X-band Radar:

Radar for Monitoring the Airport Environs

FAA University Design Competition

Airport Management & Planning

Student Design Team

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Executive Summary

X-band radar can be used to track and count aircraft at non-towered airports. These counts will allows airports to identify the number of operations at their airport, the most frequently used patterns, and track flights over noise sensitive areas.

This project will demonstrate the ability of an X-band unit to track aircraft by using four major components together. Those components are the 1834C/NT NavNet with dome radar, ARP 11 Autoplotter, PG500R rate compensated heading sensor, and BBWGPS. Together, these components allow the radar unit to track targets and transmit the data to a computer for processing.

In order to use the radar, the team needed to contact the FAA and FCC to get licenses to use it. This process of waiting for the license took longer than expected and caused a delay in the gathering of data. Although the team was unable to gather any data, the radar unit was ready to be deployed and begin the data gathering process. Once the license is received the team will proceed with the collection of aircraft counts and flight paths.

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1.0 - Introduction

Counting and tracking aircraft at airports without an air traffic control tower is often necessary to quantify the level of operations especially during busy periods and in some cases to evalutate flights over noise sensitive areas. Obtaining this data is either labor intensive and expensive, or automated with equipment that may not be very accurate. In any case, these counts evaluate the potential for enhancing safety on and around airports.

The purpose of this project is to determine the viability of using X-band radar for counting and tracking aircraft around an airport. This project is designed to be a tangible and inexpensive first step (phase 1) in the conceptual development of a system to increase runway safety and prevent runway incursions. This project serves to demonstrate that the application of a simple and inexpensive radar system can identify, track, and record airborne and ground targets.

1.1 – Background

Developing a method to monitor flight patterns without an air traffic controller is a process currently unavailable. With air traffic control towers costing millions of dollars to construct with expensive staff, it is out of the reach of some small, but busy general aviation airports. Instead, a more economical method for detecting air traffic would be preferred, and with the help of X-band radar, this method could be achieved.

The scope of this project is to better understand and demonstrate the use of X-band radar as one key component of a larger system. It is anticipated that the radar will be able to provide reasonably accurate target data that can be used to quantify aircraft operations, directionality and traffic pattern characteristics. In order to see whether or not the SATAS project would be possible with integrated radar, this project examines uses of X-band radar and current methods of counting and/or tracking aircraft at non-controlled airports.

Finally, an off the shelf X-band radar unit will be obtained and actually tested in the field to see whether or not the tracking of targets is possible, and to what degree of accuracy it can provide the information to a database. This information will be used to quantify the aircraft utilizing the airport, hoping to improve on current counting techniques; and it will also be used to plot the paths of the aircraft.

1.2 – Literature Review

Iowa Department of Transportation Study

Phillip Meraz from the Iowa Department of Transportation did some work with microwave radar and initially used it to count traffic on Iowa highways. The set up he used consisted of the radar and a computer to collect the data. This system was and is still used to collect data on Iowa highway traffic. The system collects speed, distance between cars, lane density, and keeps track of the number of cars passing. The system ran off of marine deep cell batteries and used solar cells to charge the batteries. Mr. Meraz as a side project in 2002 installed this system at two local Iowa airports in Ames and Ankeny. The system ran off of 2 marine deep cell batteries, which could power the unit for a month. He used the system to try to track take offs and landings. However, the system was not accurate due to the limited range of the digital microwave radar. The system was left up for a couple of months and the data was inconclusive[12].

ACRP 4 Synthesis Report – Counting Aircraft Operations

There are many ways to count aircraft utilizing airports, and this ACRP synthesis report explained six technologies and five methods, as well as documented the use of these methods through questionnaires. Of the 61 questionnaires sent out, 51 were returned for a return rate of 84 percent[16].

The methods of counting aircraft are to count traffic year-round, sample traffic and extrapolate annual operations, multiply a predetermined number of operations per based aircraft by the total based aircraft at the airport, do a regression analysis, and simply asking the airport manager. Of the methods mentioned, asking the airport manager was the most common method used by the respondents to the questionnaire, and it was shown to be the most inaccurate[16].

The most accurate was to deploy a traffic counter year round. This technological form of counting was the basis of our research and why we chose to go with a technological approach. The following paragraphs will describe the current forms of technological counting and how well they work out in the field[16].

