

To: Evelyn Meisenbacher

To: Answer Tech by Winfield United

From: Will Teachout

Date: 12/17/18

Subject: Recommendation Report for Integrating Agricultural Drones into Precision Agriculture Practices

Thank you for allowing me this opportunity to research agricultural drones, their features and technology, and the practices of precision agriculture in the aid of integrating drones into the practices of precision agriculture within the Winfield United Cooperative using Answer Tech technology. I have enclosed the results of my research as a recommendation report, "Droning the Fields: Recommendation for Precision Agriculture." The attached report describes my research on drones and precision agriculture which I completed in response to your approval of my proposal on November 14<sup>th</sup>, 2018.

To evaluate the compatibility of drones, I researched the different types of drones, their features, and some examples. I also did some research on current precision agriculture practices in order to evaluate how well drones could be integrated into the process of precision agriculture.

To summarize my findings, I discovered that drones and the technology associated with them would be an excellent fit into the practices of precision agriculture because they essentially practice the same techniques when applied correctly. Also, both practices essentially have the same goals, to reduce ecological harms, increase precision, and increase efficiency. Overall the information gathered in my research leads to the conclusion and recommendation that Winfield United should pursue the development and integration of drones into their precision agriculture practices.

I appreciate the opportunity to provide this information and assist Winfield United in this phase of development. If you have any questions about the material contained in this report, do not hesitate to contact me at [teach022@umn.edu](mailto:teach022@umn.edu).



# Droning the Fields: Recommendation for Precision Agriculture

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Prepared for: Winfield United & AnswerTech

## Abstract

### “Droning the Fields: Recommendation for Precision Agriculture”

The purpose of this report is to determine if the use of agricultural drones would be appropriate for integration into Precision Agriculture. On November 14<sup>th</sup>, 2018, Evelyn Meisenbacher and the AnswerTech team at Winfield United approved a proposal to investigate and identify the drone technology that would be a suitable addition into precision agriculture. This recommendation report represents the cumulation of the research process. To fully investigate the technology of the drones, I had to evaluate the different types of drones and their features. I then had to investigate their compatibility with current precision agriculture practices. To accomplish this goal, I researched the topics using the University of Minnesota Library System to which I found many print and online sources which I consulted in my research. I also conducted an online google form survey which asked about the current awareness of agricultural drones, technology, and precision agriculture. My findings revealed that the current drone technology would fit in almost perfectly with current precision agriculture practices, and that farmers are currently exploring new ways to use drones in their practices. The survey results were that most people had an understanding about drones in agriculture but did not know much about their technology or about precision agriculture. Overall, this research leads to the conclusion that drones are an acceptable and compatible technology with Precision Agriculture. Thus, I recommend that Winfield United and AnswerTech pursue development of drone technology with their precision agriculture practices.

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## Introduction

Agriculture has been the challenge to produce as much food/produce as possible while utilizing as little resources as possible. This challenge has been combined with many challenges over the years, the most relevant being the increasing population and hunger issues facing the world today. One of the most prominent technologies to help solve this issue is the use of agricultural drones, which has exploded in popularity over the last few years. Drones and their technology have the capacity to help make agricultural practices more sustainable and productive. The purpose of this project would be to implement and assess the usage of drones into precision agricultural settings to deem them successful in creating more productive and sustainable practices.

This report aims to address how Winfield United, the owner of AnswerTech, can increase the effectiveness of their sustainable practices of the members of the Winfield United Cooperatives. Currently AnswerTech is utilizing drones in their Answer Plot® program to capture real time images to see how the plants respond to their surroundings in the fields (Miller).

This report provides a description of the research methods used and the results gathered, a discussion of the results' meaning as well as a conclusion. This report ends with the recommendation that drones and their technologies should be more heavily integrated into precision agriculture practices.

## Background: Drones in Agriculture

According to an article in the MIT Technology Review, Farmers are currently utilizing drones to better manage the growing of their crops using pictures taken by their drones. To farmers, drones are simply low-costing aerial cameras that can take pictures to monitor their fields. What makes these drones different from simply taking pictures of a field from a plane is the technology

within the drones themselves. Drones can use autopilot systems that when paired with a GPS can effectively map out the entire field and create a “high resolution mosaic map” for the farmer to review (Anderson).

