The Technician behind the Artist: Where Science Meets Art

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i. Inspiration

"The most beautiful experience we can have is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science. Whoever does not know it and can no longer wonder, no longer marvel, is as good as dead, and his eyes are dimmed." (Quoted from Einstein, Reprinted Leach 1930)

During my undergraduate education, I was frequently asked the question: Why are you studying both engineering and art? During my journey through college, even my family members thought I should drop one of my interests. When I was in high school, I pursued dance and music, but I did not have enough time for art, even though I always enjoyed sketching and painting in my sketchbook. But I decided with strong resolve that I would focus on developing my visual artistic skills in college. So to me it was natural that I would pair my schoolwork with artistic passion.

In college, I learned that painting was much more than a hobby and more than a passion. It served as an outlet for channeling emotions that I dealt with throughout my difficult semesters in engineering and pre-medicine courses. I like to compare art to Michael Phelps in the Olympics. Even though he had severe ADHD, when he swam, he was able to hyper-focus and clear his mind. A similar phenomenon happens when I pick up a paintbrush and mix color. I delve into the subject of what I see and clear my mind of everything else at hand except whether or not I am able to replicate the correct color or form of the shape.
While even struggling to explain to my family why I wanted to complete my minor in art, I eventually came to the realization that art and science were not always separate. My favorite quotation from Einstein illustrates that “at the cradle of true art and true science” is an intersection where even he did not have a word to describe it, namely the “fundamental emotion” (Leach). The word “fundamental” suggests an urgency or need that is not satiated through any other human experience, except through combining art and science. This is the experience that I hope to give my readers as they delve into the topic of engineering and painting. My goal is to allow others to understand the necessity of treating art through a science lens and science through an artistic filter. I hope that my readers can realize that art and science were never truly separate, and that in order to feel the power of the “fundamental” emotion, they must be combined to achieve a greater understanding of both subjects.
First I acknowledge my parents and grandparents for helping me through completing my thesis. They have always been an integral part of my education because they provided me the support I needed emotionally and financially. Second, I acknowledge my aunt and uncle who have served as my adopted mom and dad in Oxford, MS. They encouraged me to continue to pursue my dreams, even when I would think of giving up. Finally, I acknowledge and thank all of my undergraduate professors who have shaped me to be the young woman I am today, and I am proud to call Ole Miss my alma mater. I especially thank Dr. John O’Haver, Dr. Adam Smith, Dr. Winkle, Dr. John Green, Dr. Robert Kroeger, Dr. Mattern, Dr. Susan Pedigo, Dr. Rebecca Symula, Josh Brinlee, and Philip Jackson for all of the support and knowledge they’ve taught me throughout my coursework.

I thank the Sally McDonnell Barksdale Honors College for a wonderful education that they brought me as well as exposure to new people, professors, and topics that made me sit down and think about life differently. I also thank the honors college for providing me with a research grant for this project that allowed me to both purchase supplies and fund a trip to New York.

I thank the University of Mississippi department of Biology for lending me props for my still life, especially Dr. Britson who teaches Anatomy and Physiology. Even though it may have sounded odd when I came into her office and asked for bones, she was kind and allowed me to borrow them from her lab.

I thank the University of Mississippi department of Art for lending and giving me access to studio space in the Fall of 2015 to set up my still life and paint. I especially thank Josh Brinlee as my thesis advisor, art critic, and mentor along my journey of completing my thesis. His guidance is what enabled my thesis to come into fruition, and I cannot thank him enough for his support.

During my journey to New Berlin, New York, I met some amazing people that shaped the direction of my thesis. First I would like to acknowledge Pillow and Pantry, a lovely bed and breakfast that offered me a free night in order to stay safe on the road the next day. Second, I thank all of the friendly staff at Golden Artists Colors that welcomed me in and treated me like family. I especially thank Emma Golden, the granddaughter of the founder of Golden Artists Colors for allowing me to tour their manufacturing plant, and she even gave the tour herself. I also thank Ulysses Jackson, who is the master chemist behind their research and development, and played with paint with me for hours in order to teach me some basic terminology and science behind the art of paint making. Thank you Golden Artists Colors for giving me the best visit to New York I have ever enjoyed, and I cannot wait to come back and visit again.

Thank you Sherman Jones for helping me phrase my thesis title.
iii. Abstract

The thesis has two purposes: to evaluate the difference between oil, acrylic, gouache, and encaustic paint for the purpose of glazing and to integrate engineering and artistic principles into this thesis. My final evaluation across the four paints is that oil has the highest performing glaze. I believe it is the best glazer because time is not a constraint for me as an artist. If an artist has a time constraint on their painting, I recommend using acrylic mixed with an acrylic polymer medium as a glaze because the drying time is much faster than oil. I discovered that gouache and encaustic paint do not serve as good glazers. I believe that by evaluating oil, acrylic, gouache and encaustic paint for their engineering and artistic merit, I was able to convince my readers the importance of combining both engineering and art for the purpose of this thesis. The background knowledge on the manufacturing of paint from pigment helps me evaluate the minute differences in the four paints such as drying time and viscosity. I achieved a thorough evaluation as well as explanation of why I combined art and engineering through an interview with a modern artist, Dave Ghildarducci and a visit to Golden Artist Colors manufacturer. Recommendations for further improvements to this project include using a different brand of gouache paint, delving into the differences between artist and student grade paint, and looking into both glazing and applying opaque layers of paint.
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Introduction

The purpose of this thesis is to answer the question of how engineering and art can combine. More specifically, I would like to address this question in the manner of applying it to my own engineering and art background through evaluating the quality of paint. At the University of Mississippi, I have gained painting experience through taking beginning through intermediate painting courses. I am also completing a Bachelor of Science through the chemical engineering department. Both of these educational areas shaped my interest combining science with art.

Painting involves a lot more than viewing a subject matter and reproducing it on a surface, such as wood or canvas. To delve deeper into the subject, I chose to look at chemical and physical properties of paint, and how they affect the desired quality artists look for in paint. I also compared my personal desired qualities as an artist to other artists by evaluating paint manufacturing quality. My final evaluation will be to choose the type of paint that I prefer based on the technique of glazing.

I hope to inform future artists and engineers about the difference in quality of oil, acrylic, encaustic and gouache as they act as a glaze during the painting process, and which one is both cost effective and performs with the highest quality. Glazing is a technique that was utilized by the famous painter Vermeer and other 17th Dutch painters (“Glazing”), and it is a technique that I learned from my painting professor, Philip Jackson at the University of Mississippi. It involves taking paint, for example oil paint and thinning it out to reduce the concentration of pigment. Once the paint is
thinned, the artist brushes the layer paint onto an underpainting, or grisaille. The artist applies the paint until they have both corrected the structure of the subject matter and built up a color and tone that replicates what they view in real life. The end product is a realistic and efficient painting.

I chose the subject of my still life to be related to objects that have meaning in my life. Each object and its historical representation throughout history will be discussed in the subject matter section of this thesis. I painted four paintings of the same subject matter and same technique in order to have a more accurate evaluation of the paint qualities as a glaze.

