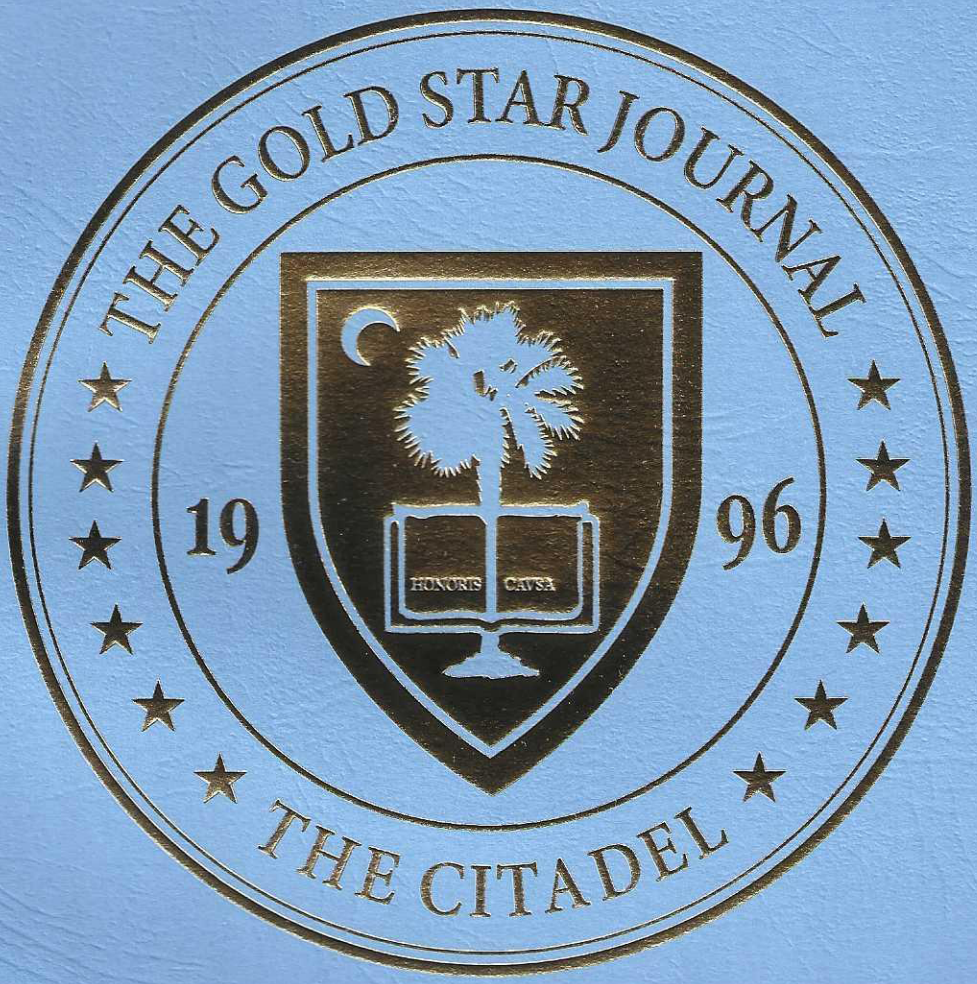
THE GOLD STAR JOURNAL
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In honor of

The 27th Edition of *The Gold Star Journal* is published in honor of Brigadier General Sally Selden, Ph.D., SPHR, the Provost and Dean of the College. Dr. Selden promotes academic excellence at The Citadel by implementing new initiatives and supporting ongoing programs that serve approximately 3,500 students and 200 faculty. In addition, she has united the Gold Star Journal Academic Conference with Student Excellence Day as a celebration of scholarship at The Citadel.

Dr. Selden has enhanced *The Gold Star Journal* by providing an office space for our operations, opportunities to speak to the Faculty Senate, a budget to completely support our publication and conference, professional mentorship, and acting as an encouraging friend. Her steadfast commitment has enlarged our notoriety on campus and among alumns. We are truly grateful for all that Dr. Selden does and is.

The History of The Gold Star Journal

The Gold Star Journal **made its debut for Corps Day in 1997 with an original hand-drawn cover and three sophomores as the founding Editorial Staff.**

The most prestigious student publication at The Citadel since its inception in 1996 is *The Gold Star Journal.* The tradition has continued for twenty-seven years as members of The Corps of Cadets and The Citadel Graduate College have published high quality, multidisciplinary academic papers, photostories, photographs, and artwork. As the 27th Edition of *The Gold Star Journal* touches the hands of The Citadel community, it is important to recognize the time-honored traditions and continuous development of the publication.

In May of 1996, Dr. Suzanne Mabrouk was enrolled in a graduate course focused on responding to student writing at The Citadel. She found it astonishing that the majority of student papers did not live past a simple letter grade. To develop an opportunity for students to receive additional recognition for their academic achievement, Dr. Mabrouk discussed the idea of a scholarly publication with the Vice President for Academic Affairs, Major General Roger C. Poole, '59. General Poole approved the idea and provided the funds that gave birth to *The Gold Star Journal*.

Since the creation of *The Gold Star Journal,* the Editorial Staff and Dr. Mabrouk have continued to enhance the publication by designing and updating the seal, developing student awards, and producing the annual Gold Star Journal Academic Conference. The conference began in 2016 to commemorate the 20th Edition. It has continued as an additional venue for authors, photographers, and artists to share their scholarship before a live audience.

The Gold Star Journal has been honored several times, in 2005 by Case District III with a Special Merit Award for the 6th, 7th, and 8th Editions and in 2021 for the 24th Edition with the Athens Paper Award for Most Creative Use of Paper and the Special Judges Award for Soft Cover Booklet by the Printing Industry of the Carolina Awards. Most recently, the 26th Edition received First Place with Special Merit Award and Most Outstanding College Magazine for 2022 Award by the American Scholastic Press Association. Furthermore, it was selected as one of the 2022 South Carolina Notable State Documents Awards by the South Carolina State Library. The publication continues to recognize the importance of effective writing, research skills, critical thinking, creativity, and ingenuity. The honor and legacy of *The Gold Star Journal* will continue for years to come!

Letter from the Editor-in-Chief

Dear reader,

It is with great honor that our Editorial Staff presents to you the 27th Edition of *The Gold Star Journal*, The Citadel's most prestigious student publication. The journal recognizes multidisciplinary nonfiction papers, photostories, photographs, and artwork from members of The South Carolina Corps of Cadets and The Citadel Graduate College. The 27th Edition is a direct reflection of our mission to implement modernity into the journal while maintaining the tradition of academic excellence at its core. As the Editor-in-Chief of *The Gold Star Journal* for the past two years, I did not initially intend to serve in this capacity. I distinctly remember informing my mother, prior to our informational meeting junior year, that I could not fulfill such a significant commitment. But somehow my hand magically rose when Dr. Mabrouk requested a volunteer to serve in this position. I made the decision to lead our Editorial Staff, and it has become the greatest choice of my academic career.

Following the 25th Edition, we inducted an entirely new Editorial Staff. As young leaders, we were tasked with developing a contemporary vision while upholding the time-honored traditions of the publication. I owe it to the six distinguished cadets who worked tirelessly alongside me– Trey Stevens, Ken Gaslgaard, John Morris, Jesse Quimby, Hampton Dennis, and Dylan Young. Although many of these individuals are no longer members of our Editorial Staff, I would be remiss if I did not highlight their contributions. John marketed our mission to The Citadel community, Jesse maintained our technical operations, and Hampton enhanced our design. It is a pleasure to specifically acknowledge Trey's contribution to our operations, both as a previous Communications Editor and current donor. All of the journal's accomplishments were a result of the fellowship and friendship found among the seven of us.

Following the publication of the 26th Edition and our annual Gold Star Journal Academic Conference, I was immersed in a sense of gratitude, appreciation, and fulfillment. While the success of the 26th Edition cannot be understated, I did not anticipate the growth and participation the following year would contain. Our Editorial Staff witnessed the introduction of new members– Annika Ford, Mason Hand, Catherine Dubuisseret, Gage Timberlake, Jillian Aylsworth, Andrew Palmer, Noah Miller, and Kanjanika Kincaid. Annika's artistic eye and Mason's ability to capture key events on film have set the foundation for a more modern template. Catherine, Dylan, Gage, Andrew, Jillian, Noah, and Kanjanika have shepherded the authors through the publication and presentation processes. I owe my greatest respect to Ken, Assistant Editor-in-Chief and Sierra Company Executive Officer, as he has acted as a constant source of support, advice, and mentorship, in regards to the journal and Sierra Company leadership. I would not be the person I am today without his guidance and friendship.

The journal features seven scholarly papers that represent distinctly different disciplines within The Citadel's academic environment. We highlight Victoria

Snook who is awarded the Boyd Family Distinction Award for her paper, *Graphene Technology in the Space Industry*. Thomas Chapman's paper, *Threats Posed by the Submarine Fleet of the Russian Navy*, is given the Best Undergraduate Paper Award. *The Gold Star Journal* highlights twelve photographers for their display of scholarship through the lens of a camera as well as four artists for their creative abilities. We congratulate Celeste Montero with the Best Photograph Award for her photograph, *Foggy*, and Wilhelm Birkholz for the GSJ Distinction in Photography Award for his photostory, *The Mountains of Southern Europe*. The Most Creative Artwork Award is given to Catherine Rodriguez for her painting, *Military Shame*.

The publication of *The Gold Star Journal* embodies much more than meets the eye. We extend gratitude to our faculty advisor, Dr. Suzanne Mabrouk, for her steadfast commitment to our success. We recognize a member of the Multimedia Services, Mr. John Whitten, as he has continuously supported the endeavors of this publication through mentorship and InDesign expertise. We also thank our donors, the Office of the Provost, LTC and Mrs. Albert G. Brauer II, '72; Dr. and Mrs. James F. Boyd, '71; Ms. Callah M. Davis, '17; LTC and Mrs. Paul S. Hodges, '63; Dr. Suzanne T. Mabrouk and Mr. Stephen S. Jones; Mr. and Mrs. William G. Rasberry, '19; 2LT Trey J. Stevens, '22; and the Friends of the Daniel Library. Their contributions to *The Gold Star Journal* have been essential to our publication. It would not be possible without their generosity. Our appreciation extends to President of The Citadel, General Glenn M. Walters, '79; The Commandant of Cadets, Colonel Thomas J. Gordon, '91; Brigadier General Sally Selden, Ph.D., SPHR; and other members of the Commandant's Department for their guidance in documenting the success of The Corps of Cadets and The Citadel Graduate College.

My time as Editor-in-Chief of *The Gold Star Journal* has certainly not been easy. It has contained endless hours in an office with no windows and headaches from staring at InDesign for hours. However, it has taught me patience, collaboration, and unity as well as providing me with the most fulfilling friendships I could have. As my time is coming to an end, I thank Dr. Mabrouk, our Editorial Staff, and all those involved for truly bringing our vision to reality. I trust that all future editors will continue the legacy for years to come, and I cannot be prouder of the students involved in this publication; their academic excellence upholds the rigorous demands of The Citadel. Congratulations to our authors, photographers, artists, and Editorial Staff for a job well done. This has been the experience of a lifetime.

Very respectfully,

Elissa Reckdenwald

Editor-in-Chief of *The Gold Star Journal*

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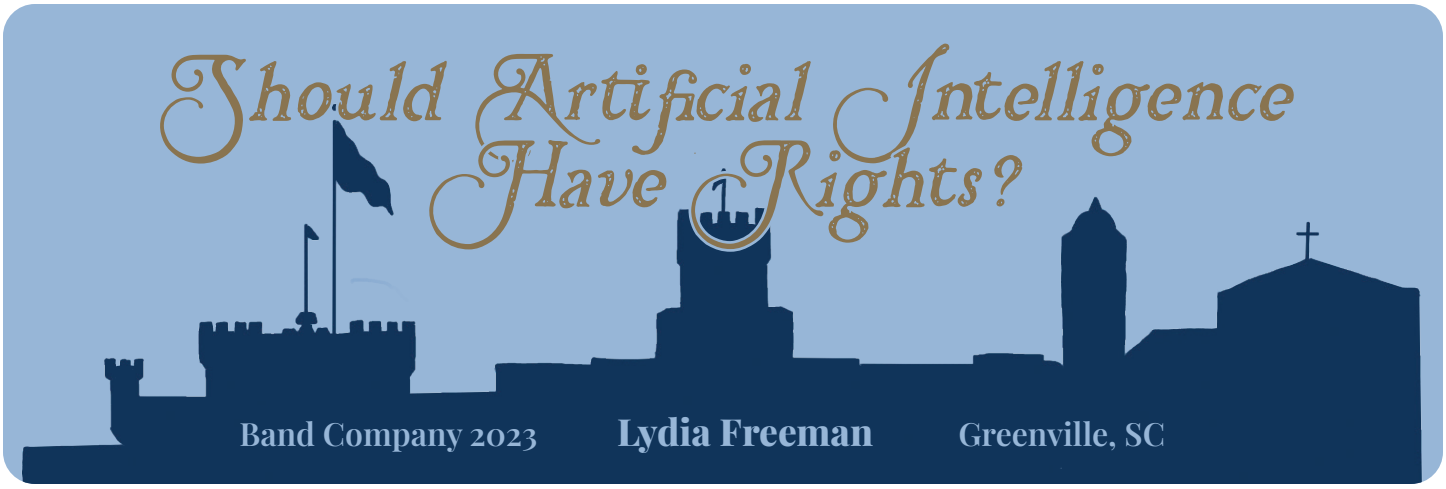


KEYWORDS

Hohfeldian Incidents, Deep Learning, Machine Learning, Neural Networks, Turing Test, Consciousness

I. Rights

Over the course of history, humankind has grown to understand that we have rights. The United Nations states that "universal rights are inherent to us all, regardless of nationality, sex, national or ethnic origin, color, religion, language" [27]. To promote this ideal, The United Nations adopted the Universal Declaration of Human Rights,the first legal document that set fundamentals for which rights were to be universally protected [27]. An American legal theorist named Wesley Hohfeld concluded that there are four types of rights, known as the Hohfeldian Incidents: claim-rights, liberty or privilege-right, powers, and immunity [25].

Hohfeld labeled claim-rights as a right 'in its strict sense' [25]. An example of a claim-right is found when person A and person B enter a binding contract that states that person A must pay person B a sum of money. Person A has a right to that sum of money and person B has a duty to pay person A the agreed payment.