According to an infographic from the company Dronefly, drones have more capabilities than just taking pictures of fields. The article lists out 4 major uses of drones in agriculture. The first is Mapping/Surveying, which was discussed in the MIT Review. The second is Crop Dusting/Spraying which means that drones can crop dust and apply sprays on areas of the field that require it at a fraction of the cost. The third is Irrigation Management, which means that drones equipped with thermal imaging can scan the fields to see where water is pooling in the fields and where plants are not getting enough moisture which will help farmers understand their irrigation practices more clearly. The final one is Livestock Monitoring, which is simply monitoring livestock without having to physically go out to the pasture where they are at, so farmers can effectively monitor their livestock always (Dronefly).

## **Background: Precision Agriculture**

According to an article on AgFunder News, Precision agriculture is essentially taking everything that can make farming more accurate and controlled and implementing those things with new technology and practices. Precision agriculture first came about in the 1990s with the introduction of Variable Rate Technology, GPS Soil Sampling, Computer-based applications, and remote sensing technology (Schmaltz). These new technologies allowed precision agriculture and agronomics to ensure profitability, efficiency, and sustainability while protecting the environment. The practice does this by only applying fertilizers and sprays when absolutely needed and where it is needed so there is no waste and overapplication of materials. This also



allows farmers to monitor their fields and have their automated technology do the difficult and complicated work for them.

## Methodology & Results

In order to evaluate the abilities of drones and their features, and assess their compatibility with precision agriculture, I conducted some research with the University of Minnesota Library Databases where I found journals, a case study, and various articles depicting these technologies. Most of these sources were online/web sources but some were digitized print sources that I could acquire in physical formats if I wanted. The empirical research I conducted was a short survey, which I posted to Facebook and Reddit, to which 29 people responded to questions that asked about the general awareness of agricultural drones, technology, and precision agriculture.

## Precision Agriculture Practices

Precision agriculture is also known as Precision Agronomy, which is simply put in a collection of journals on Science Direct, as “The matching of agronomic inputs and practices to localized conditions within a field and the improvement of the accuracy of their application” which essentially means that the practices of Precision Agriculture are focused on localizing the inputs of different sprays and materials to the areas of the fields and plants that need it the most (Finch, Samuel, & Lane). An article in the same collection from the Reference Module in Food Science Journal states that “Precision agriculture (PA) is the practice of managing variability in space and time” and “The application cycle for PA is observation, evaluation, interpretation, targeted management, and observation” (Leonard). The book Sugarcane describes Precision Agriculture as “sometimes called ‘prescription farming’ or ‘variable rate technology’, is a set of techniques that can be used in several areas of agricultural science”, “new management technology based on georeferenced information for the control of agricultural systems”, and “detailing of

georeferenced information through the application of monitoring processes and integration of characteristics of soil, plant, and climate” (Varella, et al). The book *Perspectives for Agroecosystem Management* describes the goal of precision agriculture as to “reduce environmental loadings by applying inputs such as fertilizers only where they are needed, when they are needed and in site-specific amounts. Site-specific crop management aims at optimizing agriculture production by managing both the crop and the soil with an eye towards the different conditions found in each field” (Schmidhalter, et al). In general, these definitions state that precision agriculture is the combination of new management practices with the introduction of new technology to assist in those management practices. These definitions cumulate with the idea that the goal of precision agriculture is to use these new management practices and technology to be more precise with the field inputs in order to lessen the environmental strains on the plants and the fields by taking into account all variables.

### **Agricultural Drones**

Agricultural drones are one of the most sought-after new technologies in the agricultural industry. Their variability in function as well as their relatively low cost, when compared to other agricultural machinery, makes them an obvious competitor in the race of new agricultural technology that can be integrated into precision agriculture. According to a case study done by the Food and Agriculture Organization of the United Nations, drone technology is extremely adaptable for situations. At its core, a drone is a “mobile, aerial platform for advanced image data acquisition” and it can be modified with different features based on the needs of the operator. It can have data sensors, different cameras, sprayers, and can be controlled by an automated system (Drones for Agriculture 27).



