population with bachelor's degree; manufacturing job growth rate equals the present employment level minus the past employment level divided by the past employment level; time refers to time trend. The period spans 2000-2012; business cycle equals 1 if the U.S. was in a recession during that year, and zero otherwise; μ is an error term with mean of zero and variance of 1.

Manufacturing productivity data was collected from the Bureau of Economic Analysis, the business cycle data was collected from the National Bureau of Economic Research, educational data was obtained from the Census Bureau, Manufacturing job growth rate was determined from data derived from the Bureau of Labor Statistics, and the globalization data was collected from the Bureau of Economic Analysis.

Globalization in this study was defined as the value of United States imports + Value of U.S. exports/GDP. According to the results, as the value of our exports goes up, the Manufacturing Production Index (MPI) goes up, increasing the impact of manufacturing on GDP.

The variable time trend reflects the evolution of the manufacturing sector as explained by other variables not accounted for in our model.

The descriptive statistics of the data used in this study are summarized in Table 1.

Table 1: Descriptive Statistic

Variable	Minimum	Maximum	Mean	Standard Deviation
Industrial Production	91.568	104.976	97.713	4.168
Globalization	22.864	31.551	27.061	3.068
Education	0.122	0.151	0.137	0.00883
Business Cycle	0.000	1.000	0.231	0.438
Manufacturing Job Growth Rate	-0.130	0.0180	-0.0195	0.0445
Labor Productivity	0.110	0.125	0.118	0.00554

The terms reshoring, backshoring, onshoring, and insourcing will be used interchangeably. According to the Council of Manufacturing Association, 2012, these terms are defined as "bringing back manufacture of products that will be sold or assembled here". Understanding why businesses are moving back to the U.S. and what they are doing to transition production will aid in answering the research question, what economic impact does reshoring have on the U.S. economy.

The limitations to this study were time and location. The time limited the number of interview participants and the location was limited to those who are currently working for a company in the Mid-West, but has global ties.

We made two assumptions in this study. Specifically, statements made by the interviewed candidates are generalized for those businesses stated, and that educational attainment refers to degrees that are directly transferable to the skill set required for any position in a production setting.

Results

Qualitative Results:

The individuals that were interviewed all represented medium to large companies based upon head count, with 0-35 being small, 35-99 being medium, and 100+ being large. Each company represented a different industry, but were all production based. Two of the three companies originally had production facilities in the United States, and have recently reshored their facilities back to the United States or have remained in the United States. The main reason for keeping production in the United States or moving it back is the embracement of lean, ‡5s, and six sigma

‡ *Lean is the practice of eliminating waste from a manufacturing setting. Wastes include the waste of motion, overproduction, defects, transportation, waiting, inventory, and over processing. Six sigma focuses on quality to near perfection. 5s is a practice of lean that looks to sort, set, shine, standardize, and sustain to help eliminate waste*

practices to teach their employees how to take control of their job and how to keep an open mind for improvements. One candidate stated that not only from a production standpoint are they trying to cut waste, but throughout the entire supply chain. Retailers are now reaching out to suppliers and manufactures on how to cut waste in the supply chain and therefore realize a financial gain in each node in the supply chain.

Through the lean training the companies interviewed are openly embracing continuous improvement to constantly cut waste in the sense of over-processing, unnecessary steps, and inventory management. Total Cost of Ownership models were mentioned in each interview by the interviewee as being the top item that is getting the most attention when discussing the location of their production facility. By embracing continuous improvement and understanding the TCO model, these companies said their employees feel they are more empowered over their job; they are increasing their output therefore lowering the cost of labor per item, and are able to improve overall efficiency.

Along with these practices was the implementation of technology to increase production, increase output, and increase the value of their employees. An interviewee stated that with the embracement of new technology they have increased the value added per worker in the production process, which leads to higher output and subsequently more employment to match an increased demand for their products.

Our interview with professionals in the manufacturing field reveals that government policies to revitalize small and medium sized firms did not seem to exert any impact on businesses. The price of the products or services offered have been at a relative constant due to the lessening of supply and the diminishing amount of resources being used by China during the construction boom for the movement of production facilities to China. All companies are hiring for skilled positions such as welders, die cutters, and internal auditors. All three interviewees reported troubles in hiring. One reports finding individuals with drive is a rare find for positions in a production plant. Manufacturing is viewed as an undesirable career choice. Another candidate believed high schools are not training students enough with proper work ethics or knowledge to go right into a position from high school. All three interviewees

agreed that there has more training for employees on the production floor in the past two to three years than ever before.

According to data collected from the Bureau of Labor Statistics, the results reflected an increase percentage change based on current dollars since the 4th quarter in 2008. The past two quarters in 2013 are at an ideal growth rate of 2.4 and 2.8%. Based on past growth rates, the economy is showing a healthy recovery (United States Department of Labor). This growth is based on the output of goods and services in the United States. According to the Bureau of Economic Analysis, durable goods manufactured were the largest contributor to read GDP by state in 2012 and had significant growth in 2011.

Another measure that determines the impact of reshoring on the economy is the amount of exports. Since 2009, there has been an increase in exports of more than $130 billion. This increase in exports means that the current facilities are increasing their output, utilizing skilled workers to make their processes more productive, and that there are more companies in the U.S. contributing to this increase in exports.

In terms of employment, since January 2009, 64,000 jobs in the durable goods segment were added (U.S. Bureau of Labor Statistics).

Quantitative Results: Regression Analysis.

Table 2: Regression Results.

Variable	Coefficient	t-statistic
Constant	-171.33**	-8.69
Education	351.51**	5.37
Manufacturing Productivity	1238.66*	12.03
Business Cycle**	-3.35**	-4.57
Manufacturing Job Growth Rate*	-112.02*	-13.59
Time	-0.68**	-4.94
Globalization	2.77*	.003

Note: *, **, *** indicate that the coefficient is statistically significant at 1%, 5%, and 10% levels respectively.

Equation 1 is estimated using the ordinary least squared approach. The results are shown in Table 2.

The table reveals that the adjusted R-Squared=.99, this meaning that 99% of the variations in the dependent variable can be explained by the independent variables. All the variables are statistically significant.

The estimated coefficient of the globalization variable is positive and significant at 1% level. This means that a 1% increase in international trade will lead to a 2.77% increase in industrial production. The time trend variable shows a negative coefficient, statistically significant at a 5% level; in other words, industrial production has been declining on average since 2000. The next independent variable is job growth in manufacturing. It reflects that a decrease in employment in the manufacturing sector leads to a decrease in manufacturing production. This results contrast that of Baily and Bosworth, 2014, showing that productivity has not been impacted despite the decline of employment in the manufacturing industry.

Consistent with economic theory, the estimated coefficient on the business cycle variable also shows a statistically negative correlation, with that the industrial production decreases during periods of economic slowdowns. The estimated coefficient on the education variable is positive and statistically significant at 5 % level. In other words, an increase in the level of education is associated with an increase in the manufacturing production, everything else constant.

Conclusion

The results indicate that productivity, level of education, and globalization are positively associated with reshoring

The number of facilities moving back to the United States will continue to increase over time as more companies analyze their total cost of ownership models. The types of jobs that come back will never be what they were during the industrial period; however the jobs offered will provide the training and education to meet that of the growing service sector to give the employees more power over their positions and give the companies increased output because of the lean manufacturing taking place. Reshoring will continue to play an impact on the economy and I suspect that the impact will increase as time goes on and more companies start to participate.

Finally, there are other variables that show a negative association with manufacturing production index. These

variables are business cycles, manufacturing job growth rate, and time. In line with Ray & Medoff, (1985) the reason for decrease in production during a trough is contributed to manufactures hoarding labor and assignments, decreasing the overall utilization of labor and decreasing the output of the plant.

Appendix

The results of the interviews reflect the opinions and knowledge of two chief executive officers along with a supply chain consultant.

The questions asked were as follows:

What size is your company? (small, medium or big)

How would you describe the stability/ financial health of your company?

How is the productivity of your plant?

Have you always been a U.S. based company?

If yes, how have you been influenced to change production methods to match that of offshore competitors?

If no, what influenced you to move?

What education level do you require from your workers?

What type of training is required?

Has that changed in the past few years and how?

Is the total cost of employment rising or falling?

Can you explain the reasons why for that trend?

What type of competition do you face from local/ international businesses?

If your company is struggling, what actions do you plan to take to fix the problem?

If your company is flourishing, what actions did you take to achieve that result?

What government policies do you notice impacting your business?

Do you think they are helping or not helping you?

Are they helping big/small corporations?

Do you have access to resources to help you with those policies?

What are those resources?

How have the prices of your products/services changed?

What caused that change?

What type of jobs do you mostly hire for?

Is the workforce supply higher or lower than expectations

when looking to hire?

Why do you think that is?

Do employees need more training now than, say 5 years ago?

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Skin Deep

Carley McHenry | Senior

Through figurative narratives, my paintings illustrate elements of the human experience. Specifically, my work brings attention to the disconnect between human beings and their physical and psychological existence. Using personal experience and observations, I aim to reflect a piece of the human condition in my work; one in which we may find ourselves physically separated from our bodies or psychologically separated from our psyche.

Physical disconnect between people and their bodies occurs when the inner workings of the body that make life possible are ignored during the course of everyday life. The way the human body functions inspires my work as an artist. I am interested in how the body can be beautiful yet disgusting, fragile yet strong, and so vital to human existence yet unnoticed in our daily lives. It is only when our body is not functioning properly that we realize its critical role. The subjects in my paintings are only vaguely aware of their bodies, illustrating the detachment between being alive and the mechanics that make life possible. Psychological disconnections are not as easily defined as the physical. Psychological separation can manifest itself in many different ways. Using personal experience as inspiration, I emphasize how separation occurs within the human psyche: indecision, guilt, split personalities, and naïveté are all examples of psychological separation. The narratives I create are symbolic, aiming to illustrate my observations and experiences of how far from oneself one can get if we aren't paying close attention.

I do not always know where a painting is going when it begins. Each painting begins with a general idea or narrative that develops after several edits, deviations, and experiments that emerge through both intuitive actions and deliberate decisions. Experimentation and responding to my work as it develops is a vital part of my studio practice. This manner of working creates freedom for the work to deviate from an original plan in a way that may be unexpected. I paint in thin translucent layers that echo layers of skin, inner anatomy, or layers of personality. Often I will utilize thin barriers of paint that veil parts

of the composition to separate the viewer from the subject of the painting, and the subject from themselves. Glitches and stutters are incorporated into the imagery of my paintings, varying in subtlety. I interrupt the imagery in order to add mystery and a slightly "off" quality to the painting. The kind of surrealism I aim for in my paintings leaves a great deal open to the viewer's interpretation.

Although I know I have clear intentions of highlighting the physical and psychological disconnect within human existence from a specific and personal standpoint, I want each piece to be open to interpretation. I want to let viewers determine meaning based on their own knowledge and experiences. Ultimately, I want to depict subjects and ideas that are rarely considered or even overlooked through narratives that are filled with mystery and possibility.