Pneumatic tubes are used to count car traffic, and they work for airports too. Once an aircraft puts pressure on the tube, the air triggers a counter to add one to the count. Because it is based on touch alone, it cannot distinguish between types of aircraft and the possibility of a missed approach or landing further down the runway than desired could cause the count to be slightly inaccurate[16].

Another form of counting is an inductance loop counter. This counter is actually a wire embedded into the runway that will record the aircraft either on the surface or within a few feet in the air above the counter. There is a possibility of some operations not being counted again if the aircraft do not pass within the proximity of the counter, but still utilize the airport[16].

One type of counter that is based on sound, is the tape recorded acoustical counter. The noise from the takeoff will trigger a Doppler effect. Unfortunately, the landings are not counted by the equipment and so the count is typically doubled to account for takeoffs too. This process, however, requires a lot of manual work, because the tapes need to be audited to get accurate counts[16].

A different acoustical counter monitors the signals and records only those that match a takeoff. Again, the count is doubled for landings. The benefit here is that it doesn't require a lot to power it, and most of it is automatic, but audits still need to be performed to get rid of any false takeoffs[16].

Another software-based acoustical counter uses sound-level meter technology to differ the sound of a takeoff. This system is like the other counters in that it needs to be audited for false records[16].

A visual counter uses an image detection system that counts when motion or light-to-dark events occur. This also needs to be audited, but in the process, valuable information, such as the tail number, can be obtained and the design aircraft could be determined[16].

Radar was mentioned in this report, and the discussion encouraged our group to go ahead with this research. The report mentioned that counting with this technology is feasible, but requires further testing. It also mentioned that research had been conducted by the Iowa Department of Transportation, with whom we made contact, and that no conclusions had been reached as to the accuracy or cost-efficiency[16].

Federal Communications Commission Finding:

Central Wisconsin Joint Airport Board

June 1, 1999

Central Wisconsin Airport (CWA), located in Mosinee Wisconsin, is reliant on a radar system located in Minneapolis for air traffic control. The airport is located in a depression, which makes it impossible for Minneapolis control to monitor aircraft when below 4,500 ft. James Hansford, CWA airport manager, installed a maritime radar system to "enhance the [air traffic] controller's ability to locate aircraft, heavy snow, and thunderstorms…[12]"

Mr. Hansford utilized for the first time a marine radar system to monitor aircraft at his airport. The system was extremely accurate at locking onto aircraft, and was able to pick up thunderstorms in the area. There was a need to remove "ground clutter," which interfered with the image. The system was able to monitor an area of 10 nautical miles from the radar station. In using this type of radar system to help with air traffic control, Mr. Hansford set a precedent for future experiments with alternatives of counting and tracking aircraft movements[12].

2.0 – Team's Problem Solving Approach

In order to see whether or not the radar would work, and if there were other methods of counting and tracking, the group did some research into prior applications of X-band radar or other types of radar to accomplish similar tasks.

2.1 - Research

Once the preliminary literature review was completed, the group decided that the radar would be able to accomplish goals set in place, but the problem was whether or not such a radar unit existed that could track targets in a way that was required to accomplish this part of the project.

2.2 Concept

The team decided that a radar unit was needed that had the capability of sending digital data to a computer system. Future programs would be able to interpret the information and prevent collisions. Information that would be needed for the most basic system is: the distance the aircraft is from the radar, the heading of the aircraft, the speed of the aircraft, and the heading of the aircraft from the radar unit. Desired information would be the altitude of the aircraft, a time stamp, type of aircraft (relative size at least), and estimated path data.

This information could then be used to graphically represent an x-y coordinate with the radar antennae being the point (0,0). Plotting the aircraft as points would be simple by determining the heading the aircraft is from the radar and its distance from the radar.

Eventually, the plotted points of the aircraft, along with the information on its speed and heading, would allow a computer program to analyze the information and calculate the predicted path of the aircraft. The computer program, having received data from the radar, would then be able to see whether two of the targets are converging to a point where a collision would occur. If this were to happen, the program would send a signal to the two aircraft on a collision course to warn them of the danger. This computer program would need to be developed by computer software engineers so that the process could be completely automated. For the research and development stage, the ability to prove the concept is paramount.