According to a poll to farmers done by Dronefly, one of the largest and most well-known drone stores, drones are slowly integrating themselves into the practices of farmers. 1094 farmers participated in the poll which asked the question “Are Farmers Actually Using Drones?” and the results are very interesting. About 33% of farmers said that drones are currently being used and operated on their practices either by themselves or a third party, 31% stated that they are considering using drones in 2018, and 37% are not considering using drones on their practices. This is good news for the drone industry with about 64% of polled farmers stating that they are currently backing the use of drones or are planning on in the future.

An article from the American Farm Bureau supports the poll data by stating that Farmers and Ranchers are excited to use drones to improve their practices. Combined with precision agriculture, drones can help to protect the environment, increase production, and have less inputs to the land (Farm Bureau Newsroom).

## Features

According to the infographic provided by Dronefly, there are 4 major uses for drones in agriculture. These are Mapping/Surveying, Crop Dusting/Spraying, Irrigation Management, and Livestock Surveillance/Management. The types that matter most to precision agriculture are Mapping/Surveying, Spraying, and Irrigation Management.



Drones that are designed for mapping and surveying fields are always equipped with cameras of all sorts. Whether that be a normal camera, an infrared camera, or one designed for monitoring soil pH or moisture, it will always have a camera. When drones map out a field, they are always attempting to learn as much as they can from the images. Normal pictures can become a mosaic map of the entire field which can give a general overview of how the plants are growing based on looks alone. It is also helpful for finding out where in the field needs water and where water is pooling/oversaturating the soil.



Infrared & thermal cameras operate in similar ways as the normal cameras do, except they look at the temperature of the plants and the soil to measure the effectiveness of irrigation practices to check where water is needed (Dronefly).

Surveying drones are sometimes equipped with every type of camera & scanning equipment to scan the field entirely like how satellites scan the field. Even though these practices are similar, they require many different techniques. According to two posts by the agricultural satellite company Geosys, drone scanning is similar to satellite scanning because they are both accomplishing the same goal. However, there are some key differences between the two technologies. Satellites cover a much larger area more quickly and deliver imagery at a lower resolution at a cheaper input cost. Drones can cover a smaller specific area, at a higher resolution, with a higher input cost (Geosys). When asked about drones specifically with their

satellites technology, they responded by stating they are not opposed to the development of drone scanning technology, and they are waiting to see how well the new waves of drone technology performs by itself to see if it can be complemented or compatible with the satellite technology (Geosys).



Because the objective of precision agriculture is managing inputs to limit over-application of fertilizers and to only apply where and when needed, the usage of spraying/dusting drones is very important to precision agriculture. Because these drones can utilize programs that take the survey map, they can limit their application of fertilizers and treatments to the areas that require it from the survey. These drones work hand in hand with precision agriculture to be precise with the application of fertilizers from the start.

## **Examples**

Survey and imaging drones have already been implemented into some precision agriculture practices and have been getting promising results. The agricultural company Belje has been experimenting with utilizing the imaging power of drones in their precision agriculture practices. Belje utilizes the drones to take photos of all of the arable land they manage in Mirkovac Croatia

to collect data on the fertilization needs of the wheat crops. After the data collected by the drones is analyzed it is transferred to a GIS system to create fertilization maps of the entire fields, then the maps are sent to satellite guided tractors that ensure the precise fertilization of the wheat. The article says that the drones help to protect the environment, reduce the material costs, increased productivity and improved the ecological component of their practices (ENP Newswire).

On an Oregon Potato Field experiment from the United States Department of Agriculture (USDA) and the Federal Aviation Administration (FAA), the 2 drones that monitor the field are equipped with cameras that can zoom onto a single leaf to assess water and fertilizer needs. They are also equipped with sensors that are able to track stress signs from the potato plants (The Free Library).

According to an article from DroneAddicts, there is a drone project in the African country of Malawi, that utilizes drones and sustainable agriculture to gather insight in the crop production in the area. The drone will survey fields to hopefully improve production because of the food shortage currently affecting the region. The project hopes to aid the shortage by planting crops in the most lucrative areas that the drone finds in the scans and eventually provide a permanent solution to the droughts and lack of production (Bernard).

### **Agricultural Drones, Technology, & Precision Agriculture Awareness Survey**

Agricultural drones and precision agriculture are important topics in today's world. It is important that the public is aware of these new innovations, and that they support these new practices in order to better agriculture for the future generations. In preparation for this report, I sent out a survey on Facebook and Reddit in order to analyze the awareness of these technologies in the public. The survey consisted of 7 questions with one of those being a free response about the personal opinion of the survey-taker. The goal of the survey was to see how much people

know about the new agricultural technologies that are being used today, and to see what people think about these new practices with precision agriculture.