Push Me Pull You

Acrylic and oil on panel, 15" x 17.5" Spring 2013

Stutter

Acrylic and oil on canvas 16" x 20" Spring 2013

Inside The Inside, But

Acrylic and oil on canvas 28″ x 25.5″ Fall 2013

Ways To Reveal

Acrylic and oil on canvas 17.5" x 17.5" Fall 2013

Cutting Edge Sentiment

Rachel Saeger | Senior

The nature of cultural changes over time, in a broad sense, is where my work originates. My initial investigations have stemmed from my experiences working in long-term memory care and have generated ideas regarding mental and physical transformations. I have discovered an inherent interest in selective or distorted memories and anecdotes through the progression of time, in conjunction with how these ideas filter our social ideologies. Particularly, I have chosen to narrow my studies further by attempting to understand our social reliance on convenience and instant gratification, juxtaposed with ideologies of the past.

The way our culture has learned to adapt to rapid advancements and the forceful nature in which this progression occurs allows for the conceptual foundation of my practice. The physical production of my work occurs through a variety of material outlets. The creation lingers in both two-dimensional and three-dimensional realms, and finds a way to manifest in a multitude of mediums ranging from found objects, photos, audio, video, and text.

Technology Will Never Die

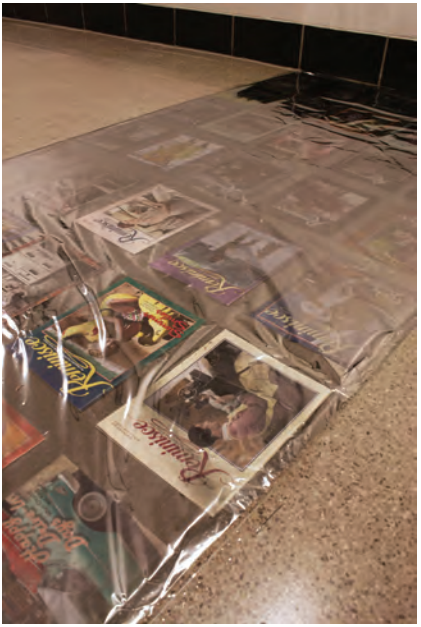
2013
Reminisce Magazines
8′ x 4′
This hallway installation that lies flush with the ground acts as a barrier, which forces the viewer to find means of crossing.

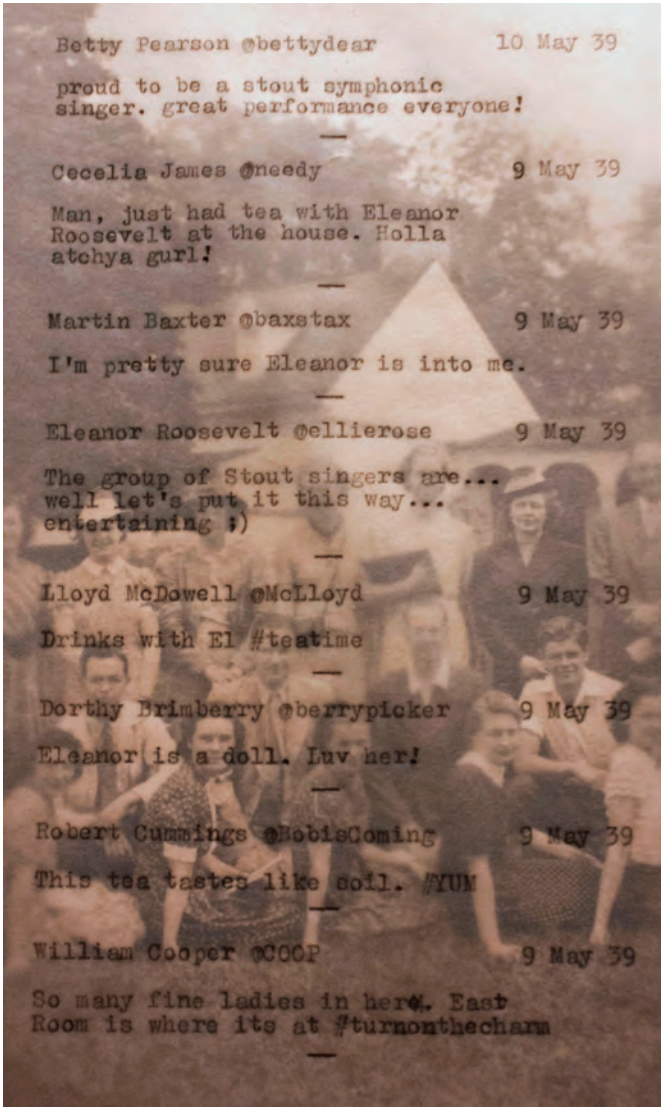
That's Life

2013 (left)
1940's Majestic Cathedral Radio,
Skullcandy Aviator Headphones,
Mp3 Player, Vellum, Touch Light
15" x 10" x 19"
Caption: This singular audio experience consists of a 2 minute, 43 second long track complied of amateur YouTube covers of the song 'That's Life' by Frank Sinatra.

Our House

2012
Rotary Dial Phone, Wooden Table,
Mp3 Player
12" x 12" x 40"
This intimate audio piece plays recorded anecdotes from elderly residents in a memory care facility when the viewer picks up the telephone.





#nofilter

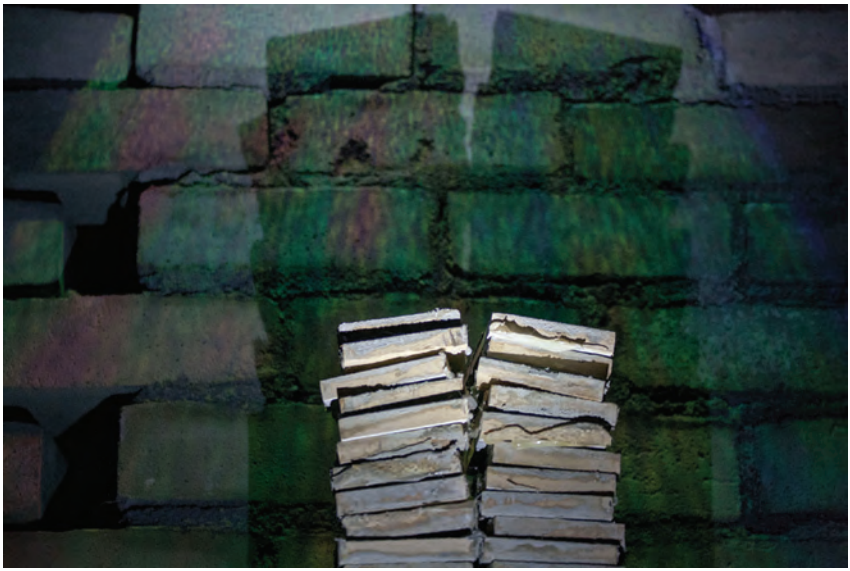
2013 Found Panoramic Photo, Vellum, Typewriter Ink, Wood, Gold Hooks
32" x 15"
This piece consists of a typewritten Twitter news feed composed of content from a UW-Stout choir event that occurred in 1939, but utilizes contemporary language.

Perceptive Surfaces

Hannah Olson | Senior

I find nuances in architectural inconsistencies of my immediate surroundings to be endearing. The way this impacts my work is preverbal, but unquestionably significant.

I trust an individual that possesses purpose when alone. What I trust even more is an individual that can also work with others for a larger purpose. Bricks are an ideal example of this. A panel of oriented strand board is composed of impractical scraps, compacted to create useful, versatile material. I am interested in the characteristics of these materials, among others, and their ability to translate into a human realm, as well as the way interpretation shifts between works presented in a two-dimensional versus three-dimensional format.