2.3a - Step-by-Step Process (Research and Development)

1. The aircraft approaches the airport and enters the range of the radar.
    a. The range will be significantly reduced at first (5nm) in order to simply see whether the concept achieves the predicted and assumed results.
2. Once the aircraft enters the range of the radar, it will show up on the screen, and the system will start logging information about the aircraft.
3. This aircraft information will be sent to a computer with HyperTerminal, and the information received will be exported to a spreadsheet and the courses will be manually plotted. This will also allow data to be gathered about aircraft counts.
    a. The information will be received in string format. Each string will include a set of data that are known as Tracked Target Messages (TTMs). In order to interpret the data, the team will export the information and decipher each set TTMs by their target number.

2.3b - Step-by-Step Process (Fully Developed)

1. The aircraft approaches the airport and enters the range of the radar (10nm).
2. Once the aircraft enters the range of the radar, it will show up on the screen, and information about the aircraft will be sent to a computer.
3. The computer receiving the information will interpret it with a program designed for use with the SATAS.

4. By predicting the future path of the aircraft, the computer program will determine if any other aircraft in the area will be affected by its path.
5. If there is a potential for a collision or runway incursion, the SATAS will send out a warning to the pilots informing them of the potential danger.

2.4a - The Radar System – Required Equipment

The radar unit is made up of multiple parts, and each part adds a unique feature to the radar "system" as a whole. Each part will be discussed to explain how it contributes to the overall functionality of the system.

1834C/NT NavNet vx2

This unit is the body of the radar system. The package includes a 10.4 inch color display and a two foot, four kilowatt dome antenna to spot targets. In order to pick up the targets in the area, this unit is required, because it is essentially the radar itself. It can tell the user the distance of targets on the display to the radar unit. In order to minimize costs, this unit was the smallest that is capable of tracking targets.

ARP-11 10 Target Auto Plotter

This is an internal component that allows the 1834C/NT unit to track targets. The auto plotter can track up to 10 targets at once and gather data on the speed of the aircraft and its heading while plotting them on the display as vectors.

PG500R (Rate Compensated Heading Sensor)

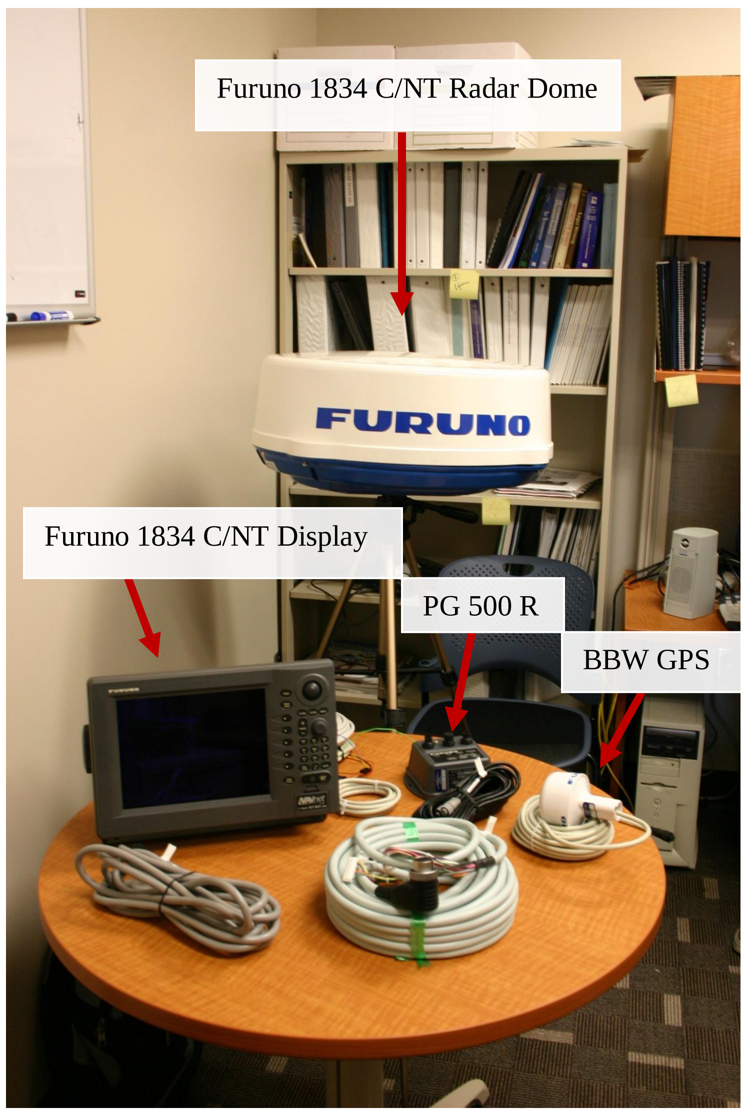
The PG500R provides the heading reference that allows the display and target data to be calibrated relative to the antenna location and alignment. This is required to determine the headings of the aircraft from the radar unit.