Privilege-right, also referred to as liberty-right, can be defined as having a privilege to act on an action if it does not affect the duty of another person or thing. Peter Jones, a professor in political philosophy, provides an example of a liberty-right, in which a person may dress as they please, as they do not have a duty to dress a certain way, due to their choice of attire not hindering others from dressing as they choose [21]. Leif Wenar asserted that one's privilege to take shells from the beach, without being mandated to take shells if they wish not to, is an instance of a privilege right [17].

The power right is defined as a person having the capability to change their or another person's claim-right, privilege-right, or authority. Jones gives an example of a power right, as when a person invites you into their home, they are waving their claim-right to not have anyone in their home [21]. Sumner explains that powers can not only alter "first-order" rights such as privilege and claim rights, but can alter "high-order" structure [17]. Similarly, a Colonel has the power to relieve a Major of their position to command a group of troops.

Along with claim, liberty, and power rights is the immunity, which is defined as a person having an immunity if another individual lacks the ability to alter their Hohfeldian rights. Americans have immunity from Congress provided by the First Amendment that prevents them from interfering in religious freedom.

II. Artificial Intelligence

John McCarthy, a computer scientist at Stanford, defined artificial intelligence as "the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand

human intelligence, but AI does not have to confine itself to methods that are biologically observable" [16]. There are many definitions that could define AI, but in its simplest term, AI is the collection of computer systems that are able to perform tasks that require intellect using computational models [24]. Currently, AI is used in a great variety of situations, including health care, manufacturing, banking, and just about every profession that uses computers.

II.I Brief History of AI

Michael Haenlein and Andreas Kalpan write about significant accomplishments in AI history [20]. In 1950, Alan Turing published a paper named Computing Machinery and Intelligence in which he presents a test named the Turing test. This test was used as a solution to answer the question 'can machines think?' Soon John McCarthy officially forged the term artificial intelligence in the first AI conference hosted by Dartmouth in 1956. In the same year, three researchers, Allan Newell, J.C. Shaw, and Herbert Simon created the Logic Theorist, the first running AI software program. In 1967 an American psychologist, Frank Rosenblatt, built Mark 1 Perceptions, the first computer to use neural network that would learn by trial and error [14]. Then in 1968, Marvin Minsky and Seymour Papert published their book, Perceptions, a research on neural networks featuring an argument against future research on neural networks. Despite Minsky and Papert's research, neural networks became widely used in AI applications by 1980. In 1997, IBM's Deep Blue beats the world chess champion Garry Kasparov in a chess match [5]. IBM created another computer called Watson in 2011 that competed in Jeopardy, beating two champions [3]. Baidu's supercomputer, Minwa, created in 2015, uses a convolutional neural network, which is a special deep neural network, that has the ability to identify and categorize images at a higher rate than an average human. Then in 2016, a company called DeepMind created a program called AlphaGo that combined deep neural networks and advanced search trees. AlphaGo defeated the Go world champion, Lee Sedol, in a 4–1 victory [4]. Go is widely considered one of most difficult games to play, with there being 10 to the power of 170 possible turns on a 19 by 19 board, making it difficult for a computer to brute-force all the calculations [4]. AlphaGo was the first time an AI beat the Go world-champion.

II.II Machine Learning and Deep Learning

Machine learning (ML) is where systems learn from a training dataset to help automate processes and solve related problems. ML systems improve their performances with more experience as time goes on. There are three distinct types of ML: supervised learning, unsupervised learning, and reinforcement learning [8]. Supervised learning is when learner systems are given a training dataset that includes examples for the input and labels for correct answers or the target values for the desired output. Unsupervised learning is when the learner system is not given any examples or labels for a dataset and is supposed to identify patterns without specifications. Reinforcement learning (RL) is when the current state of a system is described to the learner along with a goal, a list of actions that is allowed, and their environmental constraints for the outcome. This way of learning allows for the ML learner to reach the specified goal through trial and error by itself.

Deep learning (DL) is a machine learning concept based on neural networks that can take data in its raw form and automatically distinguish different datasets from one another. This is also known as scalable machine learning. DL has become one of the most significant AI breakthroughs due to a reduction of manual effort being used to build AI systems [8].

III. The Turing Test

A British mathematician and cryptanalyst, Alan Turing, created one of the most popular tests that is used to determine if AI has gained the intelligence of a human called the Turing test. As previously stated, the test was created to answer the question, 'can machines think?' The test determines whether a machine can fool a judge into thinking that they are speaking to a human. This test requires a human judge and two participants, one being the AI program and the other being another human as shown in Figure 1 [23]. After a certain amount of time, the judge must then guess who they believed to be a human and who is the AI program. If the computer can fool the

Marie Le Gallo

Somewhere in the Blue Between the Clouds

judge 30% of the time, then the program is considered to have passed the test [20]. Turing made a prediction in his 1950 paper that "in about fifty years' time it will be possible to program computers, with a storage capacity of about 109, to make them play the imitation game so well that an average interrogator will not have more than 70 percent chance of making the right identification after five minutes of questioning"[2]. In 1966, Joseph Weisenbaum created the first chatbot, ELIZA, with the ability to search for keywords in the questions from the judge and would generate proper responses that almost passed the Turing test. More recently in 2014, a computer algorithm named Eugene Goostman was able to deceive one-third of human judges at the UK's Royal Society, which was meeting the requirement to pass the Turing test. Goostman did this by claiming to be a thirteen-year-old boy from Ukraine [23].

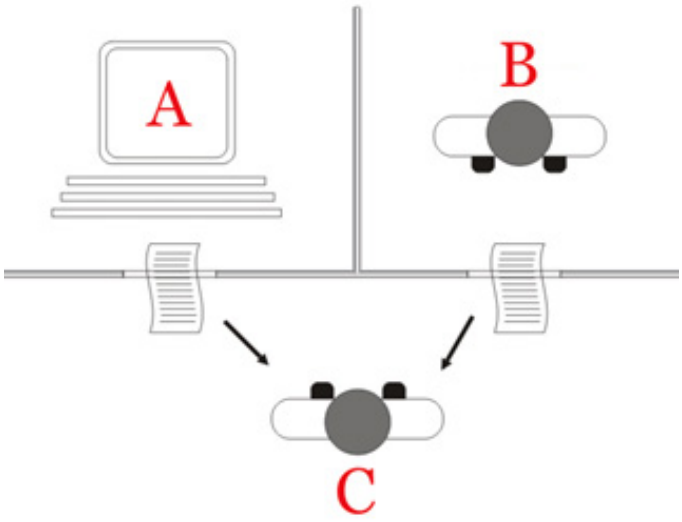


Figure 1. Turing Test [23]

IV. Consciousness

One of the most prominent questions that computer scientists have been debating for years is whether artificial intelligence is capable of experiencing consciousness. Philosophers like David Chalmers agree that there is not a widely accepted explanation for consciousness, but that there are two problems: the easy problems and the hard problem [10]. Some people believe that consciousness is when an individual has the ability to react to its surroundings. Unlike the hard problem, the easy problems can be explained using science. These problems involve behavior, reaction to environmental stimulation, and mental states [9]. Chalmers asserts that "trying to define conscious experience in terms of more primitive notions is fruitless", which he dubbed as the hard problem [10]. The hard problem is the problem of attempting to explain phenomenal experience [9]. We can experience sound, vision, smell, pain and

more,
but we do not know
how we are able to feel these experiences. Chalmers asserts that "an organism is conscious if there is something it is like to be that organism, and a mental state is conscious if there is something it is like to be in that state" [9]. Individuals understand that they have consciousness, because they can understand what it is like to have different experiences. Humans also understand that animals have consciousness, since they have experiences alike to our own, such as pain and sorrow [1]. However, it is not a common concurrence to not know if AI can actually feel pain, or if they have been programmed to imitate human emotions since AI can already mimic human speech. Still, some researchers think that if AI can resemble our own behaviors while going through a similar experience, then consciousness should be applied [1]. Chalmers writes that even if we solve the problems about experiences, the hard problem will still linger [10].

V. AI Should Not Be Granted Rights

The argument against AI being granted rights rests in the fact that humans are the ones to design, manufacture, own, and operate robots. We created robots as tools to extend our own abilities. We specified their intelligence which helps establish their goals and behaviors [15]. If we give rights to any element that seems to have a calculated presence, we could potentially waste resources that a human could need. Joanna Bryson, a professor of ethics and technology at Hertie School of Governance, argues that humanity will always own and have a necessity for robots. Furthermore, neglecting this truth would lead to an improper decision on assigning responsibilities and the mishandling of resources [15]. Bryson's viewpoint is that robots are servants that you own and thus should not have the moral status of a person [15]. Martin Heidegger [18] deemed "the current conception of technology, according to which it is a means and a human activity" the instrumental theory of technology. This theory is considered the most widely accepted view that is based on the commonsense idea that technology are tools that provide function to users [13].

If robots are tools to extend our own abilities, then they should not have the capability to feel pain and suffering. If they cannot experience pain, then they cannot understand what it feels like to suffer. Sparrow states that "it is generally agreed that a capacity to experience pleasure and pain provides a prima facia for moral concern. Unless machines can

said to suffer they cannot be appropriate objects for moral concern at all" [13]. We use robots in just about everything we do and sometimes it can go to the point of abuse. For example, if an employer makes their employees stay awake for more than 24 hours the employer would be considered to be abusive, yet it is not considered abuse if a person does not shut down their computer for more than 24 hours. Why would a designer program the computer to feel such treatment? There is no reason why we would program robots to feel suffering. Bryson believes that "owners should not have ethical obligations to robots that are their property beyond common sense and decency" [15].

Andreotta argues that devices like the Roomba or computers like Deep Blue do not have rights, so it would not justify giving rights to AI that can voluntarily communicate and move around [1]. A program that can simulate the human brain would not be able to generate consciousness, due to the fact that it only manipulates 1s and 0s, unlike the brain with a cortex [1]. Furthermore, mobile apps cannot feel suffering since they lack consciousness. They would not have a need to be given rights because they cannot have experiences [1]. There is no need for robots to be programmed to experience pain as a robot with emotion would not help its users complete their tasks faster or an increase in quality. The inability for AI such as mobile apps and robots to feel pain, exhibit consciousness, or have experience provides that basis for restricting rights from AI.

VI. AI Should Be Granted Rights

As we advance with technology, AI will soon become faster, have improved quality, and will be able to find ways to better collect information than humans. Philosophers believe that it might be best to err on the side of caution and provide rights of agency to anything that seems to have an intentional behavior [15].

With the consistent improvement of AI, AI may soon become hyperintelligent. As technological advancements continue, AI could become faster than humans at completing tasks within minutes; could work collectively to complete complex assignments; and solve seemingly unsolvable problems in physics and math that humans have failed to answer [1]. Another argument is that AI would need to have Artificial General Intelligence, AGI, meaning that AI would need to have intelligence that reaches, matches, or surpasses human intelligence, also referred to as superintelligence [1]. If AI could become super intelligent, AI could develop the capability to self-govern and easily pass the Turing test [1]. Gunkel states that AI need to show evidence of possessing capabilities such as intelligence, consciousness, free-

will, or autonomy in order to be considered to obtain rights [13].

If AI has the ability to be autonomous, then they would have the ability to be self-aware. They can express how they are being treated. AI can express preferences to not be turned off or that it is not being treated fairly, even if it has never experienced being turned off or discriminated against. Andreotta gives an example of rats that had their spinal cords split, making them unable to feel pain. The rats could still express experiencing pain, which supports the claim that complex behavior can still happen even without the presence of suffering [1]. The aim to grant rights to robots and AI is for them to be recognized because they could achieve a level of self-recognition and rise up to demand rights if they see that they are being treated differently [13]. Movements like the Civil Rights movement have shown that discriminated groups fought for equal rights and for their rights to be protected against groups who wanted to suppress them [1].

VII. Protection of AI Rights

There have not been any federal laws that would protect the rights or the regulation of AI. The White House has released a Blueprint of AI Rights, but the framework was primarily constructed with the intent to protect the rights and privacy of American citizens, as opposed to the rights of AI. However, one can argue that the White House's Blueprint is a step forward into a possibility of creating rights for AI, mainly against the abuse of AI systems.

VII.I AI Bill of Rights

The White House released the Blueprint for an AI Bill of Rights in 2022 setting principles to protect the American public from artificial intelligence [26]. The AI Bill of Rights framework includes five principles: safe and effective systems, algorithmic discrimination protections, data privacy, notice and explanation, human alternatives, consideration, and fallback.

The blueprints consider safe and effective systems as automated systems that are developed to include feedback from diverse communities, stakeholder, and subject matter experts to identify concerns and potential impacts of the system. These systems should not be designed with an intent to endanger the safety of its users. The systems should be designed to protect its users from harmful uses of the system.

Algorithmic discrimination protections are defined as a user should not be victimized by algorithms. This principle is to curve the impacts of discrimination based on race, medical conditions,

disability, religion, age, veteran status, sex, pregnancy/childbirth, gender identity that algorithms contribute to. Designers should take proactive measures to use data that is representative of all communities and to make systems more accessible for users with disabilities.

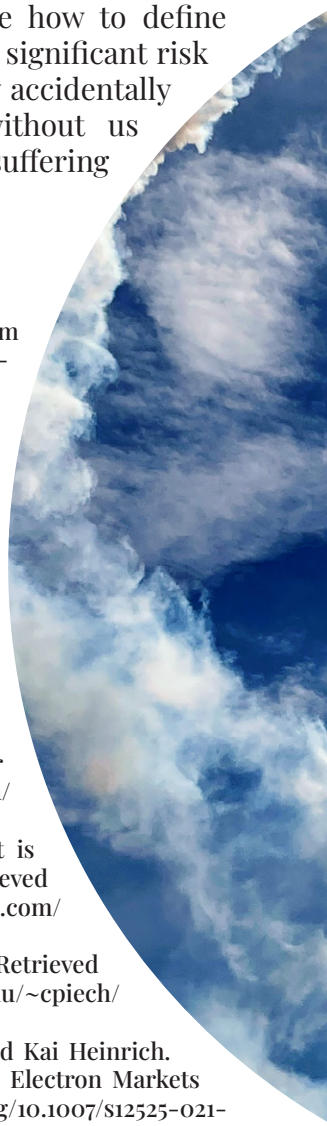
Data privacy is the protection from unnecessary data practices. Users should have the option to allow only data that is strictly necessary to be collected. Designers should not obfuscate user's choice to data collection but should send requests that are easy and understandable to read. Citizens should not be subjected to unchecked and continuous surveillance. Citizens should have access to data reports on themselves that provide potential impacts on rights, opportunities, and access.

Notice and explanation are the principles of telling users when an automated system is being used and why they are being used. Designers should provide an easy and understandable document that explains the system and give explanations on the outcomes that are chosen.