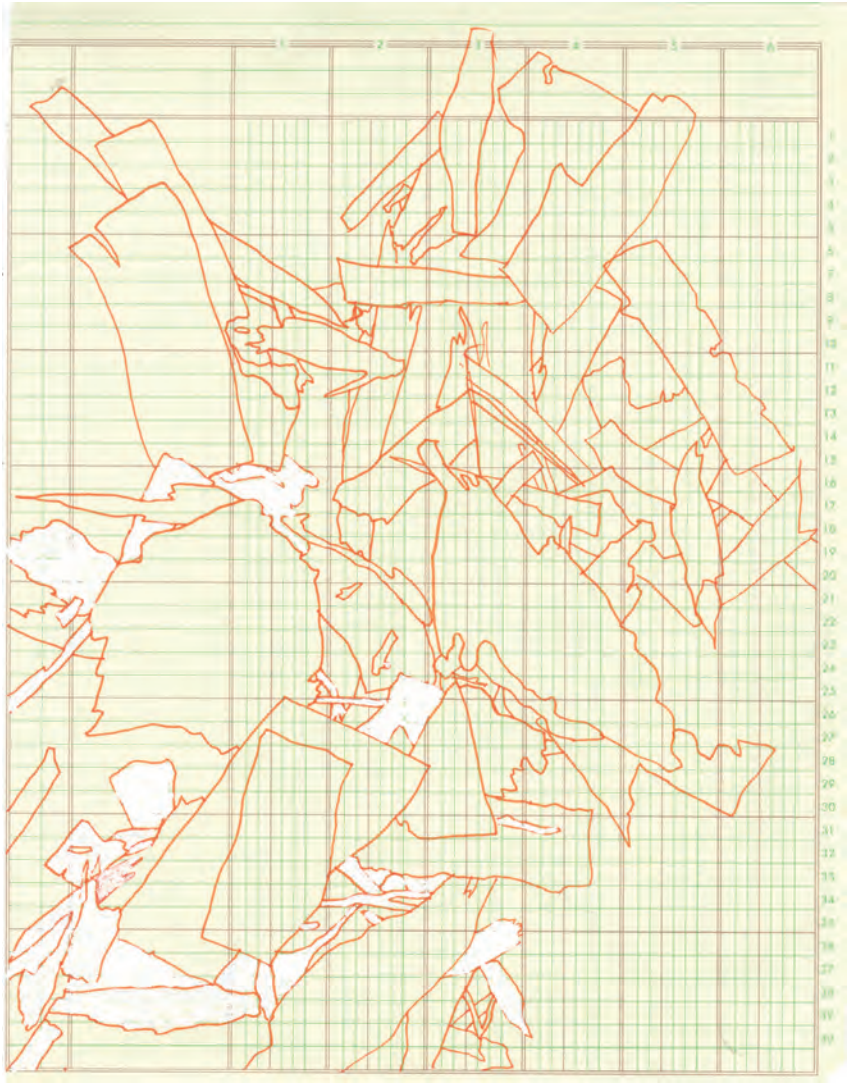


Dramatic Portrait of the Producer

digital photograph of sculpture, dimensions variable, 2013

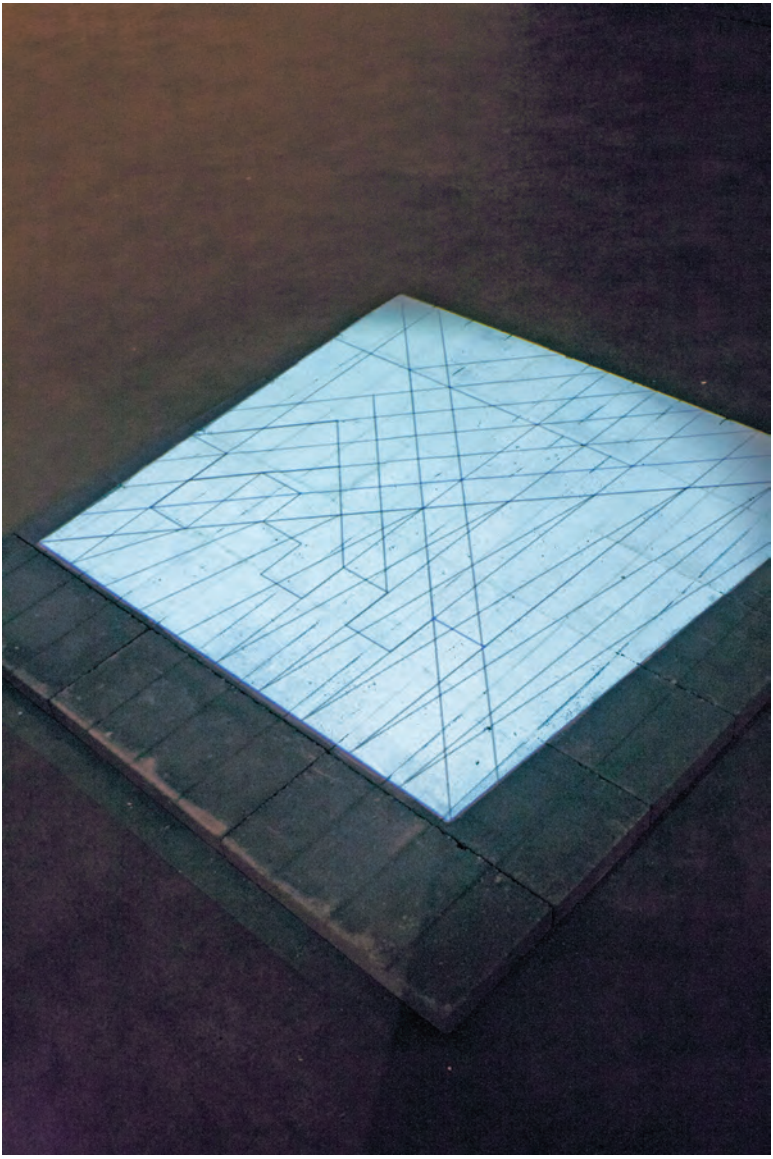
Lake

35mm photograph, 4" x 6" 2013



OSB

paper, pen, white out, 11" x 8" 2013



Untitled

bricks, spackle, latex paint, projected video, 1.75" x 40.5" x 40.5", 2013
One set of instructions was read to several volunteers. The varying results were complied into a video and projected onto brick.

Reconfiguration

Mia Russell | Senior

With an initial concept and visual in mind, each finished work transforms from what I imagined or intended to express at the start. I work in a series of layers, responding to each layer as I consider how each decision would affect the already standing parts and reconfigure each element's existence and relevance. Even the hidden layers are there, unseen by the viewer but necessary and meaningful as it informs the subsequent layers and had purpose at one point in the process. The work is finished when it has thoroughly challenged me, excites me, and sits well with me. However, as time passes, it may become evident that it is no longer finished and that I must return to work on it.

We live in a society that demands answers, solutions; to not have answers is to be invalid. We are obsessed with systems of levels, and direction, and linear progression. There isn't a place to put instances of unclarity and ambiguousness. Through the uncertainty of abstraction and a complexity of layers I can embrace a certain kind of oddness and uncomfortableness. Visual balance and cohesion within a piece is not the goal as I aim to challenge the viewer to find comfort and satisfaction within the mystery and curiosity of the work. There doesn't need to be a way or a place to be in the work, but instead to find a place and confront this unknown element without the need to have answers. There is more out there to be discovered.

Untitled

oil on canvas, 11.5 x 11.5 inches
2013

Natural Order

oil and acrylic on panel, 30 x 24 inches
2012

Untitled

oil, acrylic, and latex on canvas
48 x 48 inches
2013

As it Suits

oil and acrylic on panel
24 x 24 inches
2013

Sleep Patterns and Marital Satisfaction

Lauren Randall & Brittany Skopek | Seniors
Department of Human Development and Family Studies

Abstract

With fewer people getting married and more people getting divorced in Western industrial societies, the study of marriage continues to be a topic of great interest (US Census Bureau, 2012). This current study examined the relationship between marital satisfaction and sleep patterns with a sample of ten married couples. Email interviews were used for data collection (Meho, 2006). The qualitative approach used in this study was phenomenology, which according to Patton is the study of lived experience (2002). The lived experience comes from multiple contexts including emotions, culture, relationships, jobs, and programs. The interview brings us closer to understanding the subject's experience. A content analysis (Kvale, 1996) of the email interview responses was conducted and themes were determined. Member checking was performed to verify validity of the general ideas and themes. Results from our study revealed that spending time together before bed or in the morning increases marital satisfaction as it allows time for communication and intimacy. Implications for practitioners working with married couples are to encourage engaged and married couples to have discussion and agreement on bedtime or wake routines that leave room for interaction with one another. Implications for future research include a larger sample size, wider variety of participants, and the impact that night shift work and stress have on marital satisfaction.

Keywords: marital satisfaction, sleep patterns, married couples, night-shifts

As fewer people get married and more people get divorced in Western industrial societies, the study of marriage has increasingly become a topic of interest (US Census Bureau 2012; Adams, 2004, as cited in Fincham & Beach, 2010). In fact, Cherlin (2004) states that now more than ever, marriage in the United States is becoming "deinstitutionalized." For these reasons, we

decided to look into different factors that could play a part in the satisfaction of a marriage. One factor that has been under-researched in this area is sleep patterns, which for the purpose of our study we are defining as consistently repeated actions automatically dealing with, or surrounding an individual's daily sleep schedules ("Sleep," 2012; "Routine," 2012; "Pattern," 2012). The literature we reviewed addressed the importance sleep has on biological functioning and that pair sleeping is beneficial to the quality of sleep an individual receives (Krueger & Friedman, 2009). Literature also illustrated how people benefit from being close to one another, and married couples are generally viewed as being close (Diamond, Hicks, & Otter-Henderson, 2008). One study even suggested a link between marital happiness and time spent with one another in shared activities, such as sleep. The same study also considered that the mediating link between sleep and relationship satisfaction may be personal mood (Anderson, Van Ryzin, & Doherty, 2010).

Though this information provides support that sleep and closeness are important, research has identified a clear gap in literature regarding the connection between sleep and marital satisfaction (Rauer, Kelly, Buckhalt, & El-Sheikh, 2010; Meadows, Arber, Venn, Hislop, & Stanley, 2009; Dahl & Et-Sheikh, 2007). Baumeister and Vohs (2007) define marital satisfaction as:

> A mental state that reflects the perceived benefits and costs of marriage to a particular person. The more costs a marriage partner inflicts on a person, the less satisfied one generally is with the marriage and with the marriage partner. Similarly, the greater the perceived benefits are, the more satisfied one is with the marriage and with the marriage partner (p. 541).

The purpose of this study was threefold: 1.) to examine the relationship between sleep patterns and marital satisfaction with a sample of Midwestern married couples; 2.) to develop a qualitative interview protocol to assess married couples' perceptions of marital satisfaction; and 3.) that the results from this study would add to the scant literature on the relationship between sleep patterns and marital satisfaction.

Literature Review

A review of the literature through the EBSCOhost database was conducted to examine the relationship between female and male marital satisfaction and sleep patterns. The overall findings of the research showed an increase in marital satisfaction when couples are getting quality sleep together, though all the articles reviewed acknowledged the lack of research relating to sleep and marital satisfaction.

Though research has examined the evolved cultural norms of sleeping patterns, such as sharing a bed with a partner, there is a lack of literature on the association of sleep, relationships, and pair sleeping (Meadows et al. 2009). Diamond et al. (2008) investigated temporary partner separation to see if there were correlations between spousal time spent apart and changes in affect, behavior and physiology. They collected daily diary entries from 42 married or cohabitating heterosexual couples over a period of time surrounding and including a 4-7 day separation. When they were separated, both the homebound and traveling partners experienced an increased amount of sleeping problems. Their sleeping problems reduced significantly upon reuniting with their partner. Krueger & Friedman (2009) also concluded that pair sleeping improves the quality of sleep.

A culture's influence on the shaping of sleep patterns is widely acknowledged throughout the world, yet the relationship between sleep and its effect on human health and development still remains somewhat unrecognized throughout society (Dittami, Keckeis, Machatschke, Katina, Zeitlhofer, Kloesch, 2007). Marital satisfaction has many effects over multiple aspects of an individuals' life (Keicolt-Glaser & Newton, 2001), such as their health (Troxel, Cyranowski, Hall, Frank, & Buysse, 2007; Irwin, Wang, Campomayor, Collado-Hidalge, & Cole, 2006; Hajak, & Group, 2001; Dew, Hoch, Buysse, Begley, & Houck, 2003). In reference to marital satisfaction and physical health, research has shown that low marital quality can increase an individual's chance of cardiovascular disease as well as mortality (Troxel, Buysse, Hall, & Matthews, 2009). Understanding the nature of sleep is applicable to clinical practice as sleep medicine and treatment of sleep disorders have had positive implications for relationships (Troxel et al., 2007).

Couples with high marital satisfaction show fewer sleep problems such as fewer sleep disturbances, fewer problems

falling asleep, fewer nighttime awakenings, and less restless sleep (Pringerson, Maciejewski, & Rosenheck, 1999). A common sleep disturbance among married couples is children. As Medina, Lederhos, and Lillis (2009) found in their research, there is a postpartum decline in marital satisfaction, especially during the first year of their child's life. Their research argues that as people transition into parenthood they face new demands, emotions, and stressors. Interestingly, the cognitive skills needed to cope with this transition are those also most affected by sleep disturbance. Troxel et al. (2009) conducted an in-depth study of the link between marital happiness and sleep disturbances in middle-aged women of multi-ethnic backgrounds and found that an individual's sleep disturbances corresponded with self-reported marital satisfaction rates. Therefore, the fewer disturbances a spouse had at night, the more satisfied they claimed to be in their marriage.

Due to finding scant research investigating sleep and marital satisfaction, we decided to include an international study from southeast England. The research conduct, elements, and results of this study abide by international ethical standards, therefore we feel this survey is relevant and provides adequate information to aid our research (Portaluppi, Touitou, & Smolensky, 2008). The study compared variables such as ideal bed time and ideal wake time to the participant's actual bed and wake times. The study also took into consideration the amount of times a participant woke during the night, the effect of light and dark on sleep, and idealized sleep efficiency. The research study concluded that sharing a bed with a partner can be the cause of daytime drowsiness and sleep deficiency throughout the night.