BBWGPS – WAAS/GPS receiver

This piece of equipment allows the 1834C/NT unit to receive WAAS/GPS information. It also allows position fixing. The information is accurate to within three meters.

NET-DWN-CBL

This cable connects the radar unit with a computer so the data is able to be downloaded.



Laptop

A laptop computer is used to download the data in the field using a communications program called HyperTerminal. The HyperTerminal program allows the PC to receive real time data from the radar console. The data is streamed from the radar unit to the laptop in real-time is streamed as lines of text giving information such as the target number, the distance from the radar, heading from the radar, speed, course, time, and more.

2.4b - Radar Technical Data

Coordinates for location of radar system:

Council Bluffs Airport, Iowa North 41 degrees 15' 31" West 95 degrees 45' 38"

Elevation at airport:

1253 ft.

Council Bluffs Municipal Airport

Equipment:

Radar Unit: Furuno 1834c/NT

Compensated Heading Sensor: Furuno PG 500r

Target Auto Plotter: Furuno ARP11/PG

GPS Receiver: Furuno BBW-GPS

The Radar unit (1834c/nt) is 10.4 inches tall. It will be placed in an elevated position at the Council Bluffs Airport (KCBF) in Council Bluffs, IA. For short range (0.125-0.15 nautical miles) the pulse repetition rate is .08 microseconds/ 2100 hertz. The medium range (1.5-3 nm) repetition rate is .3 microseconds/ 1200 hertz. The long range (3-48 nm) repetition rate is .8 microseconds/600 hertz. The frequency range for the unit is 9410 MHz +/- 30MHz. The peak power is 4.0 kW.

2.4c - License Requirements

Section 301 of the Communications Act of 1934 states that no person shall use or operate any apparatus for the transmission of energy or communications or signals by radio within the United States except under and in accordance with the Act and with a license issued by the Commission. Section 80.13 of the Commission's rules also states that "stations in the maritime service must be licensed by the Federal Communications Commission (FCC)…[3]"

In order for the team to operate the X-band radar system at Council Bluffs Airport, we had to apply for an Experimental Special Temporary Authority (STA) with the Office of Engineering and Technology within the FCC. This special authority is intended for experiments that will last no longer than six months[3].

The application called for standard contact information as well as a brief explanation on the purpose and intent for the special license. An STA is required because X-band radar will be used, in a secondary application, at Council Bluffs Airport. Also required for the application was a part list of all items that will use as well as technical data for the radar system[3].

Having already completed the majority of the application for the FCC, the FCC also required coordination with the Federal Aviation Administration's Regional Office in Kansas City. This was necessary for the research to be conducted at an airport. The FAA also required technical data and other information about the radar system[3].

Other documents submitted with our application included a picture list of our radar system and a narrative describing our experiment design and steps[3].

2.5 - Issues During the Problem Solving Approach

Originally, the project was supposed to be a conceptual idea about how radar might be used to track and count aircraft. After the project was reviewed by the faculty of the institute, they spoke with the Nasa Grant Foundation and offered the team the opportunity to get funding to purchase the radar unit if the team could get the entire unit for less than the grant amount. After the offer to purchase the radar was made, the ability to actually deploy the radar unit and demonstrate the viability of using X-band radar in an airport environment was the main objective of the team. Unfortunately, due to hold-ups in licensing with the FCC and FAA, as well as issues with funding, the equipment did not arrive until just before the submittal of the proposal. There was not enough time to put the system together and gather any data.

2.6 – Work Beyond the Project Deadline

Beyond this submittal, the team plans to proceed deploying the unit and gathering data on tracked aircraft. This includes counting the aircraft using the gathered data as well as plotting their paths on an x-y coordinate system and overlay those plots onto a map of the area.

The desired outcome of the post-submittal data is to be able to count the aircraft utilizing the airport, find the most common traffic pattern by plotting paths, and finding the most commonly used runway.