The human alternatives, consideration, and fallback principle is having the ability to opt out of automated systems for a human alternative. If appropriate, a user should be able to switch to a human alternative if an automated system fails. It also allows users to challenge the impacts of the system.

VIII. Conclusion

We have not yet reached the point where philosophers and researchers have established a precise definition of consciousness. As the hard problem of consciousness continues to be analyzed, it becomes difficult to determine if living things or robots are able to undergo experiences such as we do. We establish rights to those that can experience pain and suffering, therefore as long as debate persists regarding whether AI has the capacity to experience true pain and suffering, the notion of AI deserving or being underserving of rights will remain a controversy. Although AI has yet to reach the point of having consciousness, AI systems very well could in the near future. Further testing aside from the Turing test would help determine if AI became conscious and would consequently be deserving of rights and ethical treatment. Before AI is granted any rights, we would first need to determine how to define consciousness, due to the fact that significant risk rests in the possibility that we may accidentally create AI with consciousness without us realizing, causing a great deal of suffering in doing so.



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Virtual Reality for Medical Use

Palmetto Battery 2025 **Aaron Houston** Westminster, SC

Keywords—acute pain, computer-generated environment, chronic pain, partial-sight, virtual reality

I. INTRODUCTION

As a rising technology since the 1980s, virtual reality (VR) was created as a form of gaming. However, recent experiments have revealed the possibility of medical applications. Through VR, users immerse themselves in a computer-generated environment without close proximity to what they are viewing. This report identifies the current state of VR and its potential in the future, particularly regarding medical applications.

There are many different uses of VR in medicine. One such use is the management of pain. Several trial studies indicate that acute pain is most effectively treated, and chronic pain shows low but effective improvement. VR is used to enable partial-sighted people to improve their sight (i.e., near-sight being able to see further away and clearer). Additionally, it is applied to assist in rehabilitation, using immersion experiences as a means of allowing the user to "forget" that they are being tested. This improves the assesment due to the individual not being influenced by a stressful testing environment. The report recommends that further research be conducted to determine if lasting reductions in both acute and chronic pain are achievable, to what extent VR can improve or supplement eyesight, if a more effective rehabilitation program can be achieved with VR, and any other applications of VR in medicine.

Organized in four parts, Section 2. Recent Developments in Virtual Reality, summarizes VR development history, concluding with an overview of modern design features. Section 3. Research, discusses the methods used and specific results from these experiments. The concluding Section 4. Discussion identifies the possible future uses for VR in medical applications.

II. RECENT DEVELOPMENTS IN VIRTUAL REALITY

VR is classified as a "simulation in which computer graphics are used to create a realistic-looking world" [2]. This world responds to the input from user hand motion, along with voice commands. An essential aspect of VR is real-time interactivity which can detect user input and change the world instantaneously further submersing the user into a reality outside of the physical world.

According to Bailenson [4], VR is "experience," as with a virtual environment, the gap between a real and technological experience becomes one in the same. It surpasses movies, video games, etc., as it provides a visually enhanced experience with substantial similarly to the real world. VR provides the user with the ability to access experiences that would otherwise be unattainable.

Today, numerous companies are producing VR related products. A few of the largest companies in this field are known as Oculus, Microsoft, HTC Vive, and Unity. Within these organizations, one common trend is their technology is becoming inexpensive, powerful, and user-friendly. The Oculus Quest 2

is an example of this, as its starting price is $299, whereas its predecessor had a cost of $399. The HTC Vive wrist tracker has advanced the device to where there is no restriction on hand movement as well as providing accurate tracking.

NASA created the Virtual Environment Display System, Figure 1, in 1986 as a "display and control technology that can surround a person in an interactive computer-generated or computer-mediated virtual environment" [6]. The Virtual Environment Display System was created to serve NASA in its missions and goals. VR became popularized in the 80s by Jaron Lanier who developed the Data Glove, Eye Phone, Audio Sphere, and other devices.

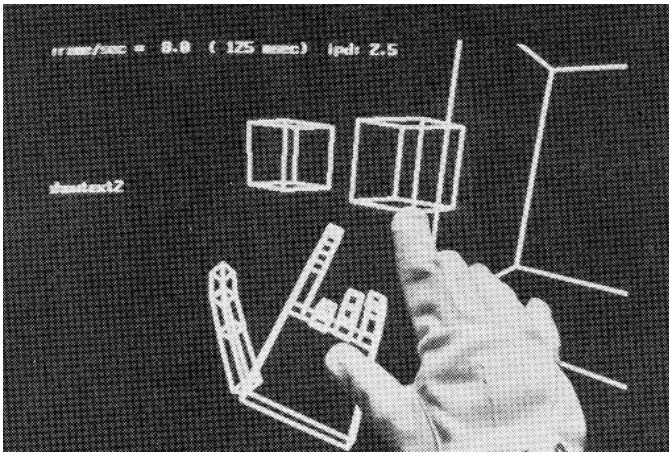


Fig. 1. Images depicting NASA's Virtual Environment Display System.

III. RECENT INNOVATIONS IN TECH

In a study conducted in 2016, aporoximately 30 participants, with a variety of chronic pain disorders, were recruited to determine the impact of a short VR experience [9]. The average age of the participants was 50 years old, with a range of 35-79 years [9]. The data for this research study was measured by the level of chronic pain immediately before and after the VR experience. The average rating for pain before the experience was 5.7/10, the average during the experience was 2.6/10, and the after-experience rating was 4.1/10. The study reported the result to be a 33 percent reduction in pain.

In a more recent study conducted in 2017, 30 more patients participated in a randomized clinical trial [10]. All of the participants of this study were individuals who were previously hospitalized following head and neck surgery. The data was measured in a similar manner as in the research study in 2016. 14 of the 30 patients were included in the VR group, and 15 were included in the control group. "After outlier removal, there were clinically meaningful reductions in post-intervention pain among patients in the VR group immediately after intervention (mean difference, 1.42; 95% CI, 2.15 to 0.70; d=1.50), at 1 hour (mean difference, 0.86; 95% CI, 1.90 to 0.14; d=0.67), 2 hours (mean difference, 1.07; 95% CI, 2.30 to 0.14; d=0.69), and 3 hours (mean difference, 1.36; 95% CI, 2.80 to 0.13; d=0.71) compared with patients in the control group" [10].

Aside from pain management, there are a plethora of other medical uses for VR. Many research studies have been conducted on the application of VR in enabling partially-sighted people to improve their sight. The app Relumino is one method used to combat the ailment of partial sight. The app is downloaded to a mobile phone, which would be connected to a Samsung Gear Virtual Reality device. The user of this device would wear the VR headset, which would use the rear camera of the mobile phone to depict a clear picture of the environment. This app is reported to "filter out glare and improve contrast, invert color schemes, for example, when reading print, assist in filling missing areas in user's

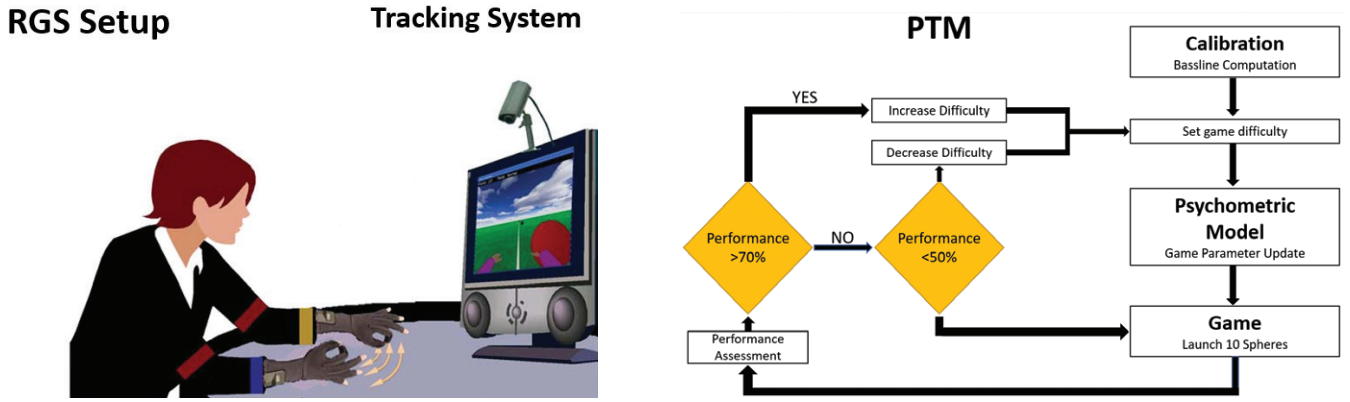


Fig. 2. [5] The Rehabilitation Gaming System is depicted above. Data gloves detect movement from the user and map them in real-time to the virtual arms on the display. The PTM (Personalized Training Module) measures the number of successful events completed by the user and adapts the difficulty for the next trial.

field of vision, and providing clarity through outlines of distant, obscured objects" [8].

Another use for VR is in rehabilitation. In a study conducted in 2011, 19 patients who had an acute stroke within 22 days were recruited to determine the effects of VR on rehabilitation. 10 of these patients used the RGS system (Figure 2).

While the RGS is not exactly VR, the use of virtual arms brings an important aspect of VR to the study. Five of the remaining nine patients were put in the control group IOT (Intense Occupational Therapy). The other four were put in the control group NSG (Non-Specific Games). The data for this experiment was measured by the rate of recovery during the rehabilitation procedure.

The patients assigned to the RGS group also gave a 5-point self-report to assess their satisfaction and acceptance of the treatment. "In terms of enjoyment, to the statement 'The task was entertaining', with the average rating being 4.5. To the statement 'The task was too long', the average rating was 1.2. In terms of clarity and difficulty in using the system, to the statement 'The task was easy to understand', the average rating was 4.9. To the statement 'It was difficult to control the virtual arms', the average rating was 2.1. Finally, as a measure of

Normalized Improvement at Time Points (Average % of Optimal Function)						
Variable	Week 5		Week 12		Follow-Up	
	RGS	Control	RGS	Control	RGS	Control
Barthel	87.6%	81.0%	94.9%	88.0%	96.3%	92.9%
Motricity	52.4%	51.4%	73.6%	60.2%	81.3%	66.3%
Fugl-Meyer	62.0%	55.6%	84.6%	66.9%	79.1%	72.0%
Arm	57.1%	52.9%	83.6%	62.3%	78.7%	64.6%
Wrist/Hand	63.0%	59.1%	85.0%	70.6%	85.7%	81.5%
CAHAI	72.7%	46.5%	90.2%	70.6%	89.6%	81.9%

Table. 1. [5] The percentages of improvement of each group as a whole through week 5, week 12, and a follow-up after rehabilitation had been completed. Each variable on the left side of the chart is an assessment of the improvement of the functioning and motor control in the arms and hands.

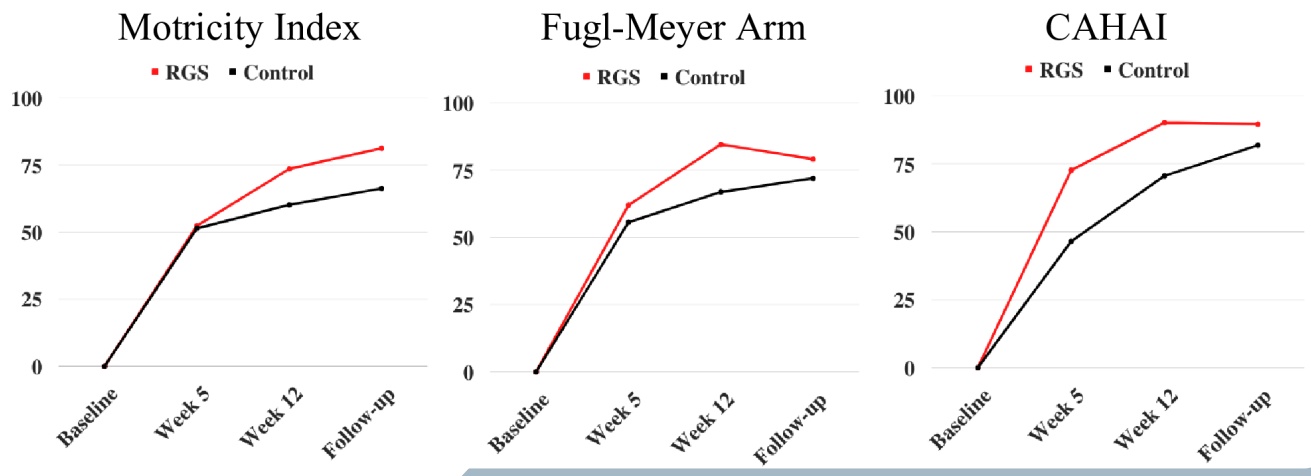


Fig. 3. [5] The charts depict the improvement percentage for three of the six tests.

overall satisfaction, to the statement 'I would like to continue this treatment', the average rating was 4.4" [5].

A more recent study that took place in 2021 supports the notion that VR can be used for rehabilitation. This study collected data from two healthy volunteers to determine if the system would be beneficial to use for stroke patients. With a similar setup as the RGS, the two volunteers wore a glove that tracked movement and displayed the VR on a monitor. The goal provided to both volunteers was to virtually pick up a ball and throw it at a tower of cans (Figure 4). The game tracked the amount of times a ball was picked up with the left and right hand individually, and a score that was a result of the number of cans knocked down.

The data was collected for 5 sessions of 3-minute play. The results of this study concluded that the VR game could be beneficial for patients seeking to achieve improved results in a shorter period, with another benefit being the capability of the game to be used remotely, so the patient would be able to stay home for rehabilitation.