I believe that my thesis is important because I do not think that looking closely at types of paint can be done solely from the perspective of art or solely from the perspective of engineering and chemistry. As an informed buyer, it is the artist’s duty to understand the chemicals and pigment that they are working with and fully evaluate the decisions they make as far as what paint they are going to purchase. This thesis devoid of art would be about the chemical makeup of the paints, solvents, and binders. But it would contain no real information regarding the artists’ intuitive feeling of their paint performance. This thesis devoid of engineering would be about the subject matter and technique alone, but would lack information regarding how the glazing technique as a scientific principle to utilize all chemical aspects of the paint. By combining both subjects, I am able to fully grasp how the quality of the paint affects my painting and the technique of glazing.
Chapter 1: Concept and Subject Matter

I. Concept

The concept behind this thesis starts with my interview with Dave Ghildarducci. I was first inspired by his art by reading an article about a recent installation and his artistic and engineering background. He creates tasteful installations that challenge the viewer to appreciate it as a work of art as a compilation of engineering principles (Morlan). Ghildarducci stated that, “It's been my engineering experience that the simplest solutions also are the most elegant and the most robust. That, to me implies the two should not be separated.” His view that engineering interlaces with art motivated me to contact him further and ask him more about his perspective on the whole issue. I discovered that his objective is to promote “STEAM versus just STEM.” STEAM stands for Science, Technology, Engineering, Art, and Mathematics. STEM stands for the same thing but without art.

Growing up in school, I heard the acronym STEM often, especially when teachers encouraged me to pursue engineering. In college, it was engrained in my schedule to take science and math classes as an engineering student, which would prepare me to be a professional engineer. Never once had I heard of the acronym
Steam. But now I realize that growing up with art as an equally important subject would have increased my creative output and drive throughout my studies.

Ghildarducci states that when he creates sculptures, in particular the installation called “Taping Shape”, which is shown below, Dave Ghildarducci notices that children start to play and discover. He says that, “Let's also notice that almost all people as children have no fear of a pen, pencil or crayon to draw a picture” so that installations like his encourage the use of both art and engineering. In chemical engineering, we learned that the first tool we use is our pencil to draw a picture of the problem.

Figure 1.1.1 Taping Shape by Dave Ghildarducci, Photographed by Kinsee Morlan,

See Morlan in Bibliography
Ghildarducci stated in the interview that “Taping Shape” started by getting together a team of mathematicians and coming up with mathematical formulas that represented the molecular structure of a nucleoside. He used the strength of the tape to form large wall-like structures hanging from the ceiling and laying on the ground. What is most impressive to me is how he was able to transform tape, which is flimsy and thin, to a tunnel a human can pass through (Appendix A contains the full interview with Dave Ghildarducci).

Like Ghildarducci, I want to use my engineering background to shape my artistic thoughts and technique. In the process section, I discussed how I created each painting and used the materials. I want to draw upon the scientific principles that shape my art and enable the paintings to have their successes and failures as a glaze.

II. Subject Matter

The subject matter in this project is treated separately from the evaluation because I chose the objects based on a personal connection that has little to do with the type of paint. This is because I wanted to incorporate all of my interests in my thesis, including medicine. The easiest way to include medicine in art is by using bodily figures. My interest with science and art began when I researched how artists and medical students both utilized cadavers and drew their form in order to learn the body parts. I looked at old photographs of medical conditions from 1843 to 1939 to see what kinds of medical conditions were prevalent as well as interesting shapes and forms that doctors would place bodies in order to demonstrate a particular disease or accident (Burns). Finally, I decided instead of drawing a contorted human figure, I
could incorporate some type of human body part in my still life that held a connection to my medical interests. Since my long held interest in the skeletal system of the body, and since I have relatives who suffer from rheumatoid arthritis, I chose to incorporate bones.

The remaining objects were collected from my belongings, and they each hold their own personal significance to me. For example, I used a blanket that I’ve held on to since I was a baby, and placed it in the foreground of my still life. I tried to marry the idea of personal importance to historical importance, while also keeping in mind the inner dynamics of each object and its context.

Historically, when still lifes were very popular in the 16\textsuperscript{th} and 17\textsuperscript{th} centuries, each object in a still life contained some type of meaning. These still life paintings were called vanitas (“Vanitas Art”). Vanitas means vanity, which was termed based on the bible verse, “Vanity of vanities, saith the Preacher, vanity of vanities; all is vanity” (\textit{New King James Version}, Ecc. 1.2). The meaning behind objects in the paintings were said to tell a story that would comment on how short life was and different human emotions such as greed and selfishness.

I chose objects, which are listed in Table 1.2.1 followed by a photograph of the final painting is listed as Figure 1.2.1. The first column names the object in my still life. The second and third column contain a description of the historical personal meaning respectively.

Many items traditionally symbolize and surround the idea of brevity of life. For example, bones tend to connote death. Despite the traditional meaning, bones to me represent strength and the essence of human structure. When bones deteriorate,
especially in diseases such as osteoporosis, mobility becomes labored and it can lead to a viscous cycle of immobility and ill health. Thus, I believe it was important to include bones such as the femur, phalanges, carpals and metacarpals. Each one of these bones has their own function and aid in the movement and productivity.

The coke can and monogrammed letter both contain my name and initials respectively. The letter in a historical view symbolizes importance and wealth. The point of a vanitas was not only to comment on death, but also to acknowledge that wealth and recognition, which lead to monogrammed letters, upon death hold no meaning. Even though I was not able to find a historical 17th century meaning of the coke can, I still believe that it can connote success and vanity. Personally, I will always keep the coke can because there are not many items that I can purchase that can personalize my name, since it is very unique.
Table 1.2.1 Items in Still Life and their Historical and Personal Meaning

<table>
<thead>
<tr>
<th>Item</th>
<th>Historical Meaning*</th>
<th>Personal Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bones (Femur, Foot, and Hand)</td>
<td>Death</td>
<td>My interest in orthopedic surgery and the skeletal system as a continually learning student</td>
</tr>
<tr>
<td>Black Coffee Mug</td>
<td>Symbol of fragility of the ceramic; empty glass is a symbol of absence of human presence</td>
<td>A mug that I used every day; used to contain the periodic table but it washed off</td>
</tr>
<tr>
<td>Blue and White Tablecloth</td>
<td>Vanity; expensive dye; blue and white colors connote clouds and love</td>
<td>Primarily used for contrasting background colors and diagonal line movement</td>
</tr>
<tr>
<td>Bronze Statuette</td>
<td>Power, lack of human presence</td>
<td>Found at a thrift store; femininity</td>
</tr>
<tr>
<td>Coke Can</td>
<td>Not applicable</td>
<td>Can with my name on it, which is not a very common name</td>
</tr>
<tr>
<td>Dissection Tools</td>
<td>Reminder of the frailty of human body; diseases are prevalent</td>
<td>My interest in surgery and tools that I used to dissect during biology lab</td>
</tr>
<tr>
<td>Large Shell</td>
<td>Lust; exotic and a symbol of wealth; vacationing to the beach</td>
<td>Shell I collected while I was snorkeling; accomplishment</td>
</tr>
<tr>
<td>Monogramed Letter</td>
<td>Ownership and accomplishment</td>
<td>Stationary I received for my birthday; adulthood and thankfulness</td>
</tr>
<tr>
<td>Pearls and Rings</td>
<td>Temporary nature of beauty, wealth and wisdom; life should be modest; femininity and sign of owner's absence</td>
<td>Jewelry that I wear all the time and never take off; symbol of wealth</td>
</tr>
<tr>
<td>Pink and White Blanket</td>
<td>Vanity; expensive dye; pink and white colors connote love and lust</td>
<td>Blanket that I have had since I was a baby; youthfulness and transitive nature of time</td>
</tr>
<tr>
<td>Small Shells</td>
<td>Laziness; connotations of a snail</td>
<td>Shells I collected snorkeling; collected to pass the time on the beach; entertainment and idleness</td>
</tr>
</tbody>
</table>