The first question on the survey asked if they knew about the use of drones in agriculture. 17 people said yes, and 12 people said no. This was not very surprising based on the demographic of the people I know on Facebook. However, I could not effectively assess the demographic from Reddit because it is an open forum.

The second question asked if they knew anything about satellites in agriculture. Unsurprisingly, this yielded the same results as the first question.

The next question asked if they thought that automation is a good practice in agriculture. I asked this because my research proved that automation is one of the key features of using drones in agriculture. The results were that 18 people agreed, 7 people strongly agreed, and 4 people were neutral about the topic. This stated that no one in my poll disagreed with the use of automation in agriculture, which is favorable for my goal of introducing drones into precision agriculture.

The next question asked how people feel about the use of precision agriculture. According to the poll 17 people responded with that they have never heard of it before and 12 people saying they support it. This surprised me because I thought precision agriculture was a trending practice, but I was mistaken.

The next question asked about how people feel about combining drones and automation with precision agriculture. Because of the results of the last question, I was not surprised by these results. 19 people stated that it could help to create more efficient practices, while 10 people said that they don't know enough to make a decision about the topic.

This last required question asked about whether they feel that the use of drones and automation with precision agriculture is a step towards solving the world food problem. The majority of

people said yes with 20 people saying yes, 8 people said that they don't know enough about the topic, and 1 person said no. This was interesting for me because after checking the rest of the responses, I did not expect anyone to say no to this question.

The final question was an open response question about the opinions of the people who responded to the survey. Many of them were talking about how they supported new technology that helps agriculture be more efficient. The one person who said no to the last question stated that food distribution is the correct way to go for feeding the world instead of new technology.

## Discussion of Research Results

The awareness survey, print sources, and online sources provided useful information for assessing whether drones should be implemented into the realm of Precision Agriculture. This section interprets the results to find whether drones should be implemented into the practice.

## Regulations

In order for drones to be integrated into the practice of Precision Agriculture, they must be favorable to farmers and the public so that regulations can be made by the USDA and the FAA so that drones will be able to effectively operate in the fields and in the sky. The poll by Dronefly and my survey gave evidence that most people and farmers are supporting the introduction of drones into agriculture. By having public support for drone use, this will make for an easier introduction of drone regulation by the FAA.

## Compatibility

Precision agriculture is an incredibly complex practice, which involves heavy management and regulation of the systems in the practice. According to the definitions of Precision Agriculture and the descriptions of the functionality of the drone technology, they both share key components. Drones utilize automation technology used by the scans of fields to manage inputs

so that there is no over-application of fertilizers/pesticides. This allows drones to be compatible with current satellite use with precision agriculture if the practice does not want to pursue scanning from drones. If the practice does want to pursue scanning with drones, they are in a good position to begin precision agriculture if they haven't already. According to the research, I believe that drones would be compatible with current and future precision agriculture techniques and practices.

### **Efficiency & Sustainability**

The combination of drones, automation, and precision agriculture is a very efficient and sustainable solution to conventional agricultural practices. Drones, with their many features and benefits, provide a cheaper and more automated version of agriculture that allows for farming practices to become more precise and efficient with 1 drone able to perform multiple scans of an area in order to track issues more easily and clearly. Because farmers can use drones on an automated system without having to control them, this will increase efficiency on the farm as the farmer does not have to busy himself with spraying an entire field using mechanized equipment, he can simply use the multiple scans of one or more drones, and send out a sprayer drone to provide individual treatments and sprays to the areas of the field that needs it the most. This will greatly reduce the need and cost of inputs and the precision of the treatments will decrease runoff which will help to create a more sustainable practice.

### **Limitations of Survey and Report**

Even though this report relies on research from print, electronic/web, and empirical sources in an attempt to provide the most useful information regarding the compatibility of drones with precision agriculture, there are still some limitations in this report. The small sample size of 29 for the survey is one limitation. The lack of demographical information collected from the



respondents of the survey is another. This report only gives a compatibility recommendation of if the features and technology of drones is capable of being integrated into precision agriculture and does not consider if it is a feasible recommendation financially and whether this tech could become outdated.