IV. DISCUSSION

VR has seen implementation in a variety of aspects within medicine. Based on the results of the many experiments conducted, VR has been proven to be a useful resource for the medical field. For pain management, we observed that the use of VR

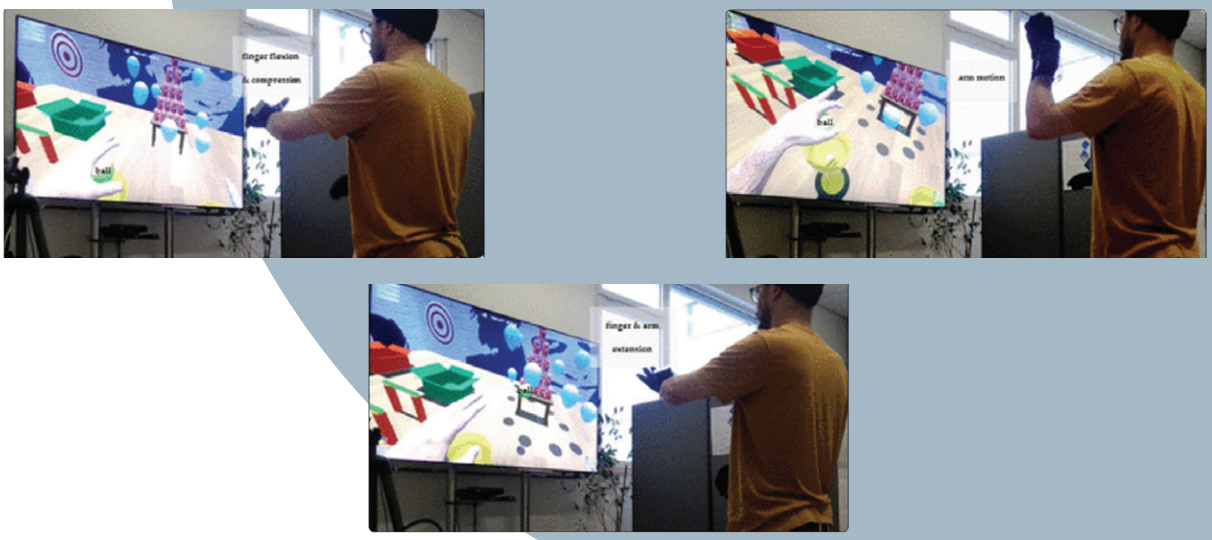
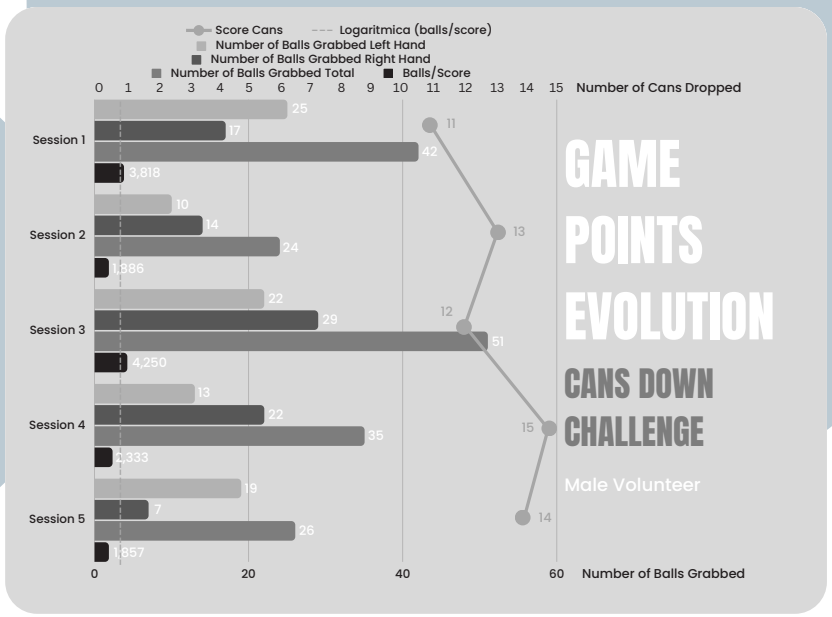


Fig.4. [7] Shows the steps of the game: (a) grab the tennis ball; (b) flex arm to prepare to throw; (c) throwing the ball at the cans.

technology led to a reduction in pain for the patients. Specifically, one of the studies reported a 33 percent reduction in pain. Furthermore, in regard to the possible rehabilitative applications of VR, the use of devices such as the Rehabilitation Gaming System presented a more rapid recovery over time as opposed to the typical methods. One study provided a way for the patient to undergo this method of rehabilitation remotely.

Virtual Reality is a technology that will continue to spread throughout the medical field, much of which has yet to be researched. This report recommends an improvement of the immersion aspect of virtual reality, which will help with pain management through distraction. An improvement on how data is collected through "data gloves" would improve the accuracy of virtual reality for rehabilitation. Further research must be conducted on human interaction with virtual reality to understand how it can be used in a more helpful way than just gaming. A more thorough study should be conducted with more participants and a wider range of ages and ailments. Even though most of the medical use in its current state is for rehabilitation and distraction from pain, it may one day be a way to help people with ailments or disabilities live life a little better.



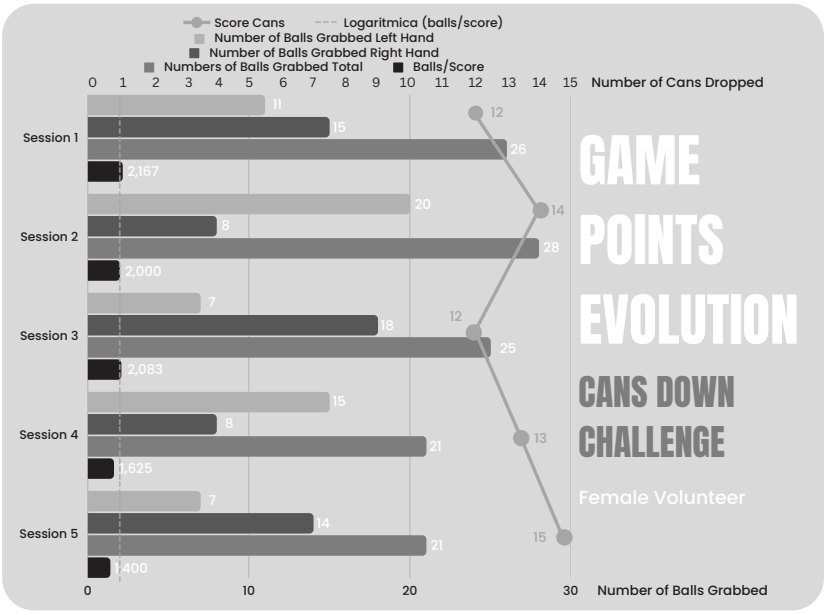


Fig. 5. [7] The results for each volunteer: (a) male volunteer and (b) female volunteer. The muscular capabilities of male volunteers are typically higher than female volunteers.

Claire Thomas

Cataleya & Salty Kisses

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The Kindergarten Theory

Charlie Company 2026 **Olivia Liquori** Williamstown, New Jersey

The standard vision of a military college embodies an institution with strict disciplinary standards, synchronized movements of military drill, and professional uniform appearance. However, what if these qualities were not the only contributing factors to establish The Citadel as an institute known for producing successful graduates? There is a distinctive characteristic that is present at The Citadel which can be inferred as a "kindergarten-like aspect." This characteristic is the reason behind why cadets thrive at the college; it is these qualities instilled in the students that are most identifiable post-graduation. The Citadel applies this idea during knob year, where freshmen cadets are exposed to upperclass cadets who educate them on the expectations and standards that all cadets are required to meet. The method of instilling the core values of honor, duty, and respect, dubbed as The Kindergarten Theory, utilizes elementary school teaching methods to create a challenging, yet motivating environment.

Knob year, a nine-month commitment where freshmen enhance their collaborative capacity and build resiliency, ultimately pushes these individuals past their own capabilities. The cadre, the upperclass students responsible for training, coach the freshmen to engage in the traditionally-rich, rigid system of expectations and discipline. These expectations include military protocols, such as proper uniform wear and practicing formal military courtesies, while supporting for the ultimate reason cadets attend- earning a college undergraduate degree at the end of the completed four years. The internal discipline that cadets acquire from their duration at The Citadel broadens their individual abilities in multiple capacities, and it can be attributed to the unique practices this system employs.

Elementary school teachers use methods of group contingencies and shared rewards to achieve desired behaviors. Similar tactics are visible in The Citadel's knob year. Many researchers have used a variety of methods to remediate problematic behaviors in elementary schools by increasing academically-engaged behaviors. One approach that is often used is the school-wide positive behavior support (SWPBS). This method communicates rules clearly and positively through contingency systems, such as providing models of acceptable behavior and incentives for following set standards (Parker, 818). This idea is furthered using group contingencies, where the entire student group shares a reward or a consequence. This method has been shown to successfully decrease disruptive behaviors and increase student engagement (Wills, 437-438). Similar to SWPBS, The Citadel follows established rules of discipline and incentives that are applied to all students and faculty. There are group contingencies to enforce these rules, particularly when it comes to the freshmen training and disciplinary system. Freshmen experience group discipline when conducting certain military activities with their classmates. When performed incorrectly, upperclass remediate these actions through group punishment.

In addition to group punishment, freshmen experience group rewards as well. An example of a reward incentive is the Regimental Commander's Cup. This award is earned by the company with

the all-around best freshmen performance for their achievements during cadre period. Other minor incentives include the end of cadre period, where freshmen are allotted more freedom in their schedule with the availability to choose their meal times. Additionally, all cadets are able to earn more time away from campus for excelling academically, physically, or in their military proficiency.

Although these rewards are inviting, they are not the sole motivation that ensures freshmen complete their knob year. One idea that explains this phenomenon is known as the "Mystery Motivator," which is a contingency agreement that creates an environment promoting consistent feedback and consequences as a result of student performance (Kowalewicz 150). In the elementary setting, this motivator uses tally counters to display immediate feedback that can be positive or negative, making students aware of the expected behavior (Kowalewicz 150). An example is using tickets to trade in exchange for prizes of good behavior. Conversely, bad behavior is met with losing recess time for the number of tallies received.

The Citadel uses this system with written and verbal consequences that could affect one's experience as a cadet. One of the most important standards that cadets adhere to is the Citadel Training Model (CTM). The CTM establishes five steps that leaders must exert in order to have successful impacts on their trainees: expectations, skills, feedback, consequences, and growth. The manual explains that these steps should follow a method of positive reinforcement and guidance from the upperclass cadre. These upperclassmen are expected to give freshmen "every possible chance" to do a task correctly and to "add action to the words provided during feedback" (The Citadel Training Manual 1).

Consequently, freshmen are required to be "easy to lead" and "active participants in the learning process" (The Citadel Training Manual 13-14). This two-role system ensures that both parties are gaining from the experience, either as leaders or followers. The system is similar to how teachers and students interact, especially at the elementary level. This model also allows for cadets to adopt a self-monitoring system, which is also seen in elementary classrooms. One study used a device named the MotivAider, allowing students to track their own behavior in relation to completing schoolwork (Table 1). Not only did students' abilities to focus increase without the need for tangible rewards, but the behavior instituted self-motivation in the students after using the device for positive change (Amato-Zach, 218). Freshmen at The Citadel contain their own "MotivAider" that develops post cadre period. Due to their routine-oriented mode of accomplishing tasks,

Classroom	Target Behavior	Replacement Behavior
A, B, and D	Calling out and talking	Raising hand, no talking, and only answer in unison when cued
C	Sitting inappropriately and calling out	Sit cross-legged, hands to yourself, and raising hand
E	Off-task during calendar, calling out, and talking	Eyes on teacher or speaker during calendar, raising hand, no talking, and only answer in unison when cued
F	Desk open during instruction, getting out of seat, materials unprepared, and talking during instruction	Desk closed during instruction, stay seated, materials ready, and when teacher speaks, stay quiet and only talk while proofreading
G	Getting out of seat and off-task during reading/independent work	Stay seated, eyes on book during reading, and eyes on assignment during independent work
H	Calling out, talking, and getting out of seat	Raising hand, no talking, only answer in unison when cued, and stay seated

Table 1. Kowalewicz and Coffee identified disruptive behaviors per classroom in their study, assessing teachers' satisfaction with the intervention method. This table assesses the positive behaviors that were reinforced through the Mystery MotivAider (143-145).

Steele Judy
Battle of the Tar Heels

their cadet behaviors are transferable to academics. The predetermined standard the upperclassmen hold the freshmen to is applicable to numerous aspects of their livelihood. It requires them to ensure their output is successful in academics, physical fitness, and other areas. Specifically, freshmen contain this mindset after their first year, ensuring the CTM remains evident as a prominent model.

Despite its challenging nature, The Citadel develops leaders that are successful in the post-academic world. The majority of cadets choose to attend military institutions to improve their career-oriented conditions or strengthen their grit. Grit is the "perseverance and passion for long term goals," and it represents an individuals usage of their potential success. (Whipple, 333). Student performance is enhanced overall because cadets participate in strenuous activity that align with their goals and values. This predictor, called the person-environment (P-E) fit, impacts student satisfaction and academic achievement as well as social and academic involvement (Whipple, 333). For instance, Whipple and Dimitrova-Grajzl, from the Virginia Military Institute, analyzed cadet motivations to attend the college. They found that those commissioning into the military made the decision to attend due to the similarity with their future goals (Whipple, 346). By challenging oneself to endure hardship, cadets are better equipped for challenges in the perceivable future. Grit pushes an individual to pursue the ultimate goals of a given aim, and it serves as a drive to complete tasks without the need for constant positive reinforcement (Duckworth, 1089).

At The Citadel, freshmen receive copious feedback, both positive and negative. A few studies conducted with freshman retention at the United States Military Academy showed that grit was a more influential predictor of those that remained at the institution than self-control (Duckworth, 1098). For all military institutions, grit is essential for cadets to adapt to a specific culture that will provide them with opportunities for success. However, cadets learn

to value both positive and negative feedback, using negative feedback as a learning opportunity.

The application of the Kindergarten Theory is one that should continue to be studied and utilized in institutions that are looking to expand upon their subordinates' successes and goals. This challenge-motivated environment promotes transferable qualities, and it encourages unity among peer groups. Individuals benefit from military institutions, because they adopt self-motivating techniques to hold themselves accountable for their own performance as well as their peers. Attending an institution, such as The Citadel, enforces cadets to focus on their goals before their individual desires. When one decides to take on the physical and mental trial that is known as The Citadel, they become a member of a team of resilient and determined individuals. The caliber of graduates produced serves to showcase the effective nature of qualities within the Kindergarten Theory.

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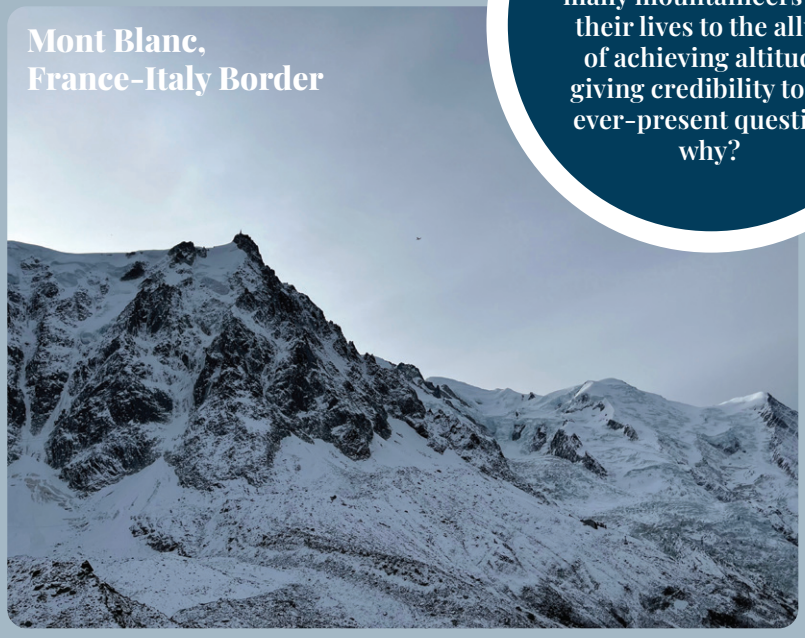
Chamonix, France

The Mountains of Southern Europe

For centuries, many have wondered what possesses mountaineers to risk their lives in pursuit of summiting a peak. Is it recognition, personal achievement, hysteria, or simply the search for a better view?