3.0 - Interaction with Industry Professionals

The team researched marine X-band radar units on available in the market and began to contact retailers. One Retailer, AnchorExpress, was especially helpful but they did not have the expertise to guarantee their units could do exactly what the group needed. They referred us to the technical departmet of a leading manufacturer of marine radar units, Furuno[1].

Contact: Rich Testa, Technical Assistant – Furuno; Contacted by: Cole Hartfiel

Mr. Testa works in Portland, Oregon and provided the team with the valuable information on the radar unit the team ultimately purchased. He spent the first part of the conversation getting to know more about the ideas behind the project and understanding how he might be able to develop a system to help the team out. Once he was done listening, it was his turn to talk[15].

The description given on the radar units and the pieces needed to do what we wanted was, “like drinking out of a fire hose.” The information came from him very rapidly, and he changed his plan frequently while asking many questions to make sure he understood exactly what was being required out of the radar unit he was developing. Rich knew his information well and was able to recite product numbers and functions without looking anything up. He also mentioned that once we received our radar, he would be around to help us make sure we get everything set up and working correctly. Without his help, the group might not have been able to develop a system to track aircraft and gather the data on their courses[15].

Contact: Ronnie Mitchell, director of the Nebraska Department of Aeronautics; Contacted by: Thane Seeley

We contacted Mr. Mitchell to discuss the safety of setting up the radar at a local airport. Mr. Mitchell concluded that there should not be any issue with setting up the radar at a local airport. We also questioned him if he had ever heard of any other individuals using X-band radar to count aircraft, which he hadn't. We also discussed the other ways small airports count aircraft and he gave us some information and ideas of how small airports do so. Finally, we asked him for information about contacting Michelle McEnany, the director of the Iowa Department of Aeronautics, reason being, we had seen on an online source that the Iowa DOT did some work counting aircraft with digital microwave radar and Michelle could put us in contact with him[11].

Contact: Michelle McEnany, director of the Iowa Department of Aeronautics; Contacted by: Thane Seeley

We contacted Michelle McEnany, Director of the Iowa Department of Aeronautics, to ask her about the DOT counting aircraft project. She told us that she know about it, but did not have any involvement. She then gave us the contact information for Philip Meraz, who completed the project. We also asked her if she had heard of anyone using X-band Radar and if she felt that there was a safety concern with this project. We also discussed using the Council Bluffs Airport, and idea she was liked and was okay with[10].

Contact: Philip Meraz, Iowa DOT; Contacted by: Thane Seeley

We contacted Philip Meraz of the Iowa DOT, to ask him about his study with using digital microwave radar to count aircraft. We asked him the about his setup, the problems he encountered, and how well it worked. He told us that he used a digital microwave radar set up towards the end of the runway. It was powered by 2 marine batteries, and ran for about a month. The main problem he encountered was the fact that the digital microwave radar he was using had to small of a swipe and you would need multiple radar units placed around the airport to adequately count the aircraft operations. He also told us that the microwave radar worked and the data could tell you when the aircraft would touch down. We also discussed our project and asked him what he thought and if he had any advice. The main piece of advice he gave us was to give ourselves plenty of time to deal with the FAA and the FCC, because they are very hard to get clearance with to set the radar up[11].

Contact: Tony Serafini- Tech Specialist Office of Engineering and Technology, FCC (202) 418-245, Contacted by: Pete Bokelman

Our group originally applied for a regular experimental license through the FCC, but after talking with Mr. Serafino, he recommended a Special Temporary Authority (STA) license instead. As a technical specialist, Tony was able to clarify many aspects of the required technical data for our system. He was called on multiple occasions to help with the application process for our license. After several steps were completed, and several weeks past the start date for the application process, Tony informed us that we needed to be in coordination with the FAA to receive a Non-Government Technical number (NGT). We did as instructed and ultimately the FAA responded with no objectives to our project[14].

Contact: Nancy Hey- Support FCC (202) 418-2432, Contacted by: Pete Bokelman

Nancy Hey helped with questions regarding the STA application as well as other documents required for processing. She was contacted on numerous dates for help[8].

Contact: Liz Corey- Media Relations FAA (847)-294-7849, Contacted by: Pete Bokelman

Liz Corey was contacted after receiving her information from the Kansas City Regional Office regular telephone number. She was our first contact for coordinating with the FAA. She forwarded our attention towards Jim McCain at the Texas Regional Office[3].