*Sources for Historical Meaning are listed under the Bibliography as “Vanitas Still Life” and they reference vanitas during the time period of the 17th century (“Vanitas”).
Figure 1.2.1 Photograph of Final Still Life
The final selection of each object mainly depended on the aesthetics of the overall composition. I chose the blue checkered blanket as the background to give the composition a strong diagonal line so that the otherwise still life had a sense of motion. The cup and coke were placed along the end of the diagonal in order to cut the line and focus the eyes of the viewer on the two objects. I created another diagonal line by arranging a skeleton hand and femur across the blanket. In front of the femur is a statuette of a woman that is bronze with a green marble base. While it is not meant to be the sole focus of the painting, I feel that it is vital to the dynamics of the paintings due to the strong contrast of its color to the bones and blanket behind it. In front of the statuette on the ground are some small shells with two rings inside one of the shells. These shells were placed mainly to break up the strong lines of the statuette. Also lying across the foreground is a string of pearls. As mentioned in Table 1.2.1, one of the first successful paintings that I did with a glazing technique was with pearls, so I decided I could use the pearls as a connection between the shells and skeleton foot. The letter that is sitting on the white blanket in the foreground is used to break up the white color and connect the pattern of the pink and white blanket with the blue and white-checkered blanket.

The purpose is not only to keep the viewer’s eyes moving along the two cross-crossing diagonals but also to hold a certain amount of merit in each object. Even though the placement of the objects might be successful, I hope to achieve an even deeper meaning than simply a collection of items. The story that I hope to tell the viewer is about the brevity of life and while there may be medical ways of lengthening life and material ways of staying happy, in the end, death in imminent. I believe I challenge the viewer to think about that and encourage them to make the most out of their life.
Chapter 2: Process

I. Introduction to Glazing

In this project, I chose to compare the technique of glazing across four different paints: oil, acrylic, gouache and encaustic. Even though oil is the most commonly used media for glazing, I decided to glaze all of the paints and compare the quality of how they perform. Glazing is when an artist spreads a paint using paint thinner and applies it to a pre-existing painting in many layers. The overall effect creates color that is not only luminous but also realistic. Glazing is different from body color, which is when a layer of opaque paint is applied to a surface, covering anything underneath.

I first discovered the use of glazing with my professor Philip Jackson at the University of Mississippi. My first attempt at glazing was a master copy, where I zoomed into a section of a painting. The painting is labeled Figure 2.1.1 on the next page. I followed the following modified glazing process:

1. Gridding the original image with pencil and drawing with charcoal the correct proportions and shading
2. Sealing the charcoal drawing with acrylic aerosol sealer
3. Using burnt umber and ultramarine blue oil color to create warm and cool tones as well as correct proportions. The oil is applied opaque.

4. Completely waiting for the painting to dry

5. In layers, glazing thin coats of paint directly from the bottle or mixed on the pallet to match the colors of the original painting

6. Waiting in between each coat for the glaze to completely dry

7. Adding lowlights and highlights without a thinner

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Figure 2.1.1 Photographs of Pearl and Ribbon Painting, Oil on Canvas. *Demonstrating the Difference in the Underpainting and Glaze.* On the left is the charcoal drawing, in the middle is the grisaille, and on the far right is the final painting.
The underpainting with ultramarine blue and burnt umber paint is called the grisaille, which means grey (Chilvers 314). In addition to blue and brown, I can create the grisaille from a variety of different combinations such as alizarin crimson and phthalo green. The two colors are chosen both to be complimentary (i.e. green and red or blue and orange) as well as cool and warm.

Vermeer was known to employ the technique of painting an opaque grisaille with thin glazes of color. I do not mean to overstate his use of glazing; many times Vermeer and other artists of his time used “opaque and semi-opaque” colors, saving the glaze for specific areas of the painting (“Glazing”).

The purpose of glazing on top of an opaque surface is to optically mix the colors. When a thin, dark blue is painted across an opaque, dark brown, it optically creates black. The blue acts as a thin film for light to pass through and it reflects on the opaque surface underneath. Because the colors are not mixed physically, their absorbance spectrum is less muddied, and the color they reflect is purer (Mayer).

II. Grisaille

In order to prepare the surface, I sanded the wooden boards with coarse and soft sand paper and layered the wood with gesso. Gesso is an important primer for wood and canvas because it allows the paint particles to latch on and stick (Mayer). Gesso can also be used as a primer for a variety of paints, including the two paints I used: oil and acrylic.

For this project, I chose to tone my paintings. Toning a painting is important because it prevents any object from directly showing the white surface of the board. It allows the items and background to interact on the same playing field.
paintings I used an alizarin crimson tone and two of the paintings I used a burnt umber tone. The two-step process of layering paint onto the white wooden panel is shown below in Figure 2.2.1.

Figure 2.2.1 Photographs of a Primed and Toned Wooden Panel with Alizarin Crimson

(On the left: panel covered in paint with the white panel underneath, and On the right: fully primed panel after the excess paint is removed)

As shown in Figure 2.2.1, the acrylic paint did not remove the pencil drawing underneath. While I attempted to tone the oil paintings, the moment that I applied paint over the drawing, my sketch was removed. Thus, I decided to re-paint the grisaille
instead of skipping the toning step. An easy change to this process is to use an acrylic sealer on the sketch so that there is a protected layer in between the sketch and oil paint.

Because I did not have enough experience with gouache and encaustic, I decided to paint two grisailles with oil and two with acrylic. My training in painting primarily consisted of techniques in oil paint, so the two acrylic grisailles took twice the amount of time as the oil grisailles. I figured that encaustic paint would lay better on an oil grisaille and that gouache paint would lay better on an acrylic grisaille. That is because both gouache and acrylic are water based. I researched different techniques that involve mixing oil sticks with encaustic, so I predicted that the encaustic could sit well on an oil grisaille (EncausticPaints.com). I also used encaustic wax on another oil painting before I applied it to my thesis project just to experiment and make sure that it did not take up any oil. In the next four sections, I will individually describe the process of the glazing oil, acrylic, gouache and encaustic paint

III. Oil Glazing

I started with the oil painting first because that was the last type of paint that I used since my last studio painting class. The grisaille is depicted below as Figure 2.3.1. The steps for glazing listed under the first section, Introduction to Glazing, all hold for oil paint, since the process was originally done with oil paint.