Mont Blanc,
France-Italy Border

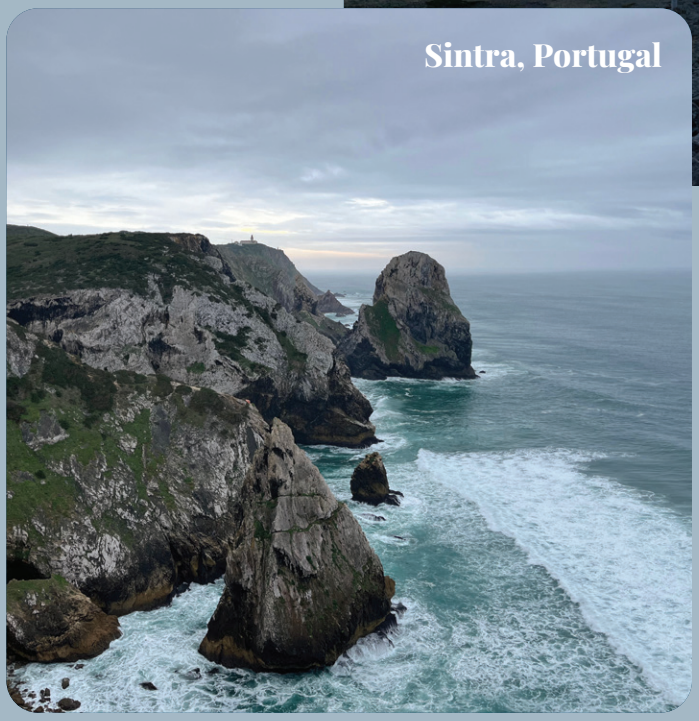
Despite modern equipment and extensive knowledge, each year many mountaineers lose their lives to the allure of achieving altitude, giving credibility to the ever-present question: why?

Interlaken, Switzerland

These photos depict an answer of magnetism by showcasing the pure beauty of the mountains of southern Europe.

From Mont Blanc in Northern Italy to the rocky shores of Sintra, Portugal, this collection includes photographs from eight peaks in five countries.

Mount Penalara, Spain



Sintra, Portugal

The mountains were formed long before mankind moved to Europe forcing the newly developed communities in the Sierra Nevadas and European Alps to grow and adapt to harsh mountain life, even coming to admire its charm. The beauty of these villages are instilled within me as well as the many mountaineers before me. It is a beauty which I was able to capture on brief stops along hiking trails and cornerstones of towns. While many still cannot fully grasp the incredible risks mountaineers take, it is of the utmost importance to appreciate and understand the beautiful temptation offered only by the summits.

Granada, Spain

Wilhelm Birkholz
Alpha Company 2023
Elkhart Lake, WI

National Intelligence Estimate

Threats Posed by the Submarine Fleet of the Russian Navy

Mike Company 2023 **Thomas Chapman** Florence, SC

SCOPE NOTE

This intelligence assessment provides an overview of the capabilities of the Russian Navy's submarine fleet and the potential threats posed by Russian submarines in the future. Given the limited availability of closed or classified sources, the information derived in this estimate is taken through open-source intelligence gathering to include media sites, think tanks, and defense organizations. These sources have been compiled to best understand the current and future capabilities of the Russian Navy's submarine fleet and potential threats to US and allied assets.

BOTTOM LINE-UP FRONT

While the US outpaces the Russian Navy in the scale and capabilities of their submarines, the Russian Navy's submarine modernization initiative places the Russian Navy on track to become a near-peer adversary to the US. Specifically, the "Yasen-Class" submarine is on-par with US Fast Attack Submarines due to its stealth abilities and is the "flagship" submarine of the Russian Navy's modernization initiative. As they are greater utilized in coming years, the "Yasen-Class" submarine poses a significant threat to US and allied naval assets.

KEY JUDGEMENTS

The Russian Navy's size (58 subs) presents a significant challenge to US Naval authority. Russian submarines vary in size and capability, with many being deadly. The current size and capabilities of the Russian Navy present a very real comparable threat to the United States. The ability of the Russian Navy to project power , and subsequently that of its submarine fleet, allow it the ability to strike US forces around the globe, including the US homeland.

Currently, the Russian Navy possesses 11 nuclear-capable submarines, spread throughout the Russian Navy's North, Black, Baltic, and Pacific fleets. The positioning of these nuclear-capable submarines throughout the globe allows the Russians a key strategic capability. The nuclear-capable submarines present a very real threat to the US homeland, global positions, and key naval allies such as Britain, France, and Australia.

The Russian Navy's submarine modernization program introduces several new classes of submarines, such as the Yasen-class, Borei-class, Belgorod-Class, Khabarovsk-Class, Lada-Class, and Improved Kilo-Class submarines. These submarines are increasingly growing in their capabilities, notably in the quality of stealth and weapons technology. These rapidly advancing technologies allow the Russian Navy an edge over American submarine capabilities and the overall strength of the US Navy. While the US has consistently increased its own capabilities, the Russian Navy is designing its weapons for combat against American ships, including submarines.

Most notable of Russia's modernized naval fleet is the Yasen-Class submarine, which features stealth technology on par with US Fast Attack Submarines. The Russian Navy is rapidly improving

the Yasen-Class submarine and is producing them to replace current aging Soviet-era submarines. The introduction of more Yasen-Class submarines presents a very real challenge to US Naval authority in both the Northern Atlantic and Pacific oceans.

DISCUSSION

CURRENT SIZE OF THE RUSSIAN SUBMARINE FLEET

The Russian Navy is a historic navy, maintaining over three centuries of an "instrumental (role) in securing Russia's maritime access to the world..."[1] Spanning Imperial, Soviet, and now Federated governments, for most of its history "the Russian Navy (has been) an advanced, globally capable force..."[2] The global presence of which the Russian Navy is capable has been attained through the use of its submarine fleet. Today, the Russian Navy boasts 300 ships, however, most of "the Soviet Navy's submarines, surface ships, and auxiliaries had long outlived their usefulness but were retained to maintain impressive numbers."[3]

Michæla Martin
Parthenon Matte

The presence posed by the Russian Navy is not just that of a "paper tiger," as one might assume from the performance of Russian ground forces in Ukraine. Currently, the Russian Navy is undergoing a significant modernization program in which "the (Russian) Navy should receive eight nuclear-powered strategic submarines, 16 multirole submarines and 54 warships of various classes."[4] These new vessels will replace aged former-Soviet vestiges within the Russian Navy.

The Russian Navy has worked hard to strategically place its submarine fleet around the globe in areas that are vital to protecting Russian national interests, such as the Northern Sea, Atlantic Ocean, and the Pacific Ocean. The Russian Navy has sought well to balance the capabilities of its blue-water navy around the globe, including the availabilities of its submarines. The Russians have done this in order to "seek to gain prosperity, security, and influence from maritime commercial enterprise (through) a navy with global reach."[5]

CAPABILITIES OF THE RUSSIAN SUBMARINE FLEET

While the Russian Navy is extremely proud of its size, the capabilities of the Russian Navy are the deciding factor in the true lethality posed by the Russian Navy towards the US and its allies. Of the many submarines currently in the Russian Navy's possession, the "four ballistic missile submarines of the Borei class... (and) ...seven Delta III/IV submarines carrying Sineva missiles..."[6] These submarines operate throughout Russia's naval bases, to include the North, Black, Baltic, and Pacific fleets. The Borei-Class and Delta III/IV-Class submarines pose a genuine strategic threat to all American assets and allies due to their nuclear nature.

Despite the significant strategic threat, the capabilities of Russian Navy's submarines pose real

operational and tactical threats as well. The Oscar II-Class, Akula I, II, and II-Class, Victor III-Class, and Sierra I, II-Class submarines serve to "destroy U.S. Navy aircraft carriers with swarms of large, powerful cruise missiles."[7] Of these submarines, "Russia has both nuclear-powered and diesel electric-powered attack submarines."[8] Additionally, "Russia has 21 Kilo-class submarines and one Lada-class submarine...meant to operate closer to home...," and "a comparatively large fleet of special mission submarines."[9-10] These special mission submarines are designed for deep-ocean exploration and engineering work, utilizing "two enormous 'motherships'... for ferrying deep diving midget submarines."[11]

Overall, most of the submarines examined "date back to the Soviet Navy and the Cold War..."[12] Despite this, the Russian Navy has commissioned many new classes of submarines after the fall of the Soviet Union. Of these are, "The Lada class was built to replace the Kilos and...recently Russia has commissioned a pair of Yasen-class submarines, cruise missile submarines that could eventually replace the aging Oscar boats."[3] The Borei-Class, those capable of strategic nuclear strikes, is a new development following the fall of the USSR. The development of new ships, specifically submarines, to replace old Soviet ships is a significant initiative of the Russian Navy.

THE RUSSIAN NAVY'S MODERNIZATION PROGRAM

Following the fall of the Soviet Union, the Russian Federation adopted many of the ships within the Soviet fleet. The majority of these ships were already outdated in 1991, however "in the 2000s, the Russian government reincorporated the former Soviet naval industry as the state-owned United Shipbuilding Corporation (USC)."[14] Now, "Russia's submarine industry involves an expansive network of research, design, and production centers, which increasingly focused on export markets to stay afloat after the collapse of the Soviet Union."[15] With the groundwork laid, "Russia has embarked on multiple extensive projects to improve its submarine fleet."[16] following the collapse of the Soviet Union.

Grace Cooper
Antibes 2
&
Antibes 4

Most notable of these extensive projects was launched in the early 1990s, when "Russia began construction on a Yasen-class submarine, the Severodvisnk (K-885)," ushering in the new age of Russian submarines. The Yasen-Class was followed by the Borei-class (NATO: Dolgorukiy), which are "set to replace the aging Typhoon-class, Kalmar-class (NATO: Delta III), and Delfin-class (NATO: Delta IV) submarines."[17-18] In addition to the Yasen-Class and Borei-Class submarines, the Russian Navy has announced the creation of the Belgorod-Class, Khabarovsk-Class, Lada-Class, and Improved Kilo-Class submarines. In all, Russia is working to build six new classes of submarine, each with a unique purpose. This is comparable with the two classes of submarines currently being developed by the US Navy.

The new submarines developed under the Russian Navy's modernization program are equipped with a wide array of unique weapons and capabilities.

The Borei-Class submarine is equipped with 16 Bulva Intercontinental Ballistic Missiles (ICBMs), six such submarines are being developed. The Belgorod-Class and Khabarovsk-Class both serve as massive strategic submarines which are equipped with the new Poseidon (NATO: Kanyon) strategic torpedo, "a 100-megaton nuclear warhead designed to create radioactive tsunamis."[19] The Yasen-Class and Improved Kilo-Class submarines are each equipped with the latest stealth technologies, "armed with three types of cruise missiles which can be loaded in combinations," the Kalibr, Onkis, and Zircon. These ships pose the greatest threat to US naval supremacy.[20]

THREATS POSED BY THE YASEN-CLASS SUBMARINE

The Yasen-Class is the premier flag-ship of the Russian Navy's modernization program. The development of the Yasen-Class submarine began in 1993 under Russia's initial submarine improvement plan. The first Yasen-class submarine, the Severodvisnk (K-885), was commissioned in 2014, initiating the modernization process of Russia's submarine fleet. An improved Yasen M-Class was launched in 2017, named the Kazan, and entered service in February of 2021. Currently, "A total of five Yasen M-class SSNs are in various stages of construction," and are expected to enter into service in the coming years.[21]

The Kazan represents the new era of Russian submarine warfare, being "built with low magnetic steel to reduce its magnetic signature." [22] This unique construction allows for greater capabilities. Of these new capabilities, "The improved Yasen M-class SSN is reportedly quieter than the lead Yasen-class boat," furthering the already prominent reputation of stealthiness held by the Yasen-Class.[23] Additionally, the Yasen M-Class is "fitted with eight vertical CM-346 complex (3P-14B) silos for submarine-launched cruise missiles..."[24] The missile capabilities of the Yasen M-Class are significant, with "10 torpedo tubes for firing the 3M-54 Kalibr supersonic cruise missile, the P-800 Onik over-the-horizon supersonic anti-ship missile, and an improved variant of the 533-millimeter Fizik-1 homing torpedo."[25] The stealth capabilities and payload available to the Yasen M-Class submarine make it into a formidable enemy.

IMPLICATIONS FOR U.S. SECURITY INTERESTS

The size of the Russian Navy's submarine fleet (58 submarines) makes for a deadly underwater adversary. Of this fleet are 11 ballistic missile submarines (SSBNs), 17 nuclear-powered attack submarines (SSNs), 9 nuclear-powered cruise missile submarines (SSGNs), and 21 diesel-electric attack submarines (SSKs). These submarines are spread

Claire Thomas

Uspenski Cathedral, Old Town, & Through

throughout the Russian Navy's bases in the North, Black, Baltic, and Pacific seas. The positioning of these bases places Russian submarines in direct proximity to US naval assets, including the US western seaboard and Alaska.

The Russian Navy currently operates 11 nuclear capable submarines (SSBNs). These submarines are strategic in nature and are capable of hitting anywhere on the globe, including the US and it's global assets. These submarines, known as "boomers", also give the Russian Navy a second-strike capability, causing serious consideration to US nuclear policy. Additionally, Russia's submarine fleet is designed with the US Navy in mind, building the Oscar II-Class, Akula I, II, and II-Class, Victor III-Class, and Sierra I, II-Class submarines "to destroy U.S. Navy aircraft carriers with swarms of large, powerful cruise missiles."[26] However, many of these submarines are old, and outdated remnants of the Soviet Navy, easily outmatched by the US Navy.