## Conclusions and Recommendation for Drones & Precision Agriculture

In conclusion, drones and their features/technology are a perfect match for precision agriculture practices. Drones provide new ways of management, versatility, adaptability, and variability that will fit in and has been fitting in perfectly with the practices of precision agriculture. Therefore, I recommend that Winfield United along with AnswerTech and Geosys peruse the use of drones and their automated technology to use in their precision agriculture practices within their cooperative and businesses. Drones offer the possibility to create even more efficient and sustainable practices with these new technologies and features with the full integration into precision agriculture.

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## Appendix

# Technology & Drones in Agriculture

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This survey is for my Formal Report for WRIT 3562w about the recommendation of increased usage of drones and technology in agriculture. Thank you for your participation!

---

### Email address \*

Valid email address

---

This form is collecting email addresses. [Change settings](#)

Have you ever heard of the use of drones in agriculture? \*

- Yes
- No

Have you ever heard of the use of satellites in Agriculture? \*

- Yes
- No

Do you agree that automation is a good practice in agriculture? \*

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

How do you feel about the use of Precision Agriculture? \*

- I support it
- I do not support it
- I have never heard of it

Do you feel that the use of drones and automated technology in agriculture could help create more efficient practices with precision agriculture?

- Yes
- No
- I do not know enough about this topic

Do you feel that the use of drones and automated technology with precision agriculture is a step towards solving the world food problem?

- Yes
- No
- I do not know enough about this problem

Do you have any opinions or comments on the usage of drones, automation, or satellites in Agriculture?

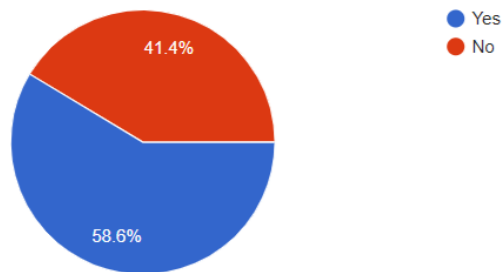
Long answer text

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## Charts of Survey Results

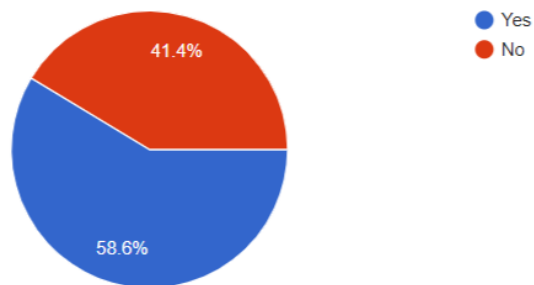
Have you ever heard of the use of drones in agriculture?

29 responses



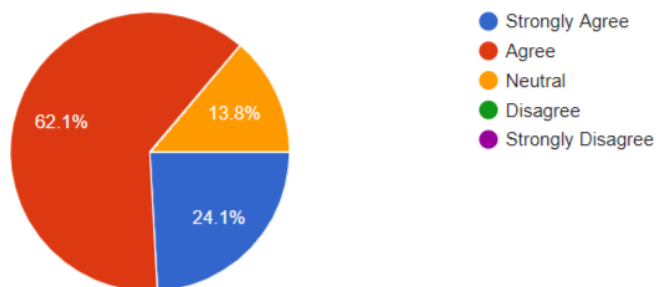
### Have you ever heard of the use of satellites in Agriculture?

29 responses



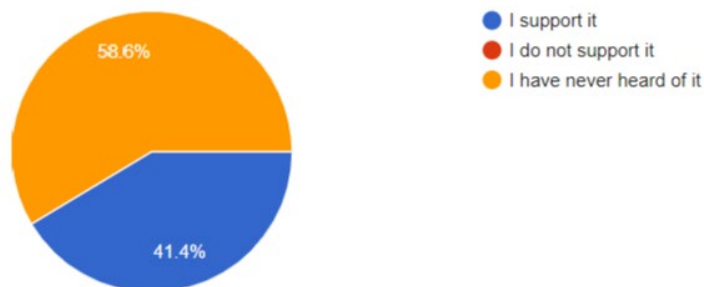
### Do you agree that automation is a good practice in agriculture?