Each layer took a day to dry, even with the addition of Liquin. I noticed that the white paint in particular took longer to dry, and I made sure to add plenty of Liquin at the beginning. As I started building up the painting, it was evident that I would need to change some of the colors. For example, the skeleton hand and foot ended up too yellow
after layering yellow on top of white. I decided to keep the pattern of the blue and white-checkered blanket impressionistic and implied. In addition, some of the medical tools in the coffee mug got lost in the layering, and I decided to leave them out instead of staying completely true to the still life. Figure 2.3.5 depicts the final painting in oil.

Figure 2.3.1
Photographs of
Grisaille of Oil
Painting used for Oil
Glaze
To start the process, oil paint is mixed with Liquin, which is a gel that thins oil paint and reduces the drying time. Figure 2.3.2 shows the paint before and after the paint thinner is mixed with the paint.

The paint was applied in layers. Figure 2.3.3 and Figure 2.3.4 depict the layering effect of the paint.
Figure 2.3.3 Layering Oil Paint  (*Top Left: layering light blue; Top Right: layering cadmium yellow light; Bottom: layering green on statuette*)
Figure 2.3.4 Oil Painting in the Glazing Progress (Painting on left has less layers of glazes than the painting on the right)
Figure 2.3.5 Final Oil Painting of Still Life on Oil Grisaille
Vaughnn, Joella

If I were to make some changes to the painting, I would fix some of the proportions of the statuette and move the lettering on the monogramed letter upwards. Since I am used to glazing in oil, the only downfall that I noticed was the drying time and that if I didn’t wait until the glaze was completely dry, I would either mix the glaze to an undesirable color or smudge the details. I was also getting used to all of the colors in the still life, and learned some of the colors that I needed to lay down first before other. For example, I need to lay down the pattern of the blue and white-checkered blanket before I add highlights and lowlights. It also makes it much easier and efficient to lay down the correct base color of each object and then add detail. The strength of oil as a glaze was that even when mixing the paint with Liquin, the under-layers did not come up and dissolve in the Liquin. Overall, I am very satisfied with my painting.

IV. Acrylic Glazing

Acrylic is the second material that I glazed with on top of one of the acrylic grisailles. In the past when I painted with acrylic, I noticed that the paint dried fast and opaque. When I painted the acrylic grisaille, it was frustrating that I had to keep mixing the paint every time I wanted to add paint to the panel. I used alizarin crimson and phthalo green as the gray-scale because the alizarin crimson was a slow drying acrylic made from Golden Artist Colors. I thought that by mixing one of the colors with a slower drying time with a normal acrylic, I could length the drying time of my grey. While it did last longer than anticipated, it still was not enough time to maintain the color integrity of my pallet after an hour.

In order to stay true to the technique of glazing, I used an acrylic medium made of polymer gloss from Golden Artists Colors. The gloss both prolonged the drying time and
thinned the paint into films that I applied to the grisaille. Figure 2.4.1 depicts the process of glazing the acrylic paint. In the figure, I contrasted a glaze with the acrylic gloss medium and with water. Figure 2.4.2 shows the original acrylic grisaille.
Figure 2.4.2 Acrylic Grisaille for Acrylic Glaze
Figure 2.4.1 shows the difference in glazing acrylic paint with medium and water. The medium glaze is much smoother and contains minimal bubbles. It also creates a smooth and glossy surface that enables the painting to have a greater amount of texture and shine. The painting took several layers to completely capture the color of each object in the still life. Figure 2.4.3 depicts photographs of the painting along the glazing process.

![Figure 2.4.3 Layering Acrylic Paint](image)

*Top Left: lower right portion without cobalt blue glaze; Top Right: lower right portion with cobalt blue glaze; Bottom Right: painting with one coat of acrylic glaze)*

The main benefit that the acrylic glaze had over oil is the drying time in between glazes. I had to wait for the oil glaze to dry over night whereas the acrylic glaze dried during the time it took for me to work on another section of the painting. Since the acrylic glaze mostly involved using paint directly from the tube and thinning it with the polymer gloss, the mixing was not as time-consuming as it was during the grisaille stage. The final painting is depicted as Figure 2.4.4.
Figure 2.4.4 Final Acrylic Painting of Still Life on Acrylic Grisaille
The acrylic glazing process was much easier than normally handling acrylic paints due to the slower drying time. I definitely think this painting is successful, but there are some areas that could be improved, such as adding more highlights on the blue and white-checkered tablecloth. Additionally, it was difficult to achieve a glaze that was clear enough to keep the grisaille consistency but opaque enough to keep the color. The bottom right painting in Figure 2.4.3 shows the painting with one acrylic glaze, but the glaze itself is already too thick to work as a glaze.

V. Gouache Glazing

I chose gouache as the third paint to work with because it was a common paint that art teachers used in beginning art classes in order to teach the students how to mix color. Since I personally never painted with it, I decided to give it a try as a glaze by thinning the pigment with water (Meeks). Figure 2.5.1 pictures the original acrylic grisaille and Figure 2.5.2 depicts glazing gouache paint.
Figure 2.5.1 Acrylic Grisaille
Figure 2.5.2 Glazing Gouache (*Top Left*: Glaze of white gouache; *Top Right*: Glaze of primary blue mixed with white, visible bubbles; *Bottom*: application of white glaze onto acrylic grisaille)
As evident in Figure 2.5.2, the gouache paint did not seem to be a full glaze. In fact, in the later sections of painting, when I applied more opaque highlights and lowlights, the gouache completely covered the grisaille. Another undesirable characteristic was the chalky feeling of the paint after it dried. The oil and acrylic paints dried glossy, enabling them to look more life-like. The gouache dried very matte, and the layers of the glazes did not seem like they were strongly bonded together.

I experimented with adding salt to the mixing water, because I know that some artists buy water that is demineralized. When I applied gouache with saltier water, I noticed that not only did it dry matte, but it also left an even more present white film residue. That means I probably could have changed my solvent and gotten much better resulting texture of gouache paint. Figure 2.5.3 depicts the progress of the gouache painting during the glazing process and Figure 2.5.4 depicts the final gouache painting.
Figure 2.5.3 Photographs of Gouache Glaze During Painting Process *(Left: Light blue glaze on the background blanket and Right: Full painting glaze with one coat of color)*

I left the hand and black background bare of gouache color, as evident by the alizarin crimson that shines through the background. I believe that this was one of the most successful decisions of this painting and among my other paintings as well.
Figure 2.5.4 Final Gouache Painting on Acrylic Grisaille
I am pleased with how the gouache painting turned out, but there were several aspects of the paint that did not enable easy glazing. This will be discussed in more detail in the evaluation section. What gave the painting most of its character are the moments where the underpainting shines through and adds depth. For example, on the white foreground, some of the warm alizarin crimson is apparent, and it adds warmth and volume to the white blanket.

My color pallet was extremely limited because I did not have any brown-pigmented gouache color, so I created depth with black. When I re-created brown gouache color using the three primary colors, red, yellow, and blue, the brown was muddy and not the ultimate color that I wanted to use with the still life. I believe that the color and tone of the painting would improve with a wider variety of pure pigment, especially since glazing relies on optical mixing rather than physical mixing.