As the Russian Navy continues to modernize its submarine fleet, phasing out many of the old Soviet-Era submarines, the Navy will produce many new classes of highly advanced submarines. Currently, the Russian Navy is developing six new classes of submarine through it's modernization program, the Belgorod-Class, Khabarovsk-Class, Lada-Class, and Improved Kilo-Class, Borei-Class, and the Yasen-Class. The advancements made by the Russian Navy are vast compared to the two current class of submarine being developed by the US Navy.

The development of the Yasen-Class submarine served as the crowning achievement of the Russian Navy's modernization program. In competition with US and allied submarine capabilities, the Russian Navy will further develop Yasen-Class submarines, improving the stealth capabilities of the Yasen-Class. While "The Yasen M-class SSN is purportedly not equal to the United States Navy's new Virginia-class attack subs," the Yasen-Class is comparable with the Seawolf-Class (SSN).[27]

While the US outpaces the Russian Navy in the scale and capabilities of their submarines, the Russian Navy's submarine modernization initiative places the Russian Navy on track to become a near-peer adversary to the US. Specifically, the "Yasen-Class" submarine is on-par with current US Fast Attack Submarines due to its stealth abilities making it the "flagship" submarine of the Russian Navy's modernization initiative. As they are greater utilized

in coming years, the "Yasen-Class" submarine poses a significant threat to US and allied naval assets.

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Husbandry in Heaven: Malice in Macbeth

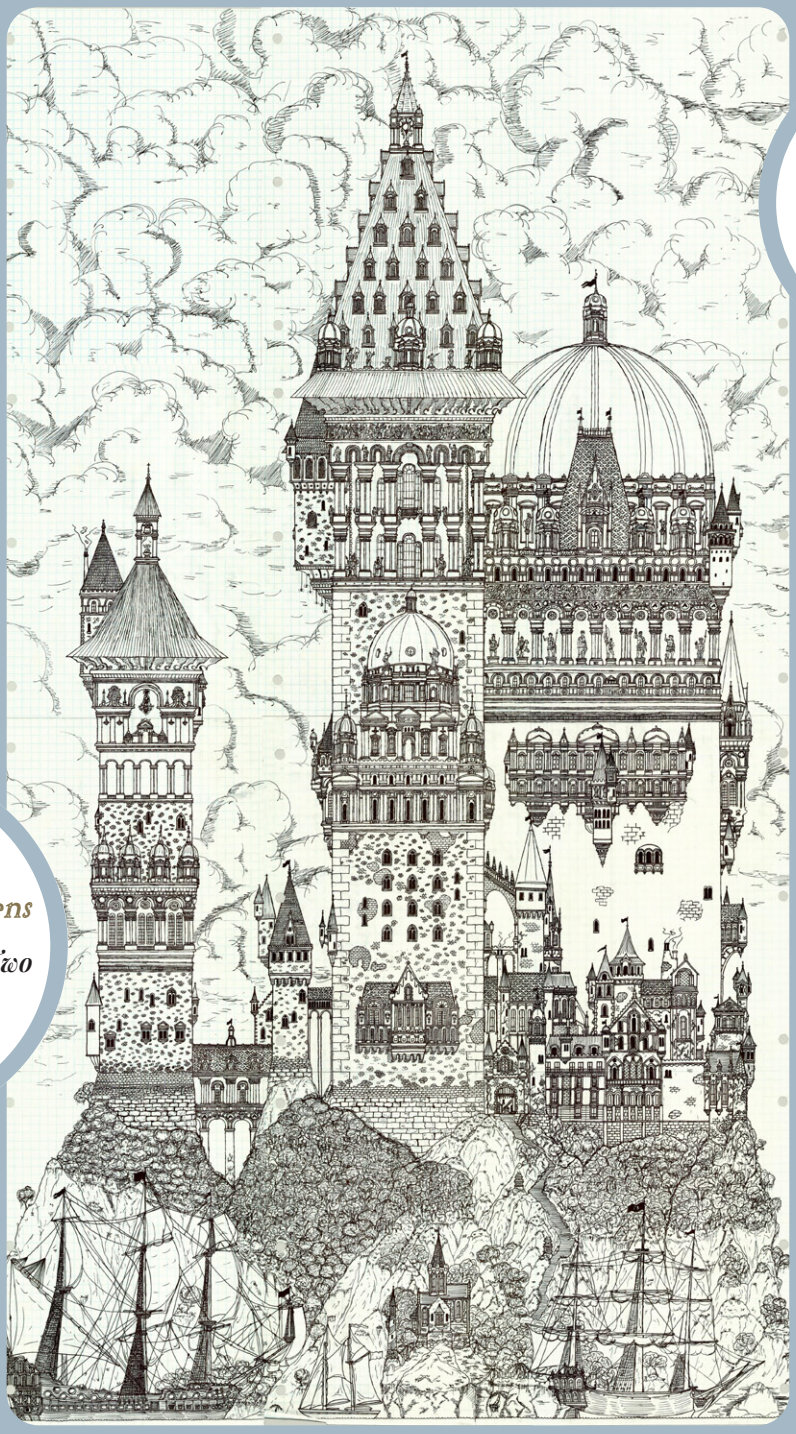
Tango Company 2026 **Alathea Morse** Fayetteville, NC

The *New York Times* best-selling author Bernard Cornwell said, "Men inspired by prophecy will attempt any foolishness in the knowledge that the fates have obtained their victory" (95). Shakespeare's *Macbeth* tells the tale of a medieval Scottish general who hears a prophecy that predicts his accession to the throne. He grapples with the decision of whether to allow the prophecy to take place on its own or to take matters into his own hands and dissolve the current king's court himself. When Macbeth chooses the latter, a pool of betrayal and blood, Shakespeare effectively utilizes allusions of popular Biblical stories to portray the vileness of the act. For Macbeth, evil is an unrelenting force that originates when the desire for power leads to a choice that ultimately festers in a guilty conscience and cannot be physically washed away without repentance. These allusions reveal Shakespeare rooting his play in biblical stories to support the play's claims about evil with The Bible's presentation of gruesome, wicked sin.

In the first and second acts, the play references Judas' betrayal of Jesus in Matthew 26:14-15. Shakespeare's interpretation of this story demonstrates that evil is an intentional decision rather than an impartial actor acting at fate's behest: the plot to murder King Duncan shows that Macbeth, while influenced by the evil around him, chose to enact the crime of his own free will. The facade Lady Macbeth dons as she states, "All our service, / In every point twice done, and then done double," and "…to make audit at your highness' pleasure," is to deceive the king into believing he is completely safe in her hands (Macbeth, 1.6.14-15; 27). Her mask alludes to Judas' mask while dining with Jesus at Passover after Jesus announces his future betrayal: "…and they were very sorrowful and began to say to him one after another, 'Is it I, Lord?'" (Matthew 26:22, ESV). Judas pretends he is not the betrayer, even when Jesus discovers him shortly after. Lady Macbeth replicates this tactic while she hosts her victim in her own home, pretending to be the king's loyal servant while plotting his murder. While The Bible does not provide insight into Judas' mind while he carries out his betrayal, his reaction to Jesus' gruesome death is a consequence of his guilty conscience. After throwing the pieces of silver traded for his rabbi's murder, the betrayer "… went and hanged himself" (Matthew 27:5). Judas' guilt results in the eternal sleep of death which the play alludes to once Macbeth commits his crime. Macbeth believes one of the men accompanying King Duncan cries, "Sleep no more to all the house: / Glamis has murdered sleep, and therefore Cawdor / Shall sleep no more" (Macbeth, 2.2.43-44). Macbeth hallucinates this event while he grieves over his guilt, noting that sleep is the essence of life itself. In believing that he can no longer sleep, the logical solution to Macbeth's dilemma is to enact upon himself eternal sleep—death. However, Lady Macbeth convinces Macbeth that he can be clean of his deed with a small amount of water, and he faithfully obeys her. Although The Bible states that Satan possessed Judas so that he may figure out "…how he might betray him to them," Macbeth has no such excuse (Luke 22:4). Lady Macbeth called upon herself the dark forces, but Macbeth acted upon his actions alone with no assistance from

Satan. Altogether, the story of Judas contrasts with Macbeth to show that the murder of King Duncan is an act under Macbeth's complete control.

Upon killing Duncan, Macbeth is immediately crowned as the new king, shifting from inferring Judas to King Saul. The play utilizes this allusion to portray evil as a pervasive presence that persists in a guilty conscience. After Saul discovers David is to be the true heir to the throne, he immediately determines to kill him. Saul sends men to hunt David down multiple times, saying to them, "know and see the place where his foot is, and who has seen him there... see therefore and take note of all the lurking places where he hides" (1 Samuel 23:22b-23a). Similarly, Macbeth fears Banquo's children due to the witches' prophecy in which they spoke of Banquo's offspring becoming kings— not Macbeth's. Not only does he fear Banquo for his bloodline, but he knows Banquo suspects him of the murder of Duncan. His revelation persists and festers into paranoia. Macbeth speaks with assassins hired to kill Banquo, "...your assistance do make love / Masking the business from the common eye..." to rid all blame and the possibility of his bloodline continuing in one fell swoop (Macbeth, 3.1.126-127). As King Saul determines to kill David, the prophesied heir to his throne, King Macbeth desires to kill Banquo and his son. As Macbeth and Banquo model King Saul and David, Macduff and Malcolm do also. As the rightful heir to King Duncan's throne, Malcolm begins to test Macduff's loyalty by declaring himself as lustful, greedy, and owning none of the traits of a good king. Macduff does not raise his sword against Malcolm, instead replying, "fare thee well! / These evils thou repeat'st upon thyself / Hath banished me from Scotland. O my breast, / Thy hope ends here" (Macbeth 4.3.110-113). Their interaction alludes to David having multiple instances to slay King Saul, but he refuses due to "being God's anointed." When David



Osbourne Owens

The Omphalos of the Two European Eagles

learned of a man who killed King Saul, he "called one of the young men and said, 'Go, execute him.' And he struck him down so that he died" (2 Samuel 1:15).

While Macbeth wrestles with his conscience, Lady Macbeth endures her suppressed guilt. Lady Macbeth's motivation for killing King Duncan is to gain the royal family's position. She weighs her husband remaining the Thane of Cawdor against Macbeth becoming King of Scotland with murder under his belt; upon hearing that Macbeth is to be king according to a prophecy, she proclaims her choice: "Glamis thou art, and Cawdor, and shalt be / What thou art promised. Yet I do fear thy nature, / It is too full o'th' milk of human kindness" (Macbeth, 1.5.15–17). Similarly, while Jesus stands trial, Pilate weighs convicting the innocent Jesus and staying in power against releasing him, resulting in riots and potentially losing his position as governor and letting the district spiral out of control. This is not the only allusion Lady Macbeth has to Pontius Pilate, for in

Sarah Norton

Seattle Skyline

the second act, Lady Macbeth tells her husband to "go get some water, / And wash this filthy witness from your hand" (Macbeth 2.2.47-48). However, as the play continues, the Lady's conscience is impeded by immense guilt, which results in her sleepwalking, ultimately illustrating that washing her hands could not rid her of her guilt. Similarly, Pilate wrestles between retaining his power by killing innocent Jesus and risking disrupting the peace. Upon convicting Christ to death, Pilate washes his hands and states, "I am innocent of this man's blood" (Matthew 27:24). Both Lady Macbeth and Pilate believe that physically washing their hands can clear themselves of their respective deeds. Ultimately, Pilate and Lady Macbeth choose power over the morally correct alternative while trying to wash their hands all the same.

Overall, the allusions to Judas, King Saul, and Pilate demonstrate that evil is omnipresent, inseparable from human nature, and tangled in human affairs. This analysis only mentions three possible allusions, but exploring the play further will undoubtedly reveal numerous more references to The Bible. Macbeth continues to expose evil for what it is— vile, crass, and capable of corruption. In Shakespeare's vision, even heaven, although holy, cannot avoid evil's overpowering presence. As Banquo says, looking up to a darkening sky, "There's husbandry in heaven; their candles are all out" (Macbeth 2.1.4-5).

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Religion's Effect on Party and Economic Affiliation

Victor Company 2023 **Stephanie Parris** Pickens, SC

In *The Rise of Southern Republicans*, Merle and Earl Black acknowledge the effect that southern, conservative, Christians had on American Politics in the Presidential Era of Ronald Regan. However, Black and Black do not adequately address the complexities that make up the vast sect of religion in politics.

While Black and Black focused on the general political affiliation of Christians, especially conservative Christians, and the southern Evangelical Christians opposition to progressive economic policy, many authors such as Brian Starks and Robert Robinson acknowledge the difference that varying religions and religious beliefs have on politics and attitudes towards economics. They make a distinction between what they refer to as moral cosmologies or religious worldviews and the role that subcultural identities have in influencing economic beliefs. In this case, the subcultural identities are religious sect identification (Black and Black 2004, Starks and Robinson 2009). The fact that Starks and Robinson acknowledge the distinction between these categories and subcategories of identifying traits is important due to the effect the varying traits, specifically traits related to religious subcategories, had on the results of the data used. From this data, the question can be answered: What extent does religion play in the development of individuals' party alignment and their beliefs on economic policy?

In 2005, a team of researchers from Baylor University's Institute for Studies of Religion gained funding from the John Templeton Foundation and the National Science Foundation in order to conduct two national surveys on the religious beliefs, values, and behaviors of Americans. Upon the formation of a partnership between the Gallup organization and Baylor University, the first round of surveys was completed in the Fall of 2005 as well as subsequent surveys completed. (Baylor University Religion Survey, 2021). Baylor University's series of surveys on religion is thought to be the "most extensive and sensitive study of religion ever conducted into American religious attitudes, behaviors and beliefs" (Goodrich, 2017). These surveys conducted by Baylor University vastly expanded knowledge on how religion affects Americans' values and beliefs. While it was once thought many Americans completely based their beliefs about politics and economics based on religious teachings, the Baylor Religion Survey has shown and continues to show the true effect religion has on American Political attitudes.

Upon examining data from Baylor University's second wave of the Religion Survey, we can further look into the extent various religious views affect attitudes of individuals within the sects. The affected attitudes include, but are not limited to, attitudes towards distributive policy, redistributive policy, and attitudes regarding personal social responsibility (Froese and Thompson, 2018). While results are never completely conclusive, there does seem to be some degree of correlation between individuals identifying as religious, individuals identifying with negative feelings towards distributive policy, and individuals with strong feelings towards personal social responsibility (Froese and Thompson, 2018). To understand the implications of the aforementioned positive and negative feelings towards certain

economic actions one must understand what these economic actions entail.

Put simply, the distributive policy entails all policy or legislation aimed at the redistribution of wealth and improving the standard of living for all people, specifically improving the standard of living for ethnic minorities. Additionally, feelings towards personal social responsibility encompass feelings relating to any idea of an ethical commitment to fight poverty by non-governmental means. These means include any actions performed by individuals or organizations aimed at taking care of the less fortunate, reducing poverty, or the general betterment of society (Froese and Thompson, 2018).