Contact: Jim McCain Texas Regional Office FAA (817)-222-4500, Contacted by: Pete Bokelman

A message was left with his secretary but was never returned. The group was contacted by Mark Gallant a few hours after leaving a message with Mr. McCain. Presumably, Mr. McCain passed our interest in receiving a NGT number to Mr. Gallant[9].

Contact: Mark Gallant CSA FMO Spectrum Engineering Services, FAA (817) 222-4761
Contacted by: Pete Bokelman

Mark Gallant called our group requesting information about our experiment and technical data for our system in order to receive a NGT number. An email was sent with the data requested. We were then contacted by Mike Bowers, who would be working with us directly to receive our NGT number[5].

Contact: Mike Bowers ACE-474M FMO FAA (816)-329-3467, Contacted by: Pete Bokelman

Mike Bowers was contacted a number of times regarding necessary information to receive our NGT number. There was some confusion about the technical data given to us by the radar systems manufacturer that required several phone calls to clear up[2].

Team Conference Call: James Hansford

Right away, James was interested in how we decided on the Furuno unit we did. After telling him we spoke with the manufacturer about how to track the targets and get the data, he proceeded to ask us about the wattage of the radar. He mentioned the wattage might be an issue because the radar they were using was 60 watts and had a hard time picking anything up. Something to note is the radar unit being used by James currently, is based on technology from the mid-1990s. This puts it at more than 15 years old. Technology is assumed to have progressed to a point where it may not be necessary to have that level of wattage to pick up targets[7].

A key problem that James talked about was the clutter by objects on or near the ground. This “ground-clutter,” as it is referred to, has an effect of washing out any targets that may be in the air. A tip he gave the team was to put the antennae in a dish shaped basin. This basin would be a low point on the airport, and is part of the natural landscape. The idea is to get the radar to bounce back and wash out the clutter down low, so that the only reads received are most from above the ground objects[7].

Another question asked by the team, was what type of power supply James was using on his radar. He said that the power was basically received commercially from an outlet. It was also found out that James uses a CRT display and a normal setting of 10 nautical miles (nm). A bit of really good news from James was that the radar he is using is extremely accurate. The radar he uses, however, is older than the one the team is using, and it is also much larger using 60 watts versus four kilowatts. The hope is that the technological advances over 15 years have allowed radar units to work just as well as they did in the past, much less power and corrections for potential interference[7].

4.0 - A Brief and Simplified Economic Analysis

As mentioned earlier, air traffic control towers are very expensive to build and staff; sometimes too expensive for small but busy general aviation airports. The cost of this project is very reasonable, because of the relatively minimal investment for the potential payoff for future applications. Table 4-1 shows the estimated total cost of the system and extra accessories. The actual cost was 4,900 dollars for the radar "system." Current fully integrated radar systems can be expensive, from 50,000 to 100,000 dollars and beyond. The other disadvantage is the bulk of the units. The project is neither expensive, nor large. Another advantage is that it does not require any labor once it is installed and fully operational.

Table 4-1

Project Parts list

Part	Quantity	Price	Description
ARP 11	1	$ 600.00	Radar
Furuno 1834C/NT Radar	1	$ 4,000.00	
PG 500R	1	$ 1,400.00	
BBW-GPS	1	$ 400.00	
GPS Extension cable	1	$ 70.00	
NET-DWN-CBL	1	$ 60.00	
Brother Wireless Laser Printer	1	$ 150.00	Processing
Computer	1	$ 800.00	
Deep Cell Marine Batteries	4	$ 400.00	Power
Solar Panel 210-230 Watt	1	$ 600.00	
HomeLite Generator	1	$ 480.00	
Battery Charger	1	$ 200.00	
Equipment Housing	1	$ 250.00	Other
Miscellaneous		$ 590.00	
Total		**$ 10,000.00**	

5.0 - Safety Risk Assessment

In our research, and contacts with industry, we never found any statements that would raise safety concerns. This shows that X-band radar on an airport will not cause any aviation or civilian safety issues. The energy emitted will not affect aircraft avionics or communication systems. The radar we are using is meant to be installed on boats. We have also taken proper precautions by contacting the FCC and FAA to acquire an Experimental Special Temporary Authority license needed to use this radar at an airport. The FAA found no objection to our request and no further frequency coordination is required with them[2]. The frequency that the radar system will be operating on will be 9410 Mhz. Since other aircraft and weather systems use similar types of radar, installing one at an airport would be the same as two aircraft being in the same area. This type of radar is also being used for many different applications that are in the same areas as airports and have yet to pose any safety issues. Deployment in the field will require normal safety precautions, especially if the radar antenna is placed in an elevated location. Methods for the close monitoring of potential interference (radio, navigational aids, etc.) and the ability to turn the equipment off rapidly will be used.