VI. Encaustic Glazing

The final paint I used was encaustic paint. Encaustic paint is not as commonly used as oil, acrylic or even gouache. As a result, premade encaustic paint was very difficult to find, and only a few art stores in the nation make and sell the product. The paint is a mixture of wax with pigment, and I applied it by melting wax on a hot plate, since the wax is normally solid at room temperature. The hot plate also serves as a way to warm waxy brushes, wax medium and slick wax, which is the brush cleaner. When I was finished with using a particular color, I would simply wipe the hot surface off with a paper towel. Figure 2.6.1 depicts the oil grisaille that I used to paint with encaustic paint. I made sure that encaustic would layer on oil on an alternate painting before I started painting for this project.
Figure 2.6.1 Oil Grisaille used for Encaustic Glazing

Before now, oil, acrylic, and gouache primarily required the same process for glazing, described in the first section. Encaustic paint has different properties, and thus
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required a prime surface to work on. My first step, before I could start painting was priming the surface with wax medium and heating the surface with a heat gun (EncausticPaint.com). Figure 2.6.2 depicts the melting of the medium and heating of the heat gun.

Figure 2.6.2 Priming Encaustic

Surface (Top Left: photograph of the wax medium that I used for priming purposes; Top Right: Surface of wax medium after application, very bumpy; Bottom Right: Photograph of wet, wax surface after I supply sufficient heat via a heat gun, pictured in the bottom corner)
The bottom right picture of Figure 2.6.2 depicts the wax surface after I apply heat. After it dries, it binds to the surface underneath. I used this ability to glaze paints and keep them from interacting with new glazes I added. The heat also enables me to smooth the surface and keep the bottom layers from adding thickness, or impasto. When I started the glazing process on the primed panel, I used a heat gun in order to cover larger areas of surface with paint and make them smooth layers (Azzera). Figure 2.6.3 depicts mixing the encaustic paint with medium in order to thin the pigment content as well as the initial application of paint on the surface.

Figure 2.6.3 Encaustic Glazing Process

(Top Left: Melting Titanium White onto hot surface and mixing with the clear wax medium; Bottom Right: Heating white on panel after it has been applied; Top Right: Surface of white paint application without heat gun)
One of the biggest challenges that I faced during the encaustic painting process was due to the fact that I was limited by my brush size. Encaustic wax brushes must be made from natural animal hair and not synthetic brush hair, otherwise they will melt. I did not take into consideration that I would need a smaller brush size, and when I used other brushes, their bristles melted and the brush became useless. Thus the level of detail that I was able to achieve was minimal compared to the other three paintings. Figure 2.6.4 depicts the painting during the encaustic glazing process.

![Figure 2.6.4 Photographs of Encaustic Painting during Glazing Process (Left: Photograph of a cadmium red glaze over coke can, and Right: Photograph of white and blue glaze during the process)](image)

Figure 2.6.4 Photographs of Encaustic Painting during Glazing Process (Left: Photograph of a cadmium red glaze over coke can, and Right: Photograph of white and blue glaze during the process)
Even through some setbacks in limited brush size, I enjoyed the encaustic painting process. The colors after layered several times are brilliant and the texture of the dried wax added impasto to my painting, something that would take layers or a medium to build in any of the other paints. The final painting is depicted as Figure 2.6.5.

To make improvements to my painting, I want to add more yellow in order to increase the level of warmth in the bones and in the statuette. I also would go back through with a finer brush and clarify details in order to make the painting less impressionistic and look more like my other three paintings. I was limited because I worked outside and in colder weather, which meant that the wax would solidify in the process of taking it from the hot plate onto the brush and applying it to the panel. Working in warmer weather and utilizing the hot gun more often could improve this.
Figure 2.6.5 Final Encaustic Painting on Oil Grisaille
Chapter 3: Evaluation

I. Introduction

In the evaluation process, I will look at the manufacturer and personal qualities of oil, acrylic, gouache, and encaustic paint. First, I will discuss pigment, how it is made and different attributes that give it better or worse characteristics. Since my trip to New Berlin, New York, I learned primarily about how they manufacture paint at Golden Artists Colors rather than pigment. Furthermore, my main comparison between my paintings is the different type of paint, not pigment. I will discuss some of the differences in pigment and problems that arise for paint manufacturers.

After I discuss pigment, I will go into detail about how quality in paint is generally achieved. I will discuss the details of the solvent, binder and media of oil, acrylic, gouache, and encaustic paint. Then, I will sum it up and present my final evaluation in a table and discuss which paint I feel performs the best as a glazer.

II. Pigment Quality

Pigment manufacturing is different from paint manufacturing. For instance, Golden Artists Colors buys their pigment from pigment manufacturers around the world
(Golden and Jackson), but they do not make the pigment themselves. Changes they
initially make to the pigment includes grinding the pigment in order to achieve a
uniform pigment size before they make a paste.

Pigment can fall under the following categories: inorganic and organic. As the
name suggests, inorganic pigment is composed of metals, such as titanium white.
Organic compounds contain carbon, and they are made from organic material, albeit
they are not always soluble in organic solvents (Mayer 31). Recently, organic colors are
manufactured to resist fading from ultraviolet radiation, which is helpful for outdoor
paints (Mayer 144 and 145). Care should be taken into what context the paint is used for,
whether it is industrial paint that must withstand strong temperatures and radiation, or
for an artist’s pallet.

During the painting process, for the most part, I was able to use the proper
pigment that mirrored the light I saw in my still life. Many of the pigment colors that I
used are commonly made in all four types of binders. For example, titanium white is
compatible with all four binders whereas lead white is only compatible with linseed oil
and alkyd (Mayer 114 and 116). Since I used artist grade paint instead of student grade
paint, the tubes of paint were usually labeled with the type of pigment. However, I
noticed that in the gouache colors, instead of calling the tube color by its pigment
content, it was labeled by its color, such as primary red or primary blue. When I used the
primary red, I found that when the color was thinned, the pigment appeared bright pink
instead of a dark red. Figure 3.2.1 illustrates this phenomenon I encountered. Mayer
warns his readers about companies that do not label their colors according to the ASTM
standards, American Society for Testing Materials (Mayer 13 and 339). The standards
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are not enforced but it is up to the manufacturer to label their paint according to the pigment inside of it.

Figure 3.2.1 Photograph of “Primary Red” Gouache

Some common differences in pigment quality that paint manufacturers must operate with are transparency, bleeding, toxicity, and many other characteristics. Pigments such as ultramarine blue tend to be more useful for glazing due to its greater translucent nature. Pigments such as titanium and flake white tend to reflect a lot more pigment, and manufacturers will add white substances in order to achieve a more opaque pigment. These additives can often decrease the purity of the paint mixture. Because white tends to reflect light across the entire visible light spectrum, it is a useful tool for under paintings, or grisailles. Thus, a more scientific reason for using a grisaille, where I mixed two complementary colors along with white in order to create a grey-scale, is so that when I paint layers of glazes on top of the grisaille, it acts as a mirror and reflects light that passes through the glazes and reflects on its surface (Mayer 160-161)

Transparency of paint explains another phenomenon during my painting process. I wrote about the difficulty in achieving a brown color in the gouache painting.
Even though I mixed all three primary colors together, the brown color was muddy compared to the color I could achieve from the pigment in burnt umber. The pigment in burnt umber, which is a type of iron oxide (Mayer 77), gives a much clearer reflectance of brown than mixing three colors together, all with differing reflectance spectrums. Thus, even though it teaches students discipline to mix colors using red, yellow, and blue, as an artist, it is to my advantage to use pre-made colors that contain pigment with a much clearer color than I could achieve mixing. When I do glaze colors, usually straight from the paint tube on top of a grisaille, the colors that overlap one another add together, just as two wavelengths of sound add when they exhibit the same sign (Mayer 163).