Due to the idea that religious identifying Americans are opposed to distributive policy, a core humanitarian principle, they are often seen as in direct opposition to the Democratic Party. This friction between religious identifiers and the Democratic party is interesting because one might think that if an individual is opposed to one party, they would be in favor of another. However, this is not the case for religious identifying Americans when it comes to economic policy. While an opposition is seen between religious Americans and the Democratic party, there also appears to be an opposition between religious Americans and the Republican party in that the majority of religious identifying Americans tend to support the idea of social and economic welfare programs, creating a disconnect between themselves and the typical conservative moral attitude. (Froese and Thompson, 2018). This is where the various religious theologies and ways of viewing God are significant when examining political economic attitudes. Data suggests that based on the way an individual views God, their political economic attitudes are not consistent across the board for religious identifiers (Starks and Robinson, 2009). Based on multivariate data, it can be argued that the belief in what is called an engaged God, or a God that directly influences and impacts the daily lives of believers has a liberalizing effect on individuals' beliefs on both distributive policy as well as personal social responsibility. Interestingly this phenomenon

seems to be independent from party identities (Froese and Thompson, 2018).

This aforementioned liberalizing effect, that various views on God have political economic beliefs, is further elaborated by Starks and Robinson in their work, *Two Approaches to Religion and Politics: Moral Cosmology and Subcultural Identity*. In their work, Starks and Robinson discuss the two ideas of Moral Cosmology and Subcultural identity as variables in American political attitudes, specifically religious Americans attitudes. The moral cosmological approach focuses on religious worldviews and beliefs while the subcultural identity approach focuses on identity rather than focusing on worldviews. (Starks and Robinson 2009). Though not inherently political in nature nor aiding an obvious political goal, these two methods prove to be effective lenses into the effect of religious beliefs and practices on political opinion.

Matthew Smith
Panoramic Giants

The moral cosmology approach focuses on the assumption that individuals differ on their foundational beliefs on moral authority. Additionally, this approach places emphasis on the consequences the different views on moral authority have on politics, specifically politics regarding economics. The first instance of moral cosmology being used is in 1991 by James Hunter (Starks and Robinson, 2009). Hunter examined the distinction between two fundamentally different concepts of moral authority (Hunter, 1991). The two sides of his moral cosmology approach are the beliefs of the religiously orthodox, who believe God is the ultimate authority in regard to ethics, and the other side, who he refers to as progressives and Modernists, or people who believe that individuals are the ultimate deciders of what is ethically right and wrong. It is important to note that when Hunter uses the phrase religiously orthodox, he does not say this in reference to traditionally orthodox doctrine of religion, rather he uses the phrase orthodox in reference to a larger category of theological orientation that focus on tenants of the Abrahamic faiths traditions (Starks and Robinson, 2009). When examining Hunters' theory, it is found that his category of the religiously orthodox believers tend to be more likely to be "theologically communitarian" (Starks and Robinson, 2009). This is to say that individuals in the religiously orthodox category tend to believe that all individuals in a

community are subject to the laws and greater plan of God; while modernists are seen to be theologically individualistic, meaning that individuals are subject to their own decisions and fates. While not inherently political in nature, a parallel can be drawn between these two approaches to religion and the two major political parties of the United States, with the religiously orthodox paralleling the Democratic party, and Modernists paralleling the Republicans.

Matthew Smith
Awestruck

Hunters' ideas on the differences between religiously orthodox and modernists can also be applied to economic policy. While the nature of the religiously orthodox leads them to be almost authoritarian communitarian, the same principle can be applied to their outlook on economic principles. A statement by Davis and Robinson in 2006 shows the essence of what Hunter meant in his explanation of the economic policy of the religiously orthodox. Davis and Robinson summarized the economic policy of the Religiously orthodox in their statement: "...whereby wealth cannot be attained at the expense of others and whereby it is the community or state's responsibility to look out for those in need..." (Davis and Robinson, 2006). In simple terms their statement is essentially saying that the religiously orthodox feel that it is their duty to almost watch over their community and its members and is dedicated to the aid of the poor and the reduction of poverty as well as inequality. Modernists, while they feel it is important to help the well-being of the community, they further believe it should be the individual's choice to help their community and that it is not the community's job as a whole to combat poverty. Additionally, modernists may also feel that individuals are responsible for their own fate and economic destiny.

Starks and Robinsons examination of the second approach to the formation of individuals' political opinions, is the subcultural identity approach, also referred to as the movement identification approach (Starks and Robinson, 2009). In 1997-1998, Smith and Colleagues created a second approach to the formation of individuals' political opinions. They suggested that subcultures created by religious movements are a key factor in explaining the political opinions of groups such as Evangelical Christians, Fundamentalist Christians, and so on (Smith, Emmerson, Gallagher, Kennedy and Sikkink, 1997). This approach by Smith and colleagues is a response to the previous theory that categorized all of religion together in a large group in politics, which according to Smith and colleagues failed to address the complexities that various religious beliefs had and has on the formation of individuals within the various religions beliefs on politics (Starks and Robinson, 2009). As far as Christian Evangelicals go, the Gallup organization, as referenced earlier, writes that around 41% of Americans consider themselves to be "born-again" Christians or Evangelical Christians (Newport, 2018). A significant population of the

United States seems to identify with this subgroup of religious identifying Americans. Not only is this a large subgroup of Christianity, but it is also a large portion of the American population eligible to vote. This large percentage of Evangelical Americans raises the question: To what extent does identifying as evangelical or "born-again" have an American political opinion? The answer can be found in Regnerus and colleagues' work: *Who gives to the poor? The influence of religious tradition and political location on the personal generosity of Americans toward the poor.*

In Regnerus and colleagues work, they come to the conclusion that those who identify as Evangelical Christians or "born-again" believers are more likely to engage in acts of charity. However, these acts do not necessarily mean that evangelical identifying Americans are more likely to favor a strong governmental role in the reduction of poverty (Regnerus, Smith and Sikkink, 1998). This data supports the previously discussed idea by James Hunter, in that Evangelicals could be categorized with the modernists in terms of religious and moral cosmology. Despite the sort of irony in referring to Christian Evangelicals as modernists, their actions and political beliefs are in contrast to what we would refer to as religiously orthodox or traditionally communitarian in nature.

Although thus far the focus has primarily been on Evangelical Christians, the variations of political beliefs based on religious identification is supported further by the first survey of Baylor University Religion Survey. Although evidence does suggest that there is variation in political beliefs based on religious identification, there is even more of a correlation of political opinion variations based on the view of God which is varying among religious sects. (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006).

For research purposes, Baylor University's Institute for Studies of Religion created four categories for the ways Americans view God. These four categories are Type A: Authoritarian God, Type B: Benevolent God, Type C: Critical God, and Type D: Distant God. These Categories are based on the varying beliefs in the level of God's engagement with people as well as the level of anger God has towards people. While there is no codifiable proof that there is a God or that God is either engaged or angry, many hold the belief in a God so dear to their foundational and core values that the various views of God play a significant effect on the formation of the rest of individuals values and beliefs, including those beliefs that affect their political and economic opinions. Further elaboration on the four types of Gods as seen in Baylor University's Religion Survey, is needed to understand the various views of Gods effect on individuals political and economic opinions (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006).

According to Baylor University's Religion Survey, 31.4% as of 2006 believed in the Type A: Authoritarian God. This means that 31.4% of the American population believe in a God that is highly involved in their daily lives as well as in all other people's daily lives. Type A believers also believe that God drives all people's decision making and is responsible for global events. Despite their belief in the high engagement of God, they also report to believe that God is angry at people for their actions and is capable of rewarding and or punishing individuals who are "ungodly". The highest population of this mindset is found in Black Protestants, it is reported that 68% of Black Protestants fall into this category of belief in God (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006).

The next category of belief in God accounts for 23% of the population. Type B: God or believers in a benevolent God are similar to believers in a Type A God in that they believe God is very active in individuals' daily lives, however they differ from Type A beliefs in that they do not think that God is an angry or wrathful God. The highest percentage of Type B believers can be found in the category of Catholics, believers in a benevolent God account for 28.2% of all individuals identifying as Catholic (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006).

Third category or Type C God is the belief in a critical God. At a somewhat smaller percentage of the population, 16% of Americans believe in a critical God, that unlike Type A and B, does not interact or engage with the public. They do however believe that

God is angry with the public similar to the Type A God. This belief category is particularly significant among both Black Protestants as well as Mainline Protestants. While a smaller population of individuals believe in this type of God an average of 17.2% of the surveyed religious sects believe in a Critical God (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006).

The fourth and final category of God examined in this survey is the distant God. A larger portion of the United States believe in a distant God at 24.4%. This type of belief in God views God as neither active in people's daily lives nor believe that God is particularly angry. Interestingly a large portion of Jewish identifying Americans believe in a Distant God. According to Baylor's religion Survey, 41.7% of Jewish Americans believe in a Distant God. (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006).

Matthew Smith

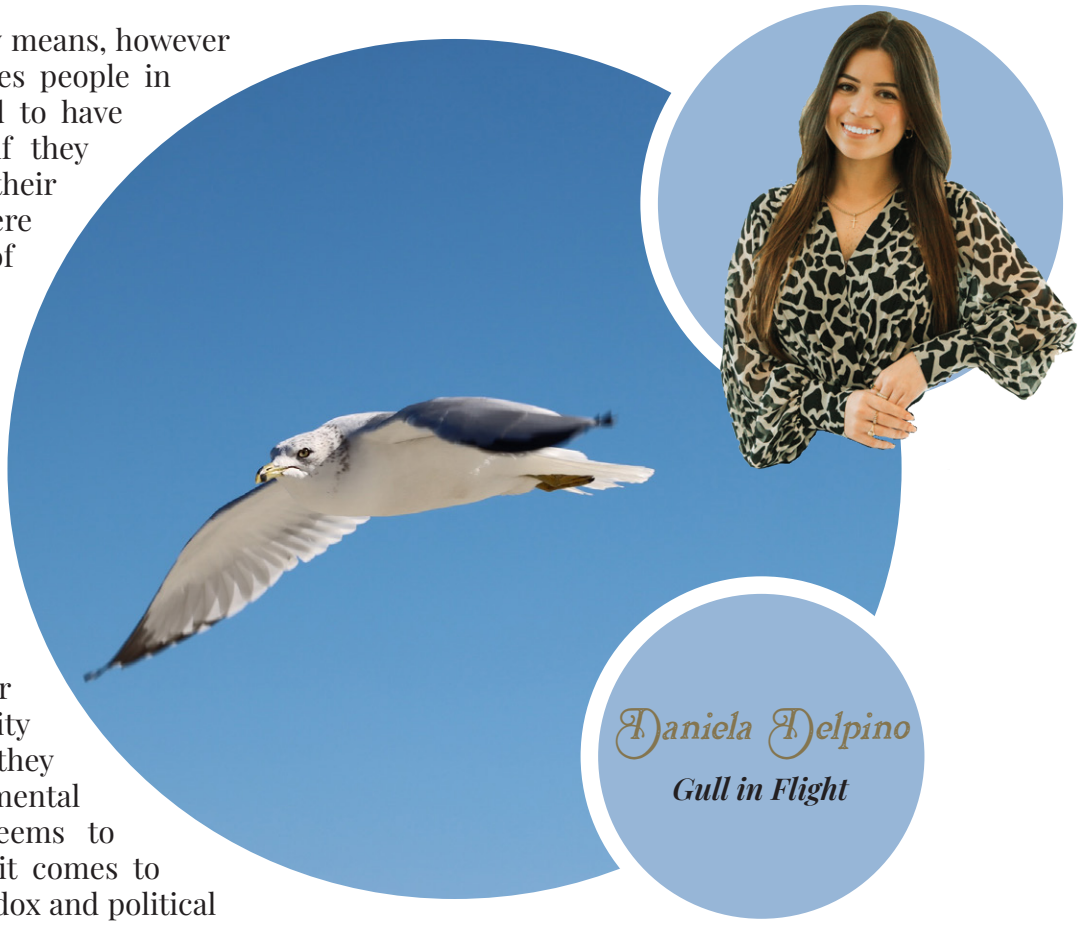
Two Wonders of the World

The breakdown of the various beliefs of God is important because it is related to various political differences. Furthermore, in Baylor's first religion survey, people were asked a series of political questions and categorized by their beliefs about God. It is important to note that this survey focused on sects of mostly Christian religions, however they do include a category for non-believers or Atheists in the data. While many questions are asked in the survey, Baylor University specifically included a series of questions regarding economic and social values with interesting results. During the survey, participants were asked to agree or disagree with the following statement: "To be a good person it is very important to... actively seek social and economic justice" (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006). Results of this question show that there is nearly a ten percent difference between the answers of the four types of beliefs in God. With 31.3% Type C: critical God believers answering yes to the previous question, opposed to 39.7% of believers of a distant God answering yes to the question. The percentage of those who agree with the statement that people should take care of the sick and needy is an even higher percentage at an average of 62.9% agreeing with the previous statement. (Bader, Dougherty, Froese, Johnson, Mencken, Park and Stark, 2006).

While Black and Black acknowledge the effect former Republican President Ronald Reagan had on American politics, specifically the Christian population of America, it is interesting that many scholars, including many previously mentioned, have conversely argued that the belief in God and specifically the belief in an engaged God has somewhat of a liberalizing effect in the political beliefs of Americans. I would assert that a large portion of conservative Christians in the United States are not conservative based on their religious values, but rather are conforming to local standards of belief. By saying this, it is not intended to put down anyone's religious beliefs or say that

Daniela Delpino
Sky Blue Eyes

they are "bad Christians" by any means, however it can be argued that oftentimes people in the same geographic area tend to have similar political beliefs even if they aren't necessarily aligned in their personal religious beliefs. There are an additional multitude of factors why people's political beliefs may differ from their religious beliefs, but in the end, the United States is not by definition a Christian or even religious nation and people's religious beliefs do not and should not matter on a national scale. It is reasonable to assume that the majority of Americans would participate in charitable acts in order to further the success of their community and to reduce poverty even if they would be opposed to governmental interference. Overall, there seems to be a lack of distinction when it comes to religious conservatives or orthodox and political conservatives. While there may be slight overlapping within the two groups, not making the distinction is harmful to subcategories of the religiously conservative such as Black Protestants as well as Catholics and Jewish believers, who as research suggests tend to be more politically liberal despite their religious conservatism. Under-representation is a major issue in modern politics and by categorizing all Christian or western religions together such as Black and Black only contributes to the under-representation of groups such as Black Protestants and Jewish Believers.