29 responses



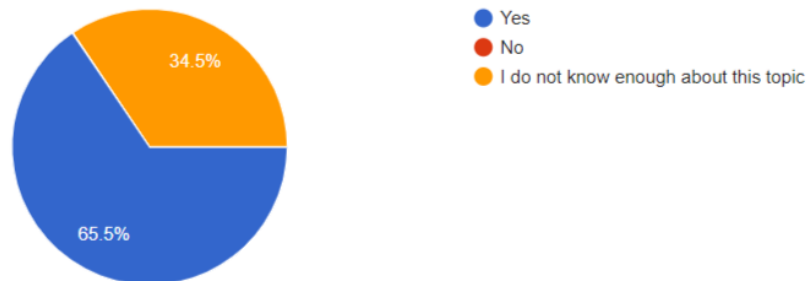
### How do you feel about the use of Precision Agriculture?

29 responses



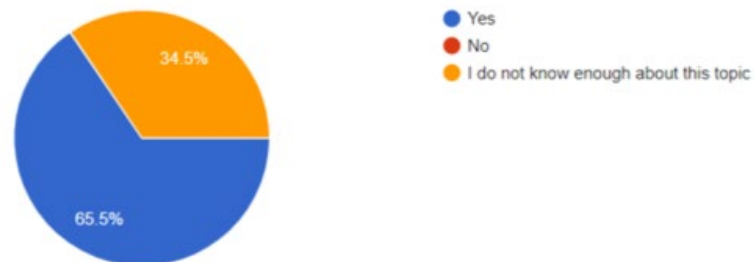
## Do you feel that the use of drones and automated technology in agriculture could help create more efficient practices with precision agriculture?

29 responses



## Do you feel that the use of drones and automated technology in agriculture could help create more efficient practices with precision agriculture?

29 responses



Drones, automation, and satellites help farmers use their land most efficiently and effectively. In order for us to get the most food out of the farmland we have, we must be as efficient as we can.

I don't know a lot about this, but if I'm guessing right I think using this technology will help to maximize crops by locating peak and problem areas for planting and feeding.

Nice step forward

Having agriculture keep up to date with innovative technologies is important. These new technologies could assist in developing solutions to problems that have faced agriculture for a long time.

There is certainly potential (probably proven) that such practices increase yield, but I'm skeptical as to whether some of these methods are cost effective. It is also important to note that such practices are likely to benefit only a small demographic portion of the farming population. Also, increased food production doesn't necessarily solve world hunger. Rather, I would say that world hunger is more an issue of food distribution.

Unfortunately I do not have the necessary knowledge to feel comfortable making an opinion on this subject. However, I am now very interested in reading into this subject in order to make my own conclusions.

just don't know enough about it

I am all for greater efficiency in agriculture. Which automation does provide.

Man, you need to get a position at land o'lakes when you graduate, then make them pay for your Graduate degree. What a fantastic idea to use drones in ag. I follow "fromwhereidrone" on instagram, just photos but from angles not normally seen by the human eye. I can definitely see a use for it, from tracking livestock to tracking land and weather conditions. Keep me abreast, I'm totally glued.



## Statement on Goals and Choices

Upon finishing this final report, I found that it was very similar to many of the lab reports that I have written, but not to this extent. I found that I have done more extensive research on this project compared to some of the other research papers that I have written. Maybe it is because I have finally found something that I am interested in instead of researching a topic just for an assignment. I am glad that I found that I enjoyed this topic to the point where I was excited to find out more things about drones and precision agriculture. I wish I would have begun writing this report earlier, so I could have evaluated my sources more carefully so that I could have found better information about my topic. I enjoyed the process of a proposal, to an outline, to a final report, and then to a final presentation that summarizes the report.

I feel that I have grown as a writer in the process of creating this formal report. I am glad that I have progressed so far in my technical and professional writing to the point where I am no longer “technically writing”, instead I feel that I have the capability to write technically with images and combine that with aspects of professional writing, like this report. Overall, I felt like this report went smoother than I expected it to, especially since I was initially worried about this report when viewing the syllabus. I also admit that I often doubt my writing capabilities when writing, but I did not seem to find that when writing this report and I am thankful for this class for increasing my own confidence in my writing.

So, in closing, I feel that the decisions that I have made when writing this report have been backed by the lessons that I have been taught both in this class and in my previous writing exploits. So thank you Evelyn!