In general, a demand has grown in research to look at the differences in males and females in pair sleep as females often report experiencing more sleep issues than males (Krishnan & Collop, 2006). It has been hypothesized that because females are more sensitive to emotions, marital problems and negative interactions within a marriage project differently in a female's life. Women actually experience lower-quality free time and less free time in general than men due to many women juggling multiple roles. Because of this, it has been hypothesized that women are more impacted by scheduling, having the least amount of 'refreshing free time' (Kiecolt-Glaser & Newton, 2001). If women are not experiencing relaxing free time during

the day or before bed, they may not be as satisfied with their marriage or sleep as well with their partner (Mattingly & Bianchi, 2003). In the case of the partner separation study (Diamond et al., 2008), the only gender-related difference found was that the female homebound partner reported an increase in negative affect while their partner was gone, whereas the males did not. When it came time for the couples to reunite, both the male and female negative affect declined upon the reunion. Another study showed significant differences between males and females in reaction to pair sleep. Though pair sleep was found to have negative implications for females, including sleep disruption throughout the night, the trend of negative implications of pair sleep was not found in the male subjects (Dittami et al.2007).

Although the current research addresses the importance of quality sleep in relation to marital satisfaction, it lacks information regarding sleep schedules between married couples. The current study examined the relationship between female and male marital satisfaction and their subsequent sleep patterns, including variables regarding interactions between couples, both at bed time and wake time.

Theoretical Framework

The theory used to inform this study was the Family Ecology Theory. This theory assumes outside influences in multiple environments of life have a significant impact over the individual, couple, or family's emotions, interactions, behaviors, and life roles (Ingoldsby, Miller, & Smith, 2004). There are four separate environments that comprise this theory: microsystem, mesosystem, exosystem, and macrosystem. As applied to our study, this theory would predict that marital satisfaction is indirectly linked to sleep patterns among married couples. In fact, it could be argued that every environment of the Family Ecology Theory impacts the satisfaction of a marriage. In the microsystem, work shifts into the night or taking care of an infant can affect when a partner goes to bed. In the mesosystem, anxiety from work may indirectly influence one partner to be up later than the other, which could lead to less communication. In the exosystem, a company may change its policy to include company-paid paternity leave, which could positively affect marital satisfaction. The husband, utilizing paternity leave, would be more available to get up during the night and help

his partner with their baby, since he does not need a full night's sleep to prepare for work the next day. In the macrosystem, the shifting American trend toward dual income families may influence a couple's decision to have the wife return to work. With both the husband and wife working, their schedules may hinder time spent together before or after sleep, inadvertently leading to a decrease in their marital satisfaction.

Method

Participants and Sampling

The participants in our study included ten married heterosexual couples, who had been married an average of 21 years. Purposive as well as snowball sampling methods were used in our qualitative email interview. Purposive sampling was applied as it allowed us to easily identify married couples through our previous personal interactions. Snowball sampling allowed us to gain the trust of our participants, empowering them to feel comfortable to share more intimate, lived experiences while responding to our survey.

Research Design

The purpose of this qualitative research was to investigate the lived experiences of married couples, and the effects that each individuals' sleep patterns have on the satisfaction in their marriage. The qualitative approach used in this study was phenomenology. According to Patton, phenomenology is the study of a lived experience (2002), which comes from multiple contexts including emotions, culture, relationships, jobs and programs. Phenomenology brings the researcher closer to understanding the subject's experience.

In recent years, as more researchers conduct qualitative studies, there has been a greater need for low-cost, efficient, timely ways to reach participants. Email interviews have been a growing method of data collection as they address these components (Meho, 2006). Our reasoning for using this method is that email interviews allowed for a high level of anonymity.

This study was approved by the University of Wisconsin-Stout's Institutional Review Board (IRB). Human subjects were protected through the completion of the IRB's Human Subjects training.

Interview Protocol

The semi-structured, in-depth, interview protocol (Kvale, 1996) was created to investigate the relationship between sleep patterns and marital satisfaction. The qualitative email interview started with an implied consent including a brief description of the study, definition of specific terms, risks and benefits of participating in the study, expected time commitment, confidentiality, information on participants' right to withdraw, the stamp of IRB approval, researchers' and supervisors' contact information, and instructions on how to complete the email interview. The protocol included our initial research question, followed by twelve open-ended questions addressing related variables.

Procedure

Ten married heterosexual couples were selected by the researchers to be offered a chance to be in the study. Prior to the email interviews, the twenty participants were individually emailed an invitation to be part of the study on October 18, 2012. The email included an introduction of the researchers and advisor, the course the study was created for, an explanation of how the study would be carried out, the study's requirements, the purpose of the study, what the researchers were hoping to accomplish, assurance of confidentiality, approximate dates the email interview would take place, and the researcher's and advisor's contact information. All twenty participants replied via email agreeing to partake in our study. The study protocol was approved by the University of Wisconsin-Stout's Institutional Review Board. The participant's names were kept confidential from each other by utilizing the blind carbon copy feature in the e-mails. The interviews took place through a Qualtrics link embedded in an e-mail. Qualtrics, the secure data collection software we used, organized the responses, which were then viewed only by the approved researchers.

The twenty participants were sent the email interview including IRB approval, the implied consent form, and the interview questions on October 26, 2012. The participants were given two weeks' time to complete the interview through Qualtrics. Nineteen out of twenty participants met the November 10, 2012 deadline.

Data Analysis Plan

A content analysis (Kvale, 1996) of the email interview responses was conducted by the two undergraduate researchers and themes were determined. An acronym was determined for each of the interview questions. The responses were read separately by each researcher to gain a general understanding of the data. Both researchers wrote down overall ideas from every category in the individual participant's responses. The researchers then met to perform "member checking" to verify validity of the general ideas and themes, which were compared until 100% member agreement was reached. The researchers decided on relevant quotes from the interviews to best represent each of the themes found in the interview responses (Patton, 2002).

Findings

In this section, selected themes that emerged from the interview questions are followed by representative descriptive definitions or primary points made from the participants. All names are pseudonyms. We have listed all of the themes below (See Table 1) but given limited space, we are focusing on the following four themes: Individual time before joined interaction with spouse (19 out of 20 participants responded); Sex is best when well rested (19 out of 20 responded); Quality of interactions with spouse (18 out of 20 responded); and, Security in sleeping with spouse (19 out of 20 responded).

Table 1
Interview Questions and Themes Derived from Interviews

Questions	Themes
How important were sleep patterns to you before you were married?	• Independence allows for a flexible sleep schedule
How do sleep patterns contribute, or not contribute to your marital satisfaction?	• Communication • Mood • Intimacy/Sex
What did you discuss about your personal sleep patterns with your spouse before you were married?	• Learned sleep patterns prior to marriage • No discussion before marriage
If you did not discuss your personal sleep patterns before you married, in retrospect what do you wish you would have discussed?	• Amount of sleep needed • Sleep patterns while raising children
What is your wake-up routine now that you are married?	• Get ready independently • Get children ready for school
What is your bedtime routine now that you are married?	• Individual time before joined interaction with spouse • Go to bed separately • Go to bed together
How does stress affect your sleep patterns with your spouse?	• Stressed spouse is awake and restless • Discussing stress before bed attributes to poor sleep
How do sleep patterns affect your sex life with your spouse?	• Sexual relations are difficult when there are differences in sleep and wake times • Sex is best when well rested
If you experience disruptions in your normal sleep pattern, what are they from?	• Kids • Stress
How do your sleep patterns affect the amount of interaction you have with your partner?	• Quality of interactions with spouse • Quantity of interactions with spouse
What is the difference in quality of sleep when you are sleeping with your partner versus when you are sleeping alone?	• Sleep quality increases with spouse • Falling asleep time increases with spouse • Security in sleeping with spouse

What is Your Bedtime Routine Now that You Are Married?

Individual time before joined interaction with spouse. Bedtime routine consists of having personal time before joined interaction with a spouse before sleep.

> *"I go up to read between 8:00 to 8:30 and my spouse comes to bed between 9 and 10." (Kristen)*

How Do Sleep Patterns Affect Your Sex Life with Your Spouse?

Sex is best when well rested. The more well rested couples feel, the more likely they are to engage in sexual activity with

their spouse.

> *"I prefer sexual relations in the morning when I am well rested. She prefers them at night. 95% of the time it happens at night, thus I am a little more tired in the morning because it cuts into my sleep time." (Brad)*

How Do Your Sleep Patterns Affect the Amount of Interaction You Have with Your Partner?

Quality of interactions with spouse. The quality of interaction and communication with a spouse increases as a spouse gets adequate sleep.

> *"Like sex life, our interaction is affected by how well rested we are. The better rested we are, the better the interaction we have." (Eric)*

What is the Difference in Quality of Sleep When You Are Sleeping with Your Partner Versus When You Are Sleeping Alone?

Security in sleeping with spouse. There is a sense of comfort and peace of mind when couples sleep together, as it cuts down on worrying and provides companionship.

> *"I like having him in bed, as there is a comfort or security with him there…" (Kelly)*

Discussion

With fewer people getting married and more people getting divorced, the study of marriage has become a trending topic of interest (US Census Bureau 2012; Adams, 2004, as cited in Fincham & Beach, 2010). Though previous research addressed some factors that play a part in the satisfaction of a marriage, we did not find research that had been conducted on the effect 'sleep patterns' have on marital satisfaction (Rauer et al.2010; Meadows et al. 2009; Dahl & Et-Sheikh, 2007). The literature supported that sleep is vital for health, and that sleeping with someone else improves the quality of sleep (Krueger & Friedman, 2009). Literature also concluded that couples with high marital satisfaction show fewer sleep problems (Pringerson et al., 1999). Responses from our participants were in agreement with the literature reviewed.

More specifically, our participants agreed that expectations from society influenced decisions on how they sleep, leading

to an imbalance between social norms and their need for sleep (Dittami et al., 2007). The remainder of the paper will include: connecting findings with the literature or theory, limitations to the study, implications for practitioners, implications for future research, and the conclusion.

Individual Time before Joined Interaction with Spouse

The social norm that spouses in a healthy, happy relationship go to sleep together (Rauer et al., 2010; Troxel et al., 2009; Meadows et al., 2009; Diamond et al., 2008; Dittami et al., 2007) is widely accepted, though it does not take into consideration the individualized physical need for sleep. In order to balance the physical need and social norm, one spouse may go to bed earlier but wait to fall asleep until their spouse joins him/her. Our research showed that although males and females made efforts to sacrifice sleep in order to spend time with one another, the females in our study reported more of a difference in ideal sleep times and actual sleep times.

Sex is Best When Well Rested

Our participants noted that the quality of their intimate and sexual interactions increased dramatically when they received more sleep. The Family Ecology Theory supports their statement because often work requirements affect sleep patterns, which then affects sex life. In the exosystem (indirect consequences the individual experiences from their surrounding institutions), work hours mandate when an individual can spend time at home with their spouse. This then affects the microsystem (direct influences that impact the individual), encompassing the interactions going on in the household, such as sex (Ingoldsby et al., 2004).

Quality of Interaction with Spouse

Our research revealed how sleep patterns affect both the amount of time couples interacted with each other as well as the quality of those interactions. When spouses had similar sleep patterns, it provided more time to spend with one another before sleep. This time allowed for communication and sharing-key components in marital satisfaction. Research supported the importance of having people in your life that will provide support, comfort, and a listening ear, which can buffer problems of everyday life (Rauer et al., 2010).