6.0 – Summary

In order to track and count aircraft at airports without air traffic control towers, the team decided to test the ability of X-band radar to do such a task. In order to get a greater knowledge of radars, and which ones would work for the project, the team consulted with numerous industry professionals. Due to unforeseen hurdles such as funding and the inability to receive the license for operation on time from the FCC, the team was unable to gather any data before the project deadline ended. The team has the radar ready to be deployed and will proceed to prove its ability to count and track aircraft at the Council Bluffs Municipal Airport.

Appendix A – Contact Information

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Student Lead: Cole T. Hartfiel

Student Co-Authors:

Pete Bokelman

Thane Seeley

Appendix B-Description of the University

The University of Nebraska at Omaha (UNO), founded in 1908, is a fundamental component of the University of Nebraska's collegiate education system. UNO is situated in Nebraska's largest metropolitan area and serves to provide exceptional educational opportunities, discovering and disseminating knowledge through advanced research and teaching, and offering public service to the community, state and the nation.

The Aviation Institute at UNO was established in 1990 as part of UNO's School of Public Administration, and is charged with providing a comprehensive program of aviation studies for both flight and non-flight disciplines. The Aviation Institute offers a Bachelor of Science in Aviation concentrations in Air Transport Administration and Professional Flight. It also provides Aviation and Transportation concentrations as part of the School of Public Administration's nationally recognized Masters in Public Administration (MPA) resident and online programs and the doctoral Public Administration (PhD) degree. The Aviation Institute is a founding member of the Aviation Accreditation Board International (AABI) and the School is accredited by the National Association of Schools of Public Affairs and Administration (NASPAA).

This project was conducted as an upper division 3 credit-hour elective course, AVN 4900, "*Special Topics in Aviation.*" It is anticipated that this course will be offered again as part of the academic program to provide students with opportunities to conduct independent research on contemporary aviation issues.

Appendix C – Description of Non- University Partners

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Appendix E – Team Observations & Reflections

Appendix E-1 – Cole Hartfiel (Project Team Leader)

1. ***Did the FAA Design Competition provide a meaningful learning experience for you? Why or why not?***

I'd say the competition provided some kind of a meaningful learning experience. The competition opened my eyes up to how communicating and keeping on top of things goes a long ways. Most of our time was spent waiting on other organizations to get us information or finish forms for us, and we had to keep on top of it and make sure they were getting done, or else it may not have been that way. It's the same way at a job too.

2. ***What challenges did you and/or your team encounter in undertaking the Competition? How did you overcome them?***

Funding was a major issue and it was extremely difficult to get the money to purchase the radar. Unfortunately, it took us so long, that we weren't able to gather data in time. Not only was the funding a mess, the communication with the FAA and FCC, and the two communicating between themselves did not work out well at all.

3. ***Describe the process you or your team used for developing your hypothesis.***

We focused on safety at airports and we'd heard about the Synthetic Air Traffic Advisory System from classmates who submitted it last year. One of the things they weren't sure about was whether or not an x-band radar could track and count aircraft, so we developed the hypothesis saying that we think it could, and we want to test out the concept.

4. Was participation by industry in the project appropriate, meaningful and useful? Why or why not?

The company Furuno was very helpful. Since I had direct contact with them, I know that Rich Testa was very helpful in getting us the necessary information to build a radar system for our research. Without Rich's help, I'm not sure whether or not we would have even had purchased a radar.

5. What did you learn? Did this project help you with skills and knowledge you need to be successful for entry in the workforce or to pursue further study? Why or why not?

As mentioned before, it opened my eyes up to complete communication being key in a project. Setting up deadlines and working to get those accomplished. Time management is a skill everybody should know, and this helped that skill out by improving my time management abilities.