Additionally, when companies use additives, or adulterants as Myer states, they will cloud the true visible light absorbance, which means they give poorer quality paint. Manufacturers call these paints “student grade”. When I was at Golden Artists Colors, I learned that the cost of pigment was the most expensive part about manufacturing paint. Sometimes a primary supplier of pigment that their company bought from would go bankrupt or close down. If that happened, the company is responsible for finding ulterior pigment suppliers. When I asked if they ever downgraded pigment quality or charged the customer more for that particular paint color, the answer I received was that the company usually “ate” the cost of the increase in price of pigment. Golden Artists Colors strives to achieve the highest quality of pigment they can in order to produce paint today that is comparable to paint they produced fifty years ago. Mayer recommends student grade paint for artists who are learning how to paint, but argues that at a certain level, it is the artist’s responsibility to find good quality paint that is permanent.
Several other issues can occur with pigment. Some brilliant pigments can bleed, especially when a white coat of paint is applied over a color. For example, if I coated white over cobalt blue, and the pigment bled, the overall effect would be light blue. This only happens when the layer of paint underneath is not completely dry (Mayer 146).

Another issue that manufacturers and artists must take into consideration is the toxicity of the pigment, especially if an artist plans on making their own pigment. Pigments such as lead, cadmium, and cobalt are toxic, and sometimes can even poison (Mayer 153). I personally love the texture of lead white as a white oil paint. I use it as a semi-translucent white, and it especially performs well with tinting colors. However, even if I take precautions such as avoiding contacting my mouth, the lead can still stick in my fingernails and get in my food. Thus, it is recommended to use gloves when handling lead, cadmium, or cobalt pigmented paint.

Regardless of what the tube of paint says, there are always going to be slight variations in color across the same type of pigment based on many different factors such as pigment manufacturing, mixing, and additives. Furthermore, the color itself, when applied to the panel, can mix with colors applied underneath or even “look” different depending on what colors they are next to. This reason for variation in color is why my professor recommended toning our paintings. That way if I left the original panel uncovered, brilliant white would not show up but rather a toned color, which would mix well with the other colors applied in the painting. An illustration of the necessity of toning is that for example, the highlight on the statuette’s forehead would not look as brilliant due to the contrasting white would shows through from the original white panel.
III. Paint Quality

I visited Golden Artists Colors to see how they manufactured paint in New Berlin, New York. For the purposes of this thesis, I understand that there are many other manufacturers of paints, but I will talk about the qualities of Golden acrylic paint in particular because I viewed their factory and was able to speak with their Research and Development director, Ulysses Jackson.

One of the things that Golden prides themselves in is their quality of paint and how a tube of paint that they manufactured this year is the same color as one that was manufactured ten years ago. Some of the qualities that they look for during the manufacturing process include pH, density, gloss, tint strength, and many more. When they measure their raw material cost, they have to look at several considerations, including the pigment, chemical makeup of solvents and binders, shelf stability, quality standards, and cost to the artist. All of these issues are important when they are making decisions as far as what they want to add to their pigment and how they want to formulate their paint (Golden and Jackson).

When I visited the plant, I learned that they operate using a three-roller mill, depicted below as Figure 3.3.1.

![Three Roll Mill](image-url)
The mill is used to achieve particles of paint that are homogeneous in size as well as composition. Paint particle size is important for three main reasons: maintaining high viscosity, preventing flocculation, and preventing settling. The higher the viscosity of the paint, the less the pigment can move around in the paint, preventing both flocculation and settling of the pigment. Flocculation occurs when the particles reagglomerate, which makes them less vivid and optically clear. It can also cause inconsistencies in the color of the paint. Settling occurs when the particles, which are suspended in the binder, settle to the bottom (Paints and Coatings 6). This is equivalent to letting oil and vinegar settle into two distinct layers. I often see student grade paint will settle during its shelf life. Additionally, when I used the gouache paint, I noticed some liquid come out with a thin pigment content. This was due to the fact that the pigment was not completely suspended in the gouache mixture. For gouache paint, however, excess binder is useful in wetting the pigment, and gouache color can dry and cake without it present in the tube. In order to have a vivid color, it is to the manufacturer’s benefit to mill the particles as much as possible.

Paint particles enter with their binder in order to disperse the particles. The paint and binder enter the mills, which rotate in opposite directions. Golden uses the three-roller mill to grind their paint, which is useful for paints with high viscosity, but since the rollers are exposed to the atmosphere, care must be taken to keep the exposed pigment away from entering human lungs or outside air (Paints and Coatings 7). Golden uses two separate mills for their acrylic paint: one for white paint and one for colored paint. They also installed plastic screens around the milling area so that the pigment stays within a certain area and can be cleaned with ease. When they clean the equipment in between
batches of paint, they send the water to a treatment facility in their plant where they separate the pigment, binder, additives and any other impurity from the water before they recycle it to their water source.

The overall process of a paint manufacturing plant is depicted under Figure 3.3.2.

Figure 3.3.2 “Flowchart of paints Manufacturing Steps” *Paints and Coatings page 5*

The general process of paint manufacturing starts with adding additives, binder, and pigment into a feed hopper where they are weighed. The process usually happens in batches, but some companies can manufacture paint in a semi-batch process. The tank is fed to a mixer, and unlike the diagram, usually the tank is physically carried rather than sent through some type of piping system. The paste is milled for reasons stated earlier and sent to another holding tank. When the tanks are stored in between the process, they usually have a plastic film that seals the paste from the air around it, protecting both the integrity of the paint and the atmosphere from possible toxins. After the paste of mostly binder and pigment is milled, it is sent to a mixing tank where it is combined with the
solvent, dryer and possible plasticizer. Plasticity is an important characteristic for paint because it allows the paint to flow, encouraging molecular deformation, while also staying put once it is painted on a surface (Mayer 463). Finally, the paint is filtered from excess additives and sent to a packaging section where it is tested, pressed in tubes, and shipped to customers.

The process is important for the evaluation of paint quality so that I and other artists can compare paints with one another. It also puts into perspective how every quality, such as pigment differences or viscosity, comes together and allows the artist to apply a brushstroke of paint on their surface.

IV. Final Evaluation of Oil, Acrylic, Gouache and Encaustic Paint

In this final evaluation, I will introduce the specific binder, solvent and any significant additive to oil, acrylic, gouache, and encaustic paint. Then, I will comment on both the quality of the paint in terms of a couple manufacturing qualities and in terms of my own qualities. Finally, I will make a choice as to the best paint that I think should be used for glazing as well as other purposes for the other paint.