Security in Sleeping with Spouse

A body of previous research supports the act of sleeping related to a feeling of safety, allowing an individual's body to relax and sleep (Rauer et al., 2010; Troxel et al., 2009; Meadows et al., 2009; Diamond et al., 2008; Dittami et al., 2007). When comparing males and females, the females in our study reported more anxiety when sleeping alone whereas their husbands saw it more as an inconvenience. This gender-related difference is supported by literature which notes that in cases of sleeping alone, the females reported an increase in negative affect while their partner was gone, whereas the males did not (Rauer et al., 2010).

Limitations

Limitations of this study include a small sample size- this study had a sample size of 19. Another limitation is that this study lacked ethnic and racial diversity, as all of our participants were Caucasian. In reference to sexual orientation, our study only addressed heterosexual marriages. Though we did not have an option for our participants to select their race in our demographics section, our method of snowball sampling people we knew made us aware of their race. In addition, our study did not address the entire spectrum of varying socioeconomic statuses- all of our participants were from the middle class.

Implications for Practitioners

Our research suggests that practitioners working with engaged couples should encourage them to discuss their personal sleep patterns as it can positively influence future marital satisfaction. Flexibility and compromise are necessary for couples to create a sleep schedule that allows them to spend time in bed with one another at night and/or in the morning.

Even if couples are consistently going to bed at different times, practitioners can encourage them to spend 15 minutes with one another before the first spouse falls asleep. For couples that have one spouse working night shifts, it may be helpful for them to make a phone call home to their spouse before the spouse at home falls asleep.

If one or both partners is going to bed stressed, practitioners can help them find a healthy release before they go to bed (journaling, taking a bath, reading, etc.). This may help them

avoid arguments with their spouse, decrease the amount of time it takes to fall asleep and lead to a more restful sleep.

Implications for Future Research

For future research, it is recommended that a study is done with a larger number of participants and with more diversity. More research needs to be done on the impact of night-shift work on a marriage. It would also be interesting to study the amount of equal compromise in a marriage to see if it would be a predictor for a higher level of marital satisfaction, a better sex life, and more effective communication. Stress was another theme in our study that inadvertently affected marital satisfaction; therefore, we see benefit in doing research on effective ways for couples to release their stress-before going to bed.

Conclusion

The findings of this study can be useful to counseling professionals and researchers working with married couples as it illustrates the lived experiences of a sample of married couples pertaining to sleep patterns and its effect on marital satisfaction. Our findings suggest that a key to positive marital satisfaction is to make communication between spouses a priority, and to continue communicating about preference of sleep patterns as each phase in life evolves.

"When we have time in bed either waking or sleeping the connection of talking with one another and physically cuddling contributes to our marital satisfaction greatly" (Alexa).

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Using Light to Create Perceptual Experiences in Space and Wayfinding

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Abstract

Although ephemeral, light can visually be read as a physical form becoming a material to be utilized by architects and artists. The Light and Space Movement has brought forth an awareness of our psychological and philosophical perception of light. Artists and architects use light as a primary material to expand and contract space by using precise projected light, homogenized light, natural light, artificial light, and colored light. Light influences color's communicative power, allowing one to use light and color to cause emotional responses and perceptual changes amongst viewers. By integrating light into structures, hierarchy is produced as a method to create wayfinding and defines space while sustaining one's sense of place, position, and time. A new dimension is given to materials that are illuminated, connecting interior dwellings to exterior environments. Light becomes three-dimensional when united with other materials, visually containing space and creating an interactive sense of boundaries. Although light is ephemeral light can be used to help define and re-define physical space.

As is evident from human physiognomy, circadian rhythms, diurnal rhythms, and solar orientation of shelter, humans have based their lives around the sun. The unique and rare natural displays of intense light in places such as Upper Antelope Canyon, Horsetail Falls and Devetashka Cave has captured the imagination of people for millennia.[1] We see echoes of a fascination with dramatic light in the construction of culturally important structures.

Early man-made structures demonstrate our need for connecting the outside environment to inside dwellings by using

light to emphasize importance. The Morturary Temple of Queen Hatshepsut rests near the banks of the Nile and is embedded in a cliff, resulting in the reflection of the vertical rock face patterns onto the colonnade integrating the natural landscape into the temple.[2] As concluded from archaeo-astronomical research, Stonehenge is one of many monuments which have been constructed to present lunar-solar alignments to astronomically show the difference of night and day, winter versus summer, and dark moon compared to full moon.[3] Similarly, Robert Hannah and Giulio Magli acknowledge that the Pantheon relied on the sun's annual and daily characteristics, to spotlight the emperor upon entering the structure creating a grand entrance.[4] Although these structures all have their own mysteries, they seem to be dedicated to the sun's predictability or using light to communicate importance and wayfinding.

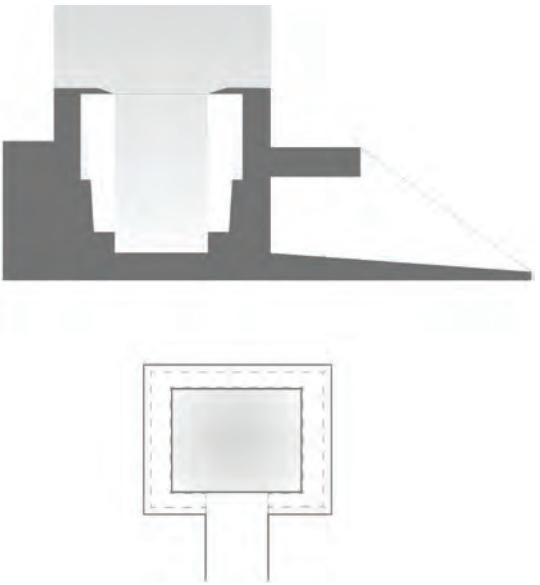
Even now, we regularly use light to create visual and spacial hierarchy. With the invention of electricity, light is used in multiple ways and often focuses our attention consciously or subconsciously. With the mere mention of a city, images of sparkling skylines come to mind. Nightlife activities in general are focused on using light for drama and hospitality. Whether it's a dimly lit bar with a liquor array hovering in an altar-like glow or a club with a light show synchronized to music, light is being used as a form of attraction. Decorative holiday lights celebrate and communicate the importance of our own values and beliefs. Regardless of specific beliefs, many religions view light as sacred and spiritual. Choreographed fireworks give the viewer a sense of awe. We use light on a day-to-day basis in our society. Strategically lit signs and displays in stores are designed to cause a response from consumers. Even in broad daylight vehicles are directed by stoplights to control traffic and help prevent collisions. However, when a medium such as light is used in a different context or in an unexpected or particular way, art is created. Using light as a primary material in structures to create hierarchy changes perception, creates and diminish space, produces a feeling of self, and establishes a sense of direction.

Well-known architects as well as artists use a hierarchy of light to change perception. Michael Govan, director of the Los Angeles County Museum of Art, points out that James Turrell is interested in the qualities that make light unique as well as light's ability to obscure objects.[5] Turrell explains, "I like to say

my work is an architecture of light into space."[6] By studying the perception of light, Turrell has been able to successfully create a true "bodily experience".[7] Turrell takes light out of context and isolates characteristics of light that we often do not recognize altering one's perception.

Light creates a sense of heaviness and the feeling of being both inside and outside throughout experiencing *Sky Pesher* testing our conventional sense of space and depth (figure A). As indicated by Lawrence Weschler, "Seeing is forgetting the name of the thing one sees."[8] Once you disregard that the ceiling is open and bare you are able to feel the weight of the dense and impenetrable sky. Light, which is thought of as immaterial, has the ability to take form, letting a void read as a barrier. This disruption of our certainty causes a perception-altering experience.

In *Sky Pesher*, one gains familiarity with light's ability to make the sky look opaque or transparent, changing our perception of depth. Entered through a heat-radiating concrete mass, the viewer is invited to contemplate the sky from perimeter benches. Turrell explains that giving his work space and adding distance affects how we perceive light, offering him the ability to connect the sky to the ceiling plane by designing an arrangement between the interior space and outside space.[9]



A

Turrell has observed that with distance light acquires solidity, but as you approach this dense object the light fades creating an experience that is both physical and transient making the sky a perfect medium because of it's constant state of change.[10] The sky's turn from day to night and night to day is one naturally occurring instance of light's ability to create space, states Turrell.[11] At night the black or nearing black sky appears to be on the ceiling of Sky Pesher; generating a visually opaque object.[12] Nonetheless, during the day there is a transition from being transparent to translucent to opaque, each causing a different feeling of space.[13] Turrell combines this characteristic of light with how one's feeling of the size of a space changes while navigating and approaching objects in a space.[14] Simultaneously our eyes try to understand these feelings of change; all this becomes essential in how Turrell lets us see the act of moving through a space.[15]

Turrell's use of light to skew our perception is continuous throughout his work in order to accomplish the "Thing-ness of light".[17] He does this by isolating characteristics of light that commonly go unnoticed. For example, contrary to mixing paint, when blue light and yellow light are mixed it becomes white light.[18] In *Twilight Epiphany* (2012) (figure B), Turrell controls the interior light in order to change the appearance of the light outside causing the illusion of the sky changing color.[19] While *Aten Reign* (2013) (figure C), is not a illusion, but a manifestation of another characteristic of light we can experience.[20]

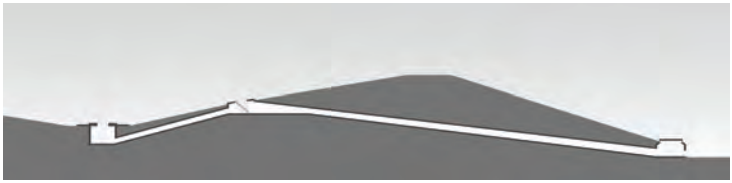
B

C

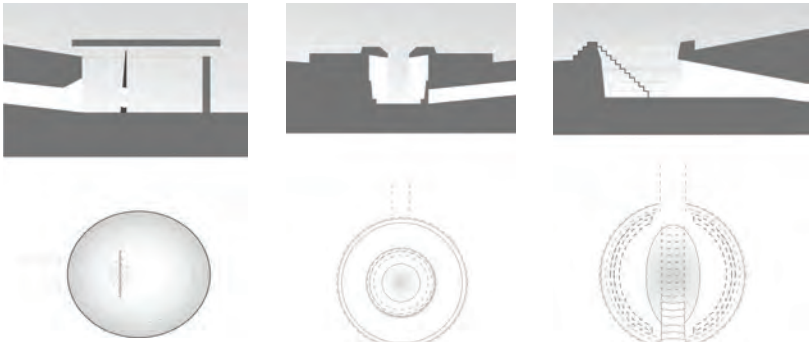
Similarly to during the day, when we are no longer able to see the stars though they are present; this observation demonstrates light's capability of adding and subtracting space.[21] By using artificial and natural light this outcome causes the viewers in *Aten Reign* to feel outside though they are inside.[22] Correspondingly, in Turrell's *Roden Crater* project in the Painted Desert in Northern Arizona, which consists of over three decades of work and is still in progress,[23] Turrell converts a natural volcanic crater into a man made structure, further using light to merg the feeling of being both inside and outside (figures D, E, F and G).[24] Turrell explains that when the ordinary is subjected in an unfamiliar way, we have to think on a different level, broadening our perspective.[25]

After experiencing a new perceptions Turrell's *objective*, "I feel that I want to use light as this wonderful and magic elixir that we drink as Vitamin D through the skin—and I mean, we are literally light-eaters—to then affect the way that we see," conveys a deeper meaning.[26] In Turrell's *Sky Pesher*, we are held inside the cool earth and blanketed by the sun, left alone with our imagination. According to James J. Gibson's second book, *The Senses Considered as Perceptual Systems*, "we do not see light that is in the air or that fills the air."[27] However, in Turrell's installations we respond to light's ability to appear as an object varying in size creating hierarchy in a space and, ultimately, light's ability to challenge our perception.