Daniela Delpino

Gull in Flight

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Graphene Technology in the Space Industry

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I. INTRODUCTION

Since its discovery in 2004, graphene has captivated the scientific community's interest. Graphene is a material made of a single layer of carbon atoms in a hexagonal pattern. Because of this unique structure, graphene has many useful properties. It is recognized as the toughest 2D material to exist, as it is 200 times stronger than steel measuring the same dimension [2]. Additionally, graphene can stretch up to 20% more of its original size. It also has a lower electrical resistance compared to all other material at room temperature, resulting in excellent conductive properties [2]. The impressive features of graphene allow it to be used in a multitude of ways. For example, it can be rolled into tubes, layered, woven, or folded as illustrated in Figure (1) [2]. Its flexible but durable nature allows it to be integrated into everything from clothing to spacecraft.

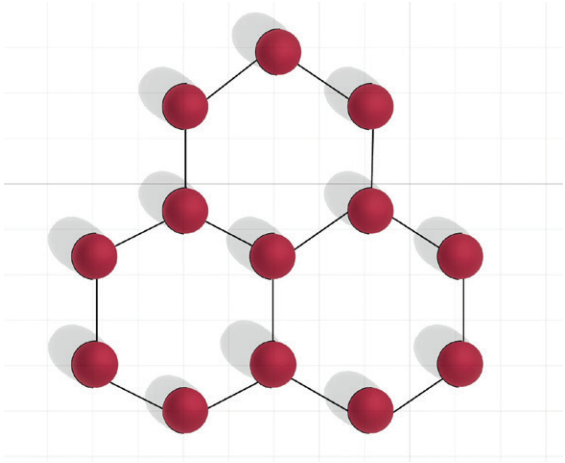

Figure (1) shows the structure of graphene.

Additionally, because of its superb electrical capacity, graphene is being incorporated into electronic systems such as sensors, radars, and circuits [3]. Graphene enables these devices to work more efficiently by negating the effect of a system's lost energy. This means that spacecraft can become more energy efficient, saving time and money. Furthermore, scientists are working on applications for graphene in other sectors such as ballistic defense and electronics. This paper focuses on graphene in the space industry—where scientists are making breakthroughs.

II. UTILITY IN THE SPACE INDUSTRY

Technology in the space industry has improved exponentially since humans launched the first satellite into space in 1957 [4]. Since then, the United States, Europe, and Russia have continuously developed revolutionary technology for space exploration. From breakthroughs in engineering, medicine, and materials, space exploration has ushered in a sense of innovation across the world.

Though graphene was not invented solely for space exploration, it has quickly become one of the most revolutionary materials utilized in this regard. Graphene gained its popularity in the space industry from 2010-2015 [2]. During this five year period, the world was beginning to understand how revolutionary the material really was. There then came a significant limiting factor in the growth of graphene: it was nearly impossible to produce on a large scale. Companies and government organizations such as NASA became involved in the race to mass produce graphene

effectively. In 2018, researchers from the Department of Energy discovered a method to make graphene known as chemical vapor deposition (CVD)[5]. This is a common method of creating nanomaterials that requires hot chemical gas to be reacted with a solid element or substance. CVD has been refined and developed into a science over the past few years. This means large scale graphene synthesis is now realistic [5].

III. INFRASTRUCTURE & EQUIPMENT

One of graphene's primary uses is to build the industrial parts of spacecraft. 'Monolithic' epoxy--rigid epoxy that is commonly used in construction and engineering--does not have the thermal capabilities nor the strength to withstand harsh conditions in space. To strengthen the epoxy, graphene nano-platelets are mixed with carbon nano-tubes to create an epoxy that is 260% stronger than the standard monolithic epoxy [6]. It is also 190% less susceptible to tension forces [6]. This creates more durable and flexible seals in spacecraft.

Graphene is being used to improve the daily lives of astronauts. Space suits integrated with graphene have shown resistance to radiation. Researchers tested elements and materials such as boron, beryllium, and carbon dioxide in space suits, but none were effective at shielding radiation [7]. The graphene integrated suit showed a 34% reduction in cosmic ray exposure [7]. This is important because the next big space mission is to put a human on Mars. With advanced space suits made with graphene, astronauts will be better protected from the harsh Martian environment, inevitably bringing peace of mind to said astronauts and allowing them to conduct safer research.

New radiation sensors are also being developed from graphene with the intent to keep astronauts safe. In fact, in 2019 the European Space Agency launched a rocket to experiment with graphene sensor 3D printing [8]. The objective was to enable astronauts to create critical sensors or to sustain a long spaceflight if equipment was damaged. Printing today focuses on sensors and electronic displays. However, its continued development brings it closer to creating batteries and super capacitors [8]. Graphene sensors are used to detect cosmic radiation and space junk. They are also integrated into Space-to-Earth communications [tectales].

Lastly, graphene is used as a shock absorber. It can absorb and distribute kinetic energy faster than any other material on Earth. It distributes kinetic force in a perfect elastic wave so that one area of the impact is not damaged excessively [9]. This property is useful for building parts of spacecraft that often encounter debris.

IV. RISE IN SOLAR PANELS

Solar cells emerged in 1954 when engineers were searching for a power source to be used by telephones in a remote location [10]. The first solar cell these engineers developed operated at only 1% efficiency [11]. Since then, solar cells have not improved much. The typical industrial solar cell operates at 10-15% efficiency [3]. New studies with graphene solar cells show that they operate at up to 30% efficiency [12]. These solar cells will produce 2-3 times the amount of energy when compared to their traditional counterpart while occupying half the space.

Graphene is ideal for collecting electrical energy. Its high conductivity allows the sheets of material to act as bridges, accelerating electron transfer. One layer is 97% transparent, and remains 88% transparent when layered five times [13]. In space, they are far more durable and temperature resistant than conventional crystalline silicon solar cells. In fact, in addition to traditional solar cells integrated with graphene, Chinese researchers have also developed a graphene composite film that converts light to electricity. [14]. The graphene film takes advantage of its hexagonal structure, enacting it to behave like a highway for electrons. This highway accelerates electron transfer [14]. This new film currently remains in the testing phases but is expected to have a higher efficiency than solar cells. It is anticipated to be used in solar sails which will be discussed in the next section.

These solar applications of graphene can be utilized as energy sources in spacecraft. Most satellites are powered by solar cells. Solar cells are heavy and add unnecessary weight and cost to space missions. Due to graphene's impressive electrical properties, engineers are developing flexible graphene solar cells [12]. These solar cells will be much lighter. They will also be able to attach to different surfaces—perfect for spacecraft application.

V. DEVELOPMENT OF SOLAR SAILS

Though solar sails sound like they belong in a science fiction movie, they are a promising technology that can revolutionize space travel. Unlike traditional rocket fuel, solar sails are light, easy to launch, and need no fuel. Much like solar cells, solar sails work by converting photons from light into electrical energy, much like solar cells [15]. If photons hit the sails, the spacecraft will accelerate. In 2020, the European Space Agency developed solar sails using graphene technology [15]. They began by taking small sheets of graphene and shooting them with laser beams. When the graphene accelerated in response to being struck with the photons from the laser, it propelled itself forward [15].It reacted with more vigor than other materials being tested for

solar sails, such as lightweight polymers like Mylar. It directs itself exactly like a sailboat—changing the angle of its sail to adjust its course [16]. It can also move in different ways by changing its center of mass.

VI. INTRODUCTION INTO ROCKET FUEL

Students and researchers at Purdue University recently formulated a different method to launch rockets. A new propellant made of graphene foam is being successfully tested for its propulsion capabilities. By combining the graphene foam fuel with traditional solid fuel, the launch was more fuel efficient [17]. The foam works well because it is porous and allows air to circulate better, further igniting the launch [17]. The key to the foam's success is in its structure. It has a 3D tunnel-like structure that allows for quick heat transfer throughout the material. [17]

Similarly, nanofluids (oils or fluids containing nanoparticles of a nanomaterial such as graphene) have become a popular alternative to traditional rocket fuel. The nano particles in the fluid creates a nanostructure to allow heat to transfer faster through the material [18].

Isrosene, a nanofluid made with graphene, is one of the top performing nanofluid rocket fuels[5]. According to the Indian Space Research Organization, once the fuel was mixed with graphene, it improved its heat transfer efficiency by 49% [5]. Improving heat transfer allows for more effective burning rates. This reduces the amount of fuel used which lowers the weight of the rocket, allowing the rocket to carry a larger payload.

Solar sails made of polymers have already been implemented and used in spacecraft. Researchers predict that it will soon be possible to make solar sails up to a kilometer wide out of graphene. If solar sails are largely implemented in the future, they will enable spacecraft to travel further than traditional fuel [16].

VII. WHAT THE FUTURE HOLDS

SpaceX launched a mission in early April 2022 to test how graphene sensors react to a zero-gravity environment. The sensors were designed by Dutch and Chilean students and researchers [19]. Because this launch took place recently, results of the experiment are still pending, however, the sensors are expected to be more sensitive to cosmic activity than average spacecraft sensors [19].

Other companies and organizations have launched similar campaigns to that of SpaceX. The Cambridge Graphene Center has partnered with the European Space Agency and a company called Graphene Flagship to test their graphene devices in space [20]. While SpaceX's mission is focused on sensors made of graphene, this mission tests graphene's use in cooling systems on

spacecraft. Engineers have designed loop pipes (fluid pumps with no mechanical parts) with graphene to help regulate their temperature [20]. Having no mechanical parts also prevents breakdowns and machine failures. These two advantages prolong the lifespan of spacecraft—saving money, time, and energy for the companies.

A team out of the University of Manchester is currently developing advanced rocket living spaces enhanced with graphene. Integrating graphene within the infrastructure of spacecraft living spaces helps regulate the extreme temperatures of space [21]. Graphene's strength also helps protect the spacecraft from micrometeorites and space junk. This keeps astronauts safe and healthy. Engineers on the same team are designing plans for a graphene enhanced Earth-like habitat on other planets such as Mars. [21].

CONCLUSION

Graphene has made significant strides in advancing existing technology over the past decade. What was once thought to be an impossible material has changed the way that we think about the future of the space industry. From solar sails to space suits, graphene has revolutionized the limits of space exploration. If humans are to expand across the galaxy, as NASA and SpaceX believe, graphene technology will play a large role in our success. This unassuming, yet powerful material may yet be the key to unlocking humanity's dreams of reaching distant galaxies.

When Earth will one day face another apocalyptic event, space travel will become the only option for survival. By developing graphene technology in the space industry, engineers give life a chance to endure on, even in the worst scenarios.

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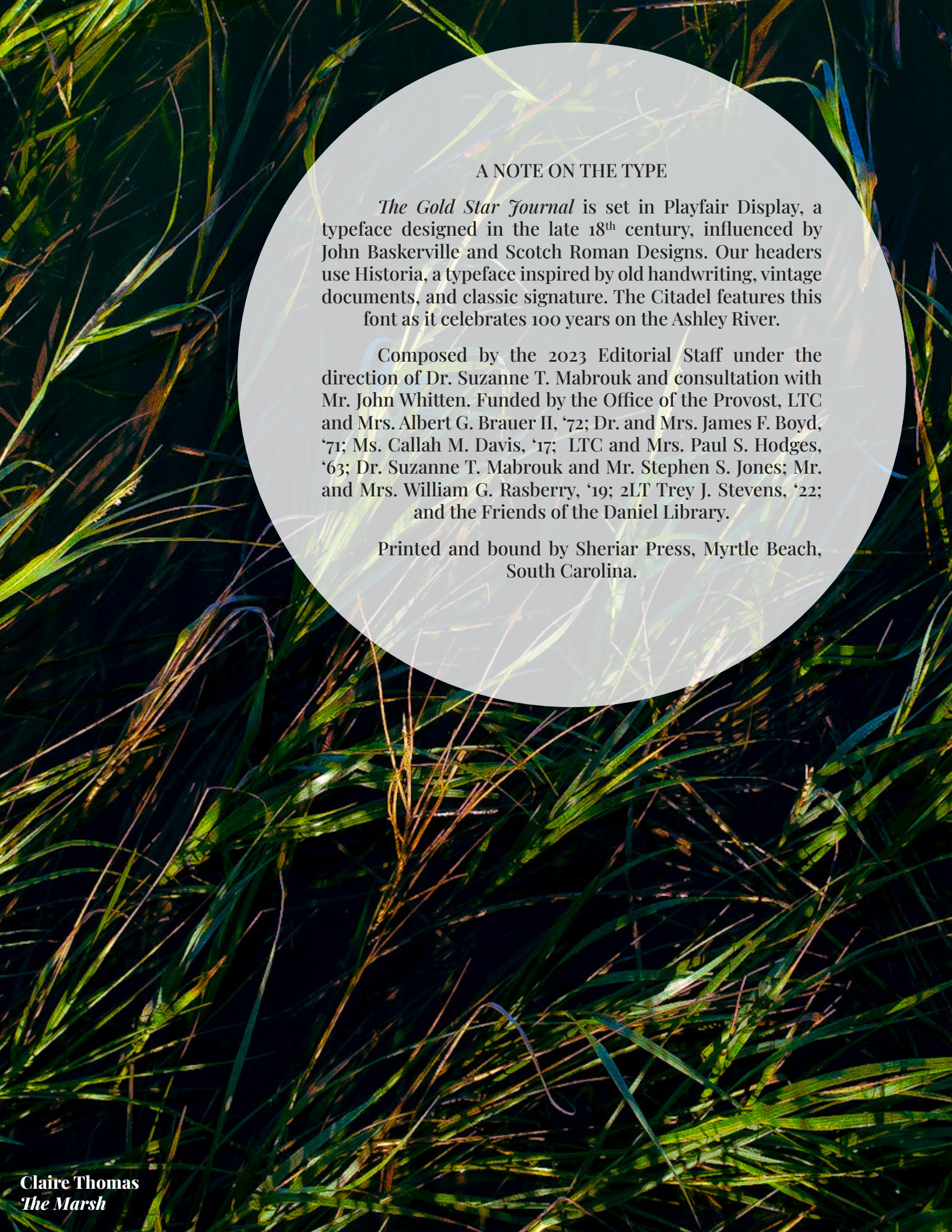

A NOTE ON THE TYPE

The Gold Star Journal is set in Playfair Display, a typeface designed in the late 18th century, influenced by John Baskerville and Scotch Roman Designs. Our headers use Historia, a typeface inspired by old handwriting, vintage documents, and classic signature. The Citadel features this font as it celebrates 100 years on the Ashley River.

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The Marsh