Manufacturers create oil paint by mixing pigment with linseed oil. Linseed oil serves as the binder and terpenoid or mineral spirit serve as its solvent (“M-6 Painting”). The purpose of a binder is to trap the pigment into a film that can dry and form an adhesive layer on a surface. Likewise, the surface must be primed in order to facilitate the adhesion of the paint film. Another purpose of the binder is to enable the pigment to optically reflect light and give the painting color. Linseed oil works in this regard because it is translucent and allows the color of the paint to dictate the color rather than the binder.
(Mayer p. 169). The solvent allows a painter to clean their brush and solvent. It also allows the painter to take off portions of the paint from their canvas. Some grisailles are formed in a subtractive process where the paint is added first in a thin coat and the painter uses a rag to take away the paint in order to paint the subject matter.

I first learned about glazing by working with oil, so naturally, the process went smoothly. Oil thins with Liquin, which is a gel that is a thinner and drying agent, but not a solvent. The pigment color stays in tact and the transparency that I created through adding Liquid was a perfect amount, not too opaque. The only setback I had with oil was the time it took for the layers to dry. Because I ended up layering the painting ten times, it took ten consecutive days in order to finish the painting. Additionally, when I added a glaze, I used extreme caution not to take off a drying layer with my hand when I worked on other sections of the painting. Oil Paint is not as expensive as gouache, but it is more expensive than acrylic paint. Oil paint also tends to be more viscous than acrylic and gouache paint, which gives a smoother texture and easier mixing.

Manufacturers create acrylic paint is by mixing pigment with a “polymer emulsion binder” (“M-6 Painting”). Artists use water as the solvent to clean their paintbrushes. When I glazed acrylic paint, I used a polymer gel medium in order to get a smoother and glossier glaze. Acrylic paint is beneficial because of its quick drying time. I was able to cover the panel with several layers of gloss in one night and finish the painting in a shorter, more concentrated amount of time. It is also non-toxic and is made with all of the same pigments as oil paint. The only draw back is also the benefit: the quick drying time. Sometimes, I find it useful to have wet paint on my pallet until I finish painting a particular area. That way I can keep all of the same colors and tones consistent.
When the paint dries quickly, I am forced to re-mix the paint, and I will never be able to achieve the same color as before. Another benefit of acrylic paint is its low price. Since acrylic paint is used in a wide variety of fields, including for industrial paints, the price of the paint is regularly low. High-grade acrylic paint has a similar viscosity to oil paint, albeit not as viscous. Student grade acrylic paint, which is the paint that I used when I first started painting, is watery and dries even faster. This further increases my resolve to use high quality paint when I am creating work.

As a glaze, acrylic paint was more opaque than oil and seemed to be less brilliant. That could be due to the fact that the medium I used with acrylic paint was colored milky white. However, when the paintings are compared, the polymer gloss that I used to glaze the acrylic paint makes the painting look brighter and more realistic. Between the two paints, I would choose oil paint. Even though it dries at a slower rate, oil paint has a better texture. Because oil paint is not significantly more expensive than artist-grade acrylic paint, I believe that it is worth the time to wait for the oil paint to dry. However, when using titanium white, care must be taken to make sure it is mixed with plenty of liquid, or it can take weeks to fully dry.

Manufactures make gouache paint by mixing pigment with a gum arabic or dextrin binder. Like acrylics, artists use water as a solvent to thin the gouache as well as clean their paintbrushes (“M-6 Painting”). Because gouache is extremely soluble in water, it can re-dissolve when water is added, even after a layer of gouache is applied to a surface and fully dry. I noticed this in particular when I layered gouache and then attempted to put another watery layer on top. I captured this experience in Figure 3.4.1. Gouache and watercolor are related by the way they use their surface to reflect light.
Artists apply watercolor in thin coats on a white paper surface. Thus, the watercolor uses the white of the paper to form a brilliant color. Gouache is typically mixed with inert substances such as chalk (Mayer 338). These colors add white to the paint, which gives the paint its opaque qualities just like watercolor uses the white of a paper to form a brilliant color. Another common characteristic of gouache is that the layers are thin, like tempera paint, and if they are applied too thick, they can crack. One problem in particular that I noticed from the gouache paint was the matte feeling that it has after drying. Gouache does not seem to share the gloss that acrylic and oil paint create when they dry. Lastly, gouache is extremely expensive. Specific pricings are listed for all paints in Table 3.4.1.

Figure 3.4.1
Photograph of Gouache Glazing that Dissolved Once Another Yellow Glaze was Added
Gouache did not serve as a good paint to use for glazing. The paint itself is fairly opaque and made for opaque purposes, which means it is not manufactured to operate as a glaze. A glaze should also be able to have adhesion to its surface. Since gouache was so soluble in water, previously dry glazes dissolved when I added new glazes. Eventually after a certain point, I had to apply more opaque layers of gouache in order to achieve the colors in my still life. I would not recommend glazing gouache or even watercolor due to the high water solubility. Gouache, however does serve well as paint for grisailles because of its high white content, and it can be useful in many other applications apart from glazing. Even so, I do enjoy how the background of the alizarin crimson shows through in my painting, especially since it gives sections like the coffee mug more warmth than even the acrylic or oil paintings provide.

Manufacturers make encaustic painting through mixing pigment with a beeswax binder (“M-6 Painting”). Artists use slick wax to dissolve pigment from their brushes, which is a compilation of artificially created waxes such as paraffin (the wax used for candles). The medium that I used to thin out the pigment load was also beeswax. In my art history course, I learned that beeswax was popular in the Egyptian times, and some of the paintings survived due to the protective properties of beeswax. The wax also gives the painting texture and brilliance, which is particularly present in my painting. The setback of beeswax is the fact that the paint can dry even before it reaches the surface, proving difficult to apply paint in thin glazes. When I used the heat gun to glaze the first layer of pigment, it worked perfectly. However, after I got a few layers in, I noticed that the heat gun would heat previously dry layers that I did not want to change and caused the layers to intermix. Thus, I ended up with a painting with a lot of texture because the paint dried
on its journey to the wooden panel, and I refused to use the heat gun unless absolutely necessary. The heat gun did prove useful in allowing me to fix my mistakes, which was not possible with gouache or acrylic paint. Encaustic paint was moderately priced, but less expensive than gouache, which serves as its main comparison.

Encaustic wax was successful at the first few layers of glazing, but it became difficult to control the temperature of the wax during application. I feel like it was more successful than gouache only because it created more brilliance and optical mixing, which was my goal of glazing the paints. Gouache and encaustic are normally not used as a transparent glaze, and I discovered that there are reasons for their higher use of body color over glaze. I believe that they are less successful as a glaze than oil or acrylic, and that encaustic paint is a better paint for the purpose of glazing than gouache.