D



Similar to Turrell, Doug Wheeler develops abstract spaces in interior settings creating hierarchy by establishing a relationship between industrial light, such as ultraviolet fluorescent, quartz-halogen, and neon bulbs, and white walls.[28] Jori Finkel and Randy Kennedy, writing for the *New York Times*, report that Wheeler's goal in his installations is to create a paradox with light and space by showing us a relationship containing tension, between light and space that we cannot detect.[29] In these displays, light becomes his primary material, often creating what appears to be vacuums or voids.[30]



E F G

Wheeler demonstrates how light deceives our senses in an installation called *Infinity Environment*, first made in 1975 in Milan (figure H).31 He dematerializes a room by turning it into a white structure with rounded edges, fully saturated in light.[32] To create these exact curves he modifies sections of fiberglass and tops them with special paints and resins.[33] This creates a vacuum-like effect because one is not able to see either surfaces or edges.[34] Through Wheeler's installation one is able to distinguish light's volume and how one's sense of space correlates causing perceptual experiences. By using a hierarchy of light to alter perception atmospheric structures are built.

H

Additionally, light focused on light absorbing materials alters perception changing our sense of space. Further showing the importance of material and light placement are Robert Irwin's scrim wall installations. In *Five x Five* (2007), the scrim's screen-like quality and the repetition of the five black scrim panels placed perpendicular to five white scrim panels, spanning floor to ceiling in height and closely placed, produced overlapping

geometric forms that changed when walking around the installation (figure I).[35] This occurs because minimal lighting is concentrated in one corner of the room, turning the simplicity of walking into an interactive experience. Each step changes the transparency and the opacity of the panels, thus creating and diminishing space.[36] When discussing scrim as a material, Irwin asserts, "Once when I was in Amsterdam, I was walking down the street, and I saw this material being used in windows, like curtains. It's a wonderful way to take hold of light. It's self-effacing, but can really change a space".[37]

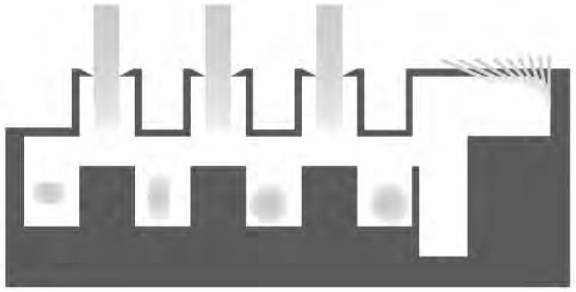
I

In *Slant/Light/Volume* Irwin experimented with how we sense and perceive space through physical, sensory and temporal experience by rear-illuminating a slanted scrim wall (figure J).[38] The invasive quality of the slant produces a feeling of monumentality and mass. A timeless illumination with a shockingly solid presence welcomes confrontation. The focus and orientation of the light invites one to meet a formerly distant horizon. Concentrating an arrangement of light on a single wall exposes the viewer to light as focal point and light's tendency to change a structure spatially and atmospherically.

J

Light has the ability to become a focal point in architecture and heightens one's sense of being. Joan Soranno and her team at the HGA Architects and Engineers used light, common among all religions, to bring an essence of spirituality to the non-denominational structure of the Lakewood Garden Mausoleum in Minneapolis (figure K). Heavy granite and onyx complemented with the weightless, ephemeral quality of light creates a feeling of solemnity that is reinforced by nesting the building into a hillside.

K



Light activates a calm interaction between the mausoleum and it's environment. The position and orientation of the mausoleum in the natural landscape allows light to interact in a way that heightens the choice of material used. Multiple slender and slanted windows line the wall of the chapel keeping the room isolated in a time of mourning and allows light to enter indirectly creating a humble setting.[39] The light soaks into the white, handcrafted plaster of the walls and is held there, generating a soft, comforting luminosity.

Influenced by Turrell, the crypts, which are tucked into the landscape, are designed with large skylights. Each skylight uses a physical component, such as an old-growth oak or pine tree that inhabit the grounds, to add a sense of texture and bring an element of nature to the space. Significantly adding to this feeling of being engaged by the external environment created by the skylight in each crypt, is the natural way that light warms and moves throughout the space. The carved ceilings that lead up to the skylights make a grand gesture of connecting one to the light. Similar to the crypts, the niche rooms are impacted by floor to ceiling windows that frame natural light. Light bathes the floor in a way that complements the precision and simplicity of the room's design, breathing life into the structure.

Saturated light generates a feeling of awakening in the

Amber Box Lobby, in Jean Nouvel's Guthrie Theater (figure L). Light enters from the primary east and west facing windows where the yellow tint of the windows saturates the natural light elevating the sun's role inducing a primal sense of energy. The Amber Box Lobby has a "golden hour" effect, giving compliments instead of revealing flaws allowing one to experience a filter. The material of the interior was picked carefully to expose the light's supple qualities. The sun naturally kisses the floors, walls and furniture of any interior with a window, but when the sun kisses the Amber Box Lobby the sun is wearing yellow lipstick. The switch from occupying a dark lobby to entering a dark elevator and then to emerging into sunlight with a yellow hue causes an initial shock awakening the body for a new sensory experience.

L

Although this grand approach has shock value the allure of the color yellow is unmistakable. Our response to light and color is often subconscious. Karen Haller, a color and design consultant states, "The language of color is communicated quicker to the brain than words or shapes as they work directly on our feelings and emotions."[40] In a sea of obstacles and lights our eyes seem to notice and gravitate to yellow, which visually overpowers, for example, the golden arches and other fast-food signs. Haller confirms this; stating, "yellow triggers the feeling of happiness and friendliness. Yellow is also the most visible color in daylight".[42] Our ability to respond to color and light subconsciously becomes significant when considering wayfinding and creating a sense of space.

Architects are also using zones of light in a system-like way

to create and differentiate spaces to establish direction. Hotels, restaurants, and bars use light zones to define spaces without the need for walls or partitions. One feels a sense of intimacy when light is used to fill a space yet an open and accessible environment still remains.

David Rockwell incorporates light to accentuate seating areas at Rosa Mexicano restaurant prototypes (figure M). To break up an otherwise overwhelmingly vast space, contrasting materials and iconic decorative pieces use light as a form of hierarchy and act as landmarks to navigate customers through the space while visually establishing zones of light.

M

The bar made of alabaster is lit from behind functioning as a decorative piece and creates a light zone of contrasting yellow. Located in the center of the Rosa Mexicano the bar visually and physically splits the restaurant seating area in half.

From floor to ceiling the area behind and in front of the bar is fully illuminated in color creating a lively zone for ordering and socializing. Near the top of the back wall of the bar Rockwell allows the glow from the bar to shine through, elevating the importance and function of this wall while hinting at the bar.

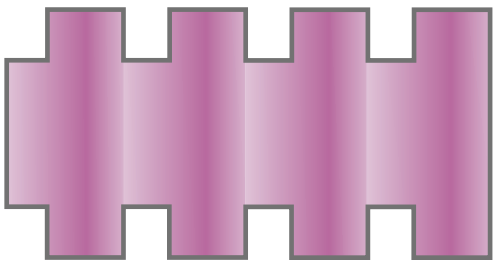
The second decorative piece is a sculptural element of miniature cliff divers. Transparent strings hold the figurines over a long pool of water. Spot lights at the bottom of the pool shine on the figurines while letting the water capture it's glow further distinguishing smaller furniture groups positioned

around the fountain. Circular shaped backrests with spotlights located behind allow light to weave through a metal netting that surrounds the booth, visually softening the material making it appear to be a soft fabric. This light also illuminates the pink wall visually closing off the space in a soft manner.

Like the pool with cliff divers, a decorative water wall also is used to create space. This full-length wall is made out of transparent glass and layered with a constant recirculating stream of water. Butterflies illuminated with light vertically descend on the wall, similarly to the figurines. Two decorative dividers, equal in size, mirror each other creating a seating area in the middle and hallways on the outside. This seating area is further distinguished by two giant rectangular light fixtures on the ceiling, which hang over the groups of tables and chairs. Past this zone is a function room located up three steps and distinguished not only by the elevation, but four smaller grouped rectangular light fixtures.

At St Martins Lane Hotel in London resides the Light Bar, designed by Philippe Starck, which is a series of similar zones distinguished only by their respective colored (figure N). When entering, the first section is orange including the furniture, tables, wallpaper and carpets, followed by the colors purple, green, and a brighter orange.[42] The walls are lit in a way that saturates its color leading the eye to the top of the wall where there are large portraits.[43] With the combined use of light and color a new perception of color is determined, for example sitting in a green light zone would cause one to perceive other colors differently.[44] Repetition further enforces these zones by using the same wall condition, the same furniture grouping, the same position, size, and correlating color of rug, and the continued use of portraits. A simple arrangement maintains order with the use of illuminated color adding variety and affecting perception while adding charm.

N



In Anthony McCall's piece *You and I, Horizontal (II)*, light takes on a trancelike quality by becoming a wall-like interactive form. Light travels from multiple projectors, but the mass of these rays rendered in a foggy mist piques the curiosity of how they are produced and takes on a sculptural quality. A computer program permits the light to slowly change its shape, adding to the curiosity of the provocative stationary, life-like beams. Using light to repeatedly question the illusion of space becomes a theme.

Impenetrable though these light beams appear to be, the shape of the structure's amid the mysterious darkness encourages viewers to interact with the light, testing its ever-changing qualities. Some explored on their own while others explored in groups. Inside the spaces formed by the structure of these light beams people took comfort. An open room filled with haze and a space divided into segments by the light beams triggers an association with layers of air or even water. The height of the horizontals with the restriction of not being able to see the ground contribute to a disconnected feeling.

The ability to experience these light rays by oneself adds to the uniqueness of *You and I, Horizontal (II)*. By being alone in one of these light-encased spaces, one is able to fully engage their senses and is encouraged to discover more residential spaces created in the areas absent of light. McCall is able to immediately separate you away from others causing a feeling of seclusion. By crossing one of McCall's beams of light you become surrounded by a piece of work that abstracts the gallery's space. A few steps into a room, one intersects abstractly shaped light beams. Formerly aware of the group of people sitting on the ground not far away, they instantly disappeared upon entering a new space created by light. The uncanny feeling of being alone though you are not challenges ones perception of reality. In this sudden transition of passing through a beam of light and entering another room without having to open or shut a door, one realizes that it is not the beauty of the light that makes this piece but rather its ability to function as a solid form creating and diminishing space.

Our imagination is triggered when light becomes a three-dimensional, interactive experience. According to Juhani Pallasmaa's book Eyes of the Skin, "Mist and twilight awakens the imagination by making visual images unclear and

ambiguous. Imagination and daydreaming are stimulated by dim light and shadow," invite one to explore new spaces, challenging our perception of space.[49] A hierarchy of light creates structure, a sense of self and atmosphere, and a continuously changing sense of space that challenges one's perception encouraging imagination. With an awareness of light's ability to transform perception, new settings are designed to amplify our feeling of space and depth.

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WhyReef: A Virtual, Educational Program Analysis

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Abstract

During the summer of 2012, The Field Museum of Natural History (FMNH) began a collaborative project with the University of Wisconsin - Stout in order to analyze the effectiveness of the museum's *WhyReef* program. *WhyReef*, an online, socially interactive coral reef simulation designed for youth ages 8-16, launched in March 2009 and has since reached over 160,000 unique players. The overall goal of this research project was to analyze the educational effectiveness of *WhyReef*. This was accomplished by a robust evaluation and analysis of *WhyReef*'s learning goals and gameplay mechanics. The research was made possible by a data set of player content and statistics provided by FMNH, as well as a personal trip to the museum to interview the *WhyReef* educational team. Research was divided into three topics and determined that 1. *WhyReef* is very successful in increasing coral reef attention and appreciation; 2. The best time to launch attention-grabbing, critical events is on weekdays during the summer; 3. Meaningful Motion is a key gameplay mechanic for increasing *WhyReef* participation and comprehension. The analysis of the *WhyReef* data set provided valuable feedback to the *WhyReef* development team, as well as opened the door for continued collaboration between FMNH and UW-Stout. Research findings were presented to the WhyReef educational team at The Field Museum and at the Games Learning Society 9.0 conference in Madison, Wisconsin.
Keywords: WhyReef, educational games, meaningful motion, GLS conference

Purpose

WhyReef is a virtual, interactive coral reef simulation housed within *Whyville.net* that launched on March 30, 2009. It is

** This project was supported by a UW-Stout Research Services grant, and was a joint endeavor of the Field Museum of Natural History (FMNH) and the University of Wisconsin - Stout (Ed.).*

accessible for free by anyone using a computer with internet access. The *WhyReef* project enables students to learn about the many diverse species living within coral reefs as well as the scientific processes that are required to understand and conserve these reef ecosystems. The educational gameplay and design elements of *WhyReef*, coupled with its online, social architecture, make it a prime example of successfully combining educational and entertainment aspects in a video game.

The *WhyReef* project is made possible by a collaboration between The Field Museum of Natural History (FMNH) in Chicago, Illinois, and the learning-based virtual world developer Numedeon, Inc. in Pasadena, California. Numedeon created *Whyville.net* in 1999. Since then more than 5 million registered users have accessed *Whyville* (Numedeon, Inc., 2012), with over 160,000 unique users visiting *WhyReef*. The FMNH continues to regulate *WhyReef* and institute changes and events in pursuit of their program and learning goals. These goals include awareness of conservation biology, ecosystem ecology, stewardship and management, and science literacy (Babcock & Aronowsky, 2010, p. 3).

Before development of *WhyReef* began, high priority was given to a list of thirty learning goals stemming from these four broad educational goals. These goals are brought to life within *WhyReef* through the use of coral reef videos, graphs, forums, encyclopedia entries, three educational games, and more. *The Mini Food Web Game* tasks players with completing fifteen food web chains focusing on various coral reef animal and plant life. The *Reef Simulator* allows players to observe disturbances in coral reef biology over time by analyzing graphs, from which hypotheses may be formed as to the cause of the changes. *WhyReef's* most popular game, the reef counter, sees players moving their avatars around a virtual coral reef in order to count the diverse species of plant and animal life present on the reef. Throughout all three of these games both Numedeon and the FMNH strove to find an optimal balance between online gameplay and scientific authenticity.

Following several successful years, the FMNH wished to examine what aspects of *WhyReef* made the program so successful (Babcock & Aronowsky, 2010, p. 3). This led to the formation of a collaborative effort between The Field Museum of Natural History and UW-Stout. The FMNH supplied a data set

containing selected *WhyReef* user statistics, writings, and digital media created by some of the over 140,000 unique users that visited *WhyReef* between March 30, 2009 and May 5, 2011. In September of 2009 the FMNH also conducted the Kids Advisory Council (KAC). Consisting of a group of on-site and off-site youth ages 10-14, the council aimed to better understand how content knowledge is acquired by youth through a virtual world and how this is supplemented by real interaction with specimens at The Field Museum. The data set supplied by the FMNH includes a wealth of first-hand data gathered during the KAC, as well as kid-produced videos showcasing what they have learned.

In addition, this author interviewed key members of the *WhyReef* educational design team and took a tour of the museum's fish collections to better understand the goals and implementation of the *WhyReef* project. Witnessing the fish collections that influenced the appearance and behavior of the organisms appearing in *WhyReef* was very helpful in understanding the scientific authenticity of the game. Asking design and gameplay-related questions of the *WhyReef* team helped the author understand educational and gameplay aspects included within *WhyReef.*

Having thoroughly explored *WhyReef* and examined the data set supplied by the FMNH, this author focused efforts on answering three research questions that he felt would provide the best feedback for the *WhyReef* educational team at The Field Museum. These research questions came to be: 1. What gameplay elements and information increase *WhyReef* user participation and comprehension? 2. How do the *WhyReef* program goals align with *Whyville's* virtual world interface? 3. Does social activism increase during critical events, such as *WhyReef's* "Save The Reef" events?

Research Question #1 – Game Design

What gameplay elements and information increase WhyReef user participation and comprehension? This research question allowed the author to blend his personal and classroom experience in game design with the social, online world created by *WhyReef*. The author strove to center game design recommendations upon a single aspect that would boost *WhyReef* user participation and comprehension the most: meaningful motion.

Objects that move present a sense of significance to the player. These objects may be interactive objects (ex. icon to click to start a game) or objects that will give the player valuable information (ex. moving textbox with directions). However, motion must not be wasted. Limited resources in an online, browser based game such as *WhyReef* are not allocated to objects that have no significance to the player. This type of game is not one that wants to make the young target audience guess what is important. *WhyReef* is a scientific, educational game that aims to inspire the player to learn about and conserve coral reefs. This can be done in a timely, efficient manner that will capture and keep the player's attention through the use of meaningful motion.

Meaningful motion is defined as motion that grabs the player's attention and supplies clues as to what should be focused upon. Used effectively, this will enhance the scientific accuracy discussed by Aronowsky et al (2010), increasing player comprehension and scientific inquiry. There are two kinds of meaningful motion: physical and implied. Physical motion can be seen in the *WhyReef* hub world. This central area describes the different areas and games within *WhyReef*, allowing players to navigate their avatars between them. An animated graph icon signals to players that clicking on this will likely result in analyzing changes in a graph. This motion is meaningful to players. It is also positioned right next to the focal point created by the implied motion of Mark's waving hand. Mark, a marine biologist at The Field Museum of Natural History, welcomes newcomers to *WhyReef*. He is one of the first things players notice when entering *WhyReef*. Mark's hand does not move, yet the player's attention is drawn by the implied motion created by Mark's hand.

The most effective use of meaningful motion within *WhyReef* can be seen in action within the virtual coral reef that serves as home for the popular reef counter game. The flagship game of *WhyReef* tasks players with counting fish, mammals, plants, and other coral reef life within a lifelike 2D replica of a tropical coral reef (Figure 1). Animal and plant life move and behave in a manner that reflects their real-life behavior, such as clown anemone fish darting in and out of their sea anemone homes. This immediately grabs players' attention and keeps it, as players attempt to fill their reef journal by using what they have learned about the commonly appearing species to find and count the rarer species.

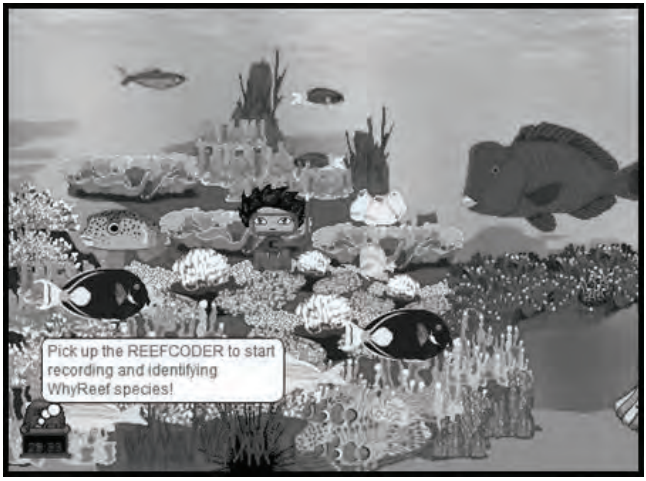


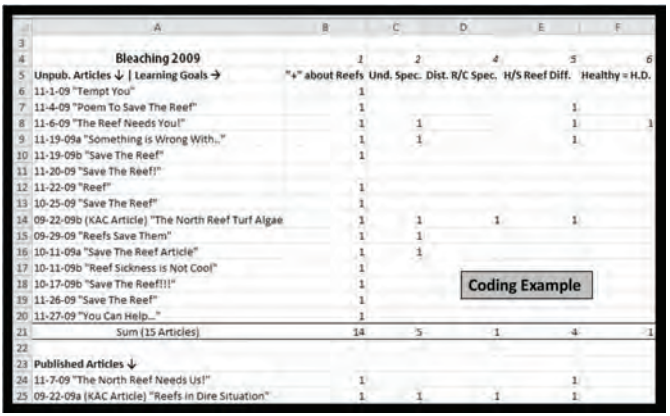
Figure 1: WhyReef reef counter game

A clever combination of physical and implied motion is the key to steering players' attention toward the most important topics within *WhyReef*. However, this must be done conservatively, as the effect of meaningful motion is reduced if an excessive amount of motion is onscreen at any one time. This limit will differ with the application, but the concept can be easily visualized by thinking of focusing on one fish in a fast moving school of fish. It would be rather easy to focus upon a lone fast moving fish, but once the number reaches the hundreds the task becomes nearly impossible. As a result of *WhyReef's* reef counter game employed meaningful motion, leading to thousands of players have counting millions of plants and animals since *WhyReef* launched in 2009. By expanding this concept to the other games within *WhyReef*, or even the whole of *Whyville*, one would see a similar increase in player participation and comprehension.

Research Question #2 – Program Goals

How do the *WhyReef* program goals align with *Whyville's* virtual world interface? This research question stems from the need for an understanding of how well the *WhyReef* program goals aligned with the way they were implemented, namely through an online, social game environment. Qualitative analysis was used to code the *WhyReef* user data to the set of

thirty *WhyReef* learning goals, as listed in the *WhyReef* Final Report (2010). The coding process is one common to many analysis efforts that draw from qualitative data (Zheng, Spires, & Meluso, 2011, p. 194), and is described as using one's own educated judgment to determine if criteria are met (Figure 2). In this case, the criteria were whether or not a player-written article demonstrated understanding of each individual *WhyReef* learning goal. These articles were submitted for publication in the *Whyville Times*, an online newsletter that is sent to *Whyville* players on a weekly basis. These *WhyReef* articles ranged from simple two-sentence statements of support for *WhyReef* to multipage submissions that went into great detail on how best to conserve *WhyReef* and real life coral reefs.