From this project, I believe that oil would be my first pick as a glaze. That is mainly due to the fact that I like to homogenize my color pallet. Some artists may prefer the quicker drying time of acrylic. For the most part, gouache should not be used as a glaze, as it contains a very opaque binder, which makes it almost impossible to thin. It also does not completely stick to the panel once it dries, which makes it difficult to layer more than one glaze. Encaustic paint is a poor glazer in a different way. Since the paint needs to be melted on a hot plate, the temperature of the paint is not constant, and therefore inconsistent in texture. Since the texture of the wax builds fast, it hides the color of the paint underneath. The heat gun helps in homogenizing the texture, but it also can liquefy previously dry layers. My final choice would be to use oil as a glazing paint, but I recognize that the difference is purely preference. Additionally, there are many other uses
of oil, acrylic, gouache, and encaustic paint other than glazing. My findings are summarized in Table 3.4.1.
Table 3.4.1 Final Comparison between Oil, Acrylic, Gouache, and Encaustic Paint

<table>
<thead>
<tr>
<th>Quality</th>
<th>Oil</th>
<th>Acrylic</th>
<th>Gouache</th>
<th>Encaustic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Binder</strong></td>
<td>Linseed Oil</td>
<td>Polymer emulsion</td>
<td>Gum arabic</td>
<td>Beeswax</td>
</tr>
<tr>
<td><strong>Solvent</strong></td>
<td>Terpenoid and mineral spirits</td>
<td>Water</td>
<td>Water</td>
<td>Synthetic wax, Paraffin</td>
</tr>
<tr>
<td><strong>Medium for Glazing</strong></td>
<td>Liquin</td>
<td>Golden Artists Color</td>
<td>Water</td>
<td>Wax Medium, beeswax</td>
</tr>
<tr>
<td><strong>Price per mL ($/mL)</strong> (prices found on Amazon marketplace of artist quality paint of titanium white)</td>
<td>0.273</td>
<td>0.148</td>
<td>1.02</td>
<td>0.190</td>
</tr>
<tr>
<td><strong>Viscosity of Glaze (Rating 1 to 10, 10 being the highest)</strong></td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Drying Time of Glaze (Rating 1 to 10, 10 being the longest)</strong></td>
<td>10</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>Texture of Glaze (1 to 10, 10 being the glossiest and 1 being the most matte)</strong></td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>Performance as a Glaze (1 to 10, 10 being the best performer)</strong></td>
<td>10</td>
<td>7</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Conclusion and Recommendations

The purpose of this thesis was to paint four paintings, each with a different kind of paint and compare the quality of paint and how it performs as a glaze. I conclude that oil paint serves as the best vehicle for glazing. I recognize that other artists may have other preferences. If artists favor a shorter drying time, then acrylic paint may be a better paint for them than oil paint, provided they use an appropriate medium other than water. I also conclude that gouache and encaustic paints, while fun to paint with, are not properly made to glaze since they are both highly pigmented and do not hold layers of glazes successfully.

I also believe that it is important to consider both my art and engineering background when making decisions as to what paint I choose, what solvent to use and what surface. Without either, this thesis would not have been complete. My artistic background served as experience that I utilized when I created the four paintings. My engineering background served as experience to investigate the chemical properties of pigment, paint, and the process in which companies manufacture paint. I believe that I was successful at capturing both aspects of my undergraduate career.
In order to improve the project, I would investigate differences between student grade and artist grade paint. This would enable me to understand the differences that the adulterators play in the performance of paint, such as chalk and drying agents. I would also choose a different company to buy my gouache colors from as well as purchase a greater variety of gouache color so that my pallet was not limited. Finally, I would investigate how paint performed not only as a glaze but also as a base color. That way I could see the differences in paint as it relates to transparency and opacity.
Bibliography


Appendix

Interview Transcription with Dave Ghildarducci

“I guess the way I look at this subject is to figure out why people have separated the arts and engineering. It’s one of those things few can clearly explain and I get a lot of rhetoric about it's always been that way. Simply put it hasn't. To be good in engineering requires creativity and the same applies to art. I realize you can make a middling career in either by becoming somewhat proficient at a method and applying that method over and over. If you look at nature and see how the natural world solves its problems, it typically does so beautifully and simply. It's been my engineering experience that the simplest solutions also are the most elegant and the most robust. That, to me implies the two should not be separated.

History is filled with examples of engineering combined with art making lasting impressions on people. Think of the great pyramids or classical roman or Greek construction. If architecture feels like too much of a blend, I'd suggest looking at how embellished furniture became. Even scientific tools became adorned, look at things like sextants and astrolabes. Orreries are amazingly beautiful and very much were a scientific tool. Closer to our time, we can observe many consumer products are engineered and designed for both aesthetics and function. People natively like things that work and that are attractive to them. Recently the iPod revolutionized music and it's not really that revolutionary, personal music players were around before it, but the blend of art and engineering made that product work in a way the others didn't.

I'm happy that educators are once again realizing the value of the arts in education. I am trying to do my part to advance STEAM versus just STEM. I find when teaching blends art with tech, people tend to learn both a little more. They get excited and then they play. Let's also notice that almost all people as children have no fear of a pen, pencil or crayon to draw a picture, it's only with age we develop some disdain for our ability to draw. I think we also talk ourselves out of our ability to solve engineering problems. If we encouraged both from an early age, imagine what we as people can do?

Good luck with your studies in medicine. Please let me know if this helped you and if you need some more thoughts. How did you find me?”
“Hi,

Some how your response to me went into my spam folder. Odd. I changed the title and added you to safe senders.

I sent you some information last weekend, but here's answers to the latest questions you have posed.

The latest installation is very broad in it's concepts. There's so many things going on and actually some of them are discoveries for me as well. Here's what happens. The idea is presented to me that they want a large immersive sculpture. They like the idea of a tape sculpture. That's about it. Then the questions, can I do it? How big can it be? How long will it take? You get the idea. So then the engineering processes start. To make something people can move in, you have to become familiar with loading of a flexible surface, tensile strength of packing tape when applied perfectly, tensile strength of packing tape when applied improperly, etc.. Then the shapes need to be referential to something. I originally thought of making molecules of nucleosides with the atoms being represented correctly in relative size and using the bonds to make the passageways through them. We had a math group get involved and they wanted to be a part of it, so then we discussed mathematical shapes. This piece gets several, toroids, pair of pants and schwarz-p surfaces. So there's the math. Then back to mechanics for the structure to form this and to apply cabling for strength. Beyond that there's all sorts of little engineering decisions while taping to make sure the structure is robust. The art part of it becomes easier. The shapes are naturally beautiful, it becomes my task to arrange them pleasantly. Then there are the happy little accidents that occur as you tension the structure and curves appear where you hadn't thought about them.

You can see the completed piece at 'Taping Shape' is a new exhibit at Reuben H. Fleet Science Center

You can also search San Diego Taping Shape and there's a bunch of hits right now.
Concepts I look for: I don't look for them, they happen naturally. In art, I feel you are trying to have a conversation with a person who may not be having a conversation with you, the work is the conduit for that interaction. So fundamentally, for me art is a language. Then the engineering becomes the tool I use to create the conduit. They are inseparable for me and truly symbiotic. Conversely, I find when I am doing engineering design, I tend toward the same design principles. I own an engineering firm and do some of the PCB design work. My boards are clearly mine and my layout guy has his own style too. My mechanics also echo my design style, I am a fan of Dieter Rams for example and his influence is clear in my work.” - Dave Ghildarducci, 09 February 2016