	A	B	C	D	E	F
3						
4	**Bleaching 2009**	*1*	*2*	*4*	*5*	*6*
5	**Unpub. Articles ↓ | Learning Goals →**	**"+" about Reefs**	**Und. Spec.**	**Dist. R/C Spec.**	**H/S Reef Diff.**	**Healthy = H.D.**
6	11-1-09 "Tempt You"	1				
7	11-4-09 "Poem To Save The Reef"	1			1	
8	11-6-09 "The Reef Needs You!"	1	1		1	1
9	11-19-09a "Something is Wrong With.."	1	1		1	
10	11-19-09b "Save The Reef"	1				
11	11-20-09 "Save The Reef!"					
12	11-22-09 "Reef"	1				
13	10-25-09 "Save The Reef"	1				
14	09-22-09b (KAC Article) "The North Reef Turf Algae	1	1	1	1	
15	09-29-09 "Reefs Save Them"	1	1			
16	10-11-09a "Save The Reef Article"	1	1			
17	10-11-09b "Reef Sickness is Not Cool"	1				
18	10-17-09b "Save The Reef!!!"	1		Coding Example		
19	11-26-09 "Save The Reef"	1				
20	11-27-09 "You Can Help..."	1				
21	Sum (15 Articles)	14	5	1	4	1
22						
23	**Published Articles ↓**					
24	11-7-09 "The North Reef Needs Us!"	1			1	
25	09-22-09a (KAC Article) "Reefs in Dire Situation"	1	1	1	1	

Figure 2: Example of coding WhyReef player-written articles

By closely coding these 85 player-written articles and examining the Kids Advisory Council results, an understanding of how well *WhyReef* accomplished its educational goals was attained (Figure 3). These results indicate that *WhyReef* is successful in increasing coral reef attention and appreciation among its players. This was evident by the high involvement and successful survey results of the Kids Advisory Council members, part of which showed that 94% of members thought coral reefs were either beautiful or interesting. Furthermore, player-written articles showed a high tendeny to demonstrate *WhyReef* learning goals, such as "feel positive about reefs" (95% of articles) and "feel reefs are important" (99% of articles). However, the results show that Whyville could improve upon its delivery of

scientific knowledge. This was demonstrated by inconsistent Kids Advisory Council survey results, such as knowing which trophic level has the highest population (33% of members). Player-written articles also demonstrated low understanding of such *WhyReef* learning goals as "understand how to read a graph" (4% of articles) and "know what a hypothesis is" (0% of articles).

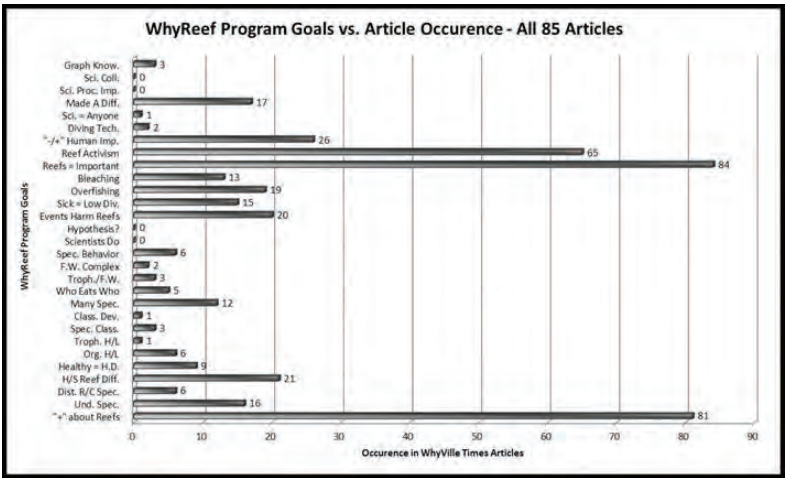


Figure 3: WhyReef program goal occurance in 85 player-written articles

Research Question #3 – Social Activism

Does social activism increase during critical events, such as *WhyReef's* "Save The Reef" events? Quantitative analysis was used to determine if social activism, demonstrated by the level of player interest and involvement, increased as a result of critical events. The critical events examined were *WhyReef's* "Save The Reef" events. During these events, perturbations were introduced to the virtual coral reefs housed within *WhyReef*. Players responded to such dangers as overfishing and coral bleaching by wearing special virtual clothing, donating virtual currency, creating management plans, and spreading the word among their peers. Over time their efforts would lead to a healthier coral reef, in which the frequency of plant and animal species would return to a normal, balanced level.

The *WhyReef* data set supplied detailed records on the number of unique player visits to *WhyReef* during days on which a critical event was occurring, as well as on normal days when no critical

event was taking place. These numbers were grouped to show the apparent increase in player participation during the summer months. SPSS statistical analysis software (SPSS, 2012) was used to run independent samples t-tests in order to assess any significance (< .05) between the daily average players on normal days versus critical days (Figure 4). A significant difference indicates that there is a decrease in the number of players on that critical day of the week. These tests were conducted for all days of the week, with a significant difference evident on Friday (.021), Saturday (.018), Sunday (.022), and on Tuesday (.047) as shown in (Figure 5).

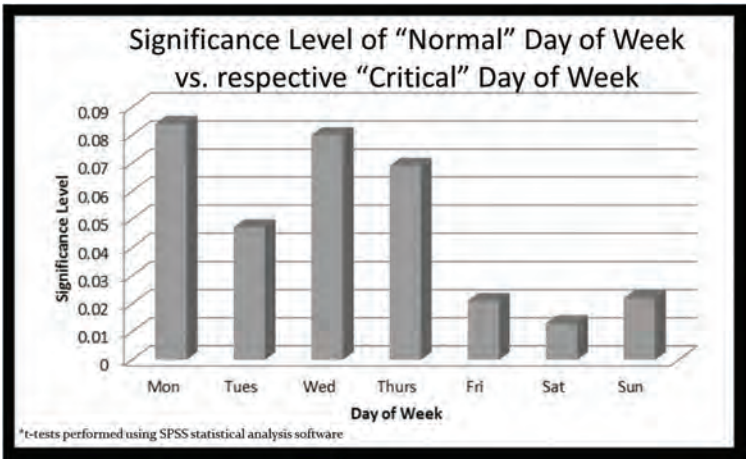


Figure 4: Significance level of "normal" vs. "critical" days of the week.

Initial Days (with high visits) Excluded for More Focused Analysis

Code	# of Days		Mean	Std. Deviation	Normal Day vs. Critical Day
1	47	Mon	426	88	0.084
2	47	Tues	427	98	0.047
3	46	Wed	422	105	0.080
4	46	Thurs	429	95	0.069
5	47	Fri	466	85	0.021
6	47	Sat	481	96	0.013
7	47	Sun	455	98	0.022
8	28	**Mon**	378	149	
9	29	**Tues**	367	159	
10	30	**Wed**	371	146	
11	31	**Thurs**	376	154	
12	28	**Fri**	412	111	
13	28	**Sat**	420	109	
14	28	**Sun**	398	108	

Figure 5: Number of unique players on "normal" days vs. "critical days" (bold)

Summer months produced the highest unique *WhyReef* player visits, particularly on weekdays. This demonstrates strong evidence supporting the timing of critical events on weekdays during the summer, helping to answer questions for further research posed by the *WhyReef* Final Report (Babcock & Aronowsky, 2010). There is no concrete answer for why summer weekdays generated more player participation than summer weekends. One possible explanation is that this is the time when parents are away at work and children are left at home with *WhyReef* only a quick click away.

Limitations

The primary limitation of this research was the scope of the *WhyReef* data set supplied by the FMNH. The roughly two year timeframe (March 2009 – May 2011) and specific topics that the data set covered only afforded analysis based upon the included data. While this data was enough to draw conclusions from, more data would allow for further investigation into the educational effectiveness of *WhyReef*.

Another limitation was the fact that it is impossible to know the exact set of external variables that are impacting players. Do children play *WhyReef* because they are already interested in coral reef science? Is the information players communicate on forums and surveys learned from playing within *WhyReef*, or is it knowledge the players already had? Access to *WhyReef* itself is an issue, as it requires a PC (or similarly powerful device) and an internet connection to play. This limits the amount and type of players that have the potential to learn from *WhyReef*, as children in poverty-stricken areas may not have easy access to the internet.

Limitations were also imposed by the objective of this research, namely to analyze the educational effectiveness of *WhyReef* and recommend improvements from a game design perspective. This allowed for effectively narrowing the scope of this research, but limited the findings that could result from looking at these specific aspects of the *WhyReef* data set.

Conclusions

WhyReef, the online, socially interactive coral reef simulation designed for youth ages 8-16, led to the formation of a collaborative research project between UW-Stout and The

Field Museum of Chicago. Coding techniques used in a similar gameplay study (Zheng et al, 2011) were applied to the *WhyReef* data set to code 85 player-written articles, determining that *WhyReef* is successful in increasing coral reef attention and appreciation among its players. This was shown by player-written articles demonstrating learning goals, such as "feel reefs are important" (99% of articles), and Kids Advisory Council survey results, such as 94% of members thinking coral reefs were either beautiful or interesting . However, *WhyReef* could improve upon its delivery of scientific knowledge. This was shown by a lack of player-written articles demonstrating certain learning goals, such as "knowing what a hypothesis is" (0% of articles), and inconsistent Kids Advisory Council survey results, such as knowing which trophic level has the highest population (33% of members).

SPSS statistical analysis indicated that the optimal time to conduct critical "Save The Reef" events is on weekdays during the summer months. Tests were conducted for all days of the week, showing a statistically significant difference calculated on Friday (.021), Saturday (.018), Sunday (.022), and on Tuesday (.047). These statistics draw from the raw data contained within the *WhyReef* data set in order to answer further research questions posed by the *WhyReef* Final Report (Babcock & Aronowsky, 2010).

In addition, *WhyReef's* gameplay mechanics may be improved through the use of meaningful motion. This game design mechanic grabs the player's attention and supplies clues as to what should be focused upon. Adding more meaningful motion will enhance the scientific accuracy discussed by Aronowsky et al. (2010), increasing player comprehension and scientific inquiry.

Recommendations

While this research targeted the educational effectiveness of *WhyReef*, there are many further studies that may be conducted to expand upon these findings or investigate different aspects of *WhyReef*. The *WhyReef* data set may be analyzed within a different context, such as determining more details about the external variables that shaped the data seen within the set. The player-created content may be investigated from a different point of view in order to see if the success of *WhyReef* is in fact

due to its game design and scientific authenticity, or if other significant factors are at play. The social aspect of *WhyReef* itself may be investigated to determine what extent playing with friends has on the educational experience that *WhyReef* provides.

Expanding beyond the data set, a worthwhile endeavor would be to add more meaningful motion to *WhyReef*, collect data over several months, and then analyze whether or not this motion increased player participation and comprehension. Furthermore, increasing the amount of interaction between players and the FMNH on the forums and directly within the game would generate new data. This data could then be used to determine, for example, whether the lessons learned during the Save The Reef critical events have been retained by players, or if the engagement was brought about more by the excitement of new content.

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