Appendix E-2 - Thane Seeley

1. Did the FAA Design Competition provide a meaningful learning experience for you? Why or why not?

Yes, this project allowed me to research and learn about different types of x-band radar. It also provided me with information on other applications for this type of radar. In doing this research I also had the opportunities to meet industry professionals and learn more about other possible employment options.

2. What challenges did you and/or your team encounter in undertaking the Competition? How did you overcome them?

We had three major challenges to overcome. The first challenge was trying to find a x-band radar that would fit our needs and not break the bank. We overcame this obstacle by contacting a radar manufacturer expert and he led us through the process. The second challenge was trying to find the radar and assocaries under our $5,000 budget. We overcame this challenge by calling varies radar suppliers and trying to get them to stay in our budget. The third challenge was getting our FCC experimental license. This was overcome by not giving up and contacting the FCC and FAA.

3. Describe the process you or your team used for developing your hypothesis.

We can up with the idea from looking at or classmate's former submission from last year. We decided to try to take the project a step further and inaite the first phase and test if marine x-band radar could count aircraft.

4. Was participation by industry in the project appropriate, meaningful and useful? Why or why not?

Yes, having the ability to discuss issues and other challenges with industry professionals helped point us in the right direction. They also provided us with information that could not be found on the internet.

5. What did you learn? Did this project help you with skills and knowledge you need to be successful for entry in the workforce or to pursue further study? Why or why not?

Working on this project allowed me to expand my leadership and listening skills. In any job field, leadership and the ability to work with others is critical. This project also helped me learn to spread out the work to other team members to complete a common goal and deadline.

Appendix E-3 Pete Bokelman

1. Did the FAA Design Competition provide a meaningful learning experience for you? Why or why not?

The FAA Design Competition provided a valuable learning experience for me. Our research team studied current issues at non controlled airports regarding ways of tracking and counting aircraft. We looked at current solutions for these problems as well as possible alternatives that could be utilized in the future. It was a different experience for me because we were working on a project for a national competition, as opposed to a grade for school.

2. What challenges did you and/or your team encounter in undertaking the Competition? How did you overcome them?

The biggest challenge for me was finding the right person/people to talk to within the industry to acquire the licenses necessary to operate our radar system. Another difficult issue was trying to understand the technical data that was required by the FCC and FAA. Several phone calls had to be made in order to clear up confusion about frequency ranges and peak pulse rates. The only way to overcome these obstacles was to pursue through them. Several phone calls led to dead ends and frustration. The answers were out there, we just had to find them.

3. Describe the process you or your team used for developing your hypothesis.

We looked at the design competition that our school worked on last year. We liked their idea about SATAS. We knew right away that we wanted to expand on their idea of using X-Band Radar as a potential solution to counting and tracking aircraft at non-controlled airports.

We studied current methods of counting aircraft and decided that X-Band could have the potential to increase the accuracy of some of these systems.

4. Was participation by industry in the project appropriate, meaningful and useful? Why or why not?

Without contacting numerous individuals within the industry I do not believe we would have been able to finish our project. It was absolutely necessary that we contacted members of the FCC and FAA in order to file and acquire the STA license and NGT number. They helped us understand the complexities of using a marine radar system for aviation purposes. There were a few members of the industry that were unfortunately unwilling to help/understand the problems that we faced.

5. What did you learn? Did this project help you with skills and knowledge you need to be successful for entry in the workforce or to pursue further study? Why or why not?

I learned a great deal about issues facing non-controlled airports within the industry and current methods of tracking and counting aircraft. Our research to address these problems helped me understand potential solutions to these issues. I gained a lot of experience making telephone calls to members of the Federal Government about applying for a Federal License. I had very little experience making cold calls like this before.

Working with other team members on a project can be difficult at times. Our group however, knew from the beginning what our ultimate goal was and set check points along the way to keep us moving. Our group gained a lot of experience working as a team in order to reach our objective.

Appendix E-5 – Faculty Advisor Evaluation

Describe the value of the educational experience for your student(s) participating in this Competition submission.

The University of Nebraska's Aviation Institute's 2010-2011 FAA University Design Competition Project was extremely valuable for my students by investigating contemporary problems associated with tracking and counting aircraft operating at an airport with no air traffic control tower. Areas for their research included background studies, benefits and weaknesses of current technological applications, and identifying unresolved problems that can affect aircraft activity in uncontrolled airspace, particularly when the traffic pattern is busy and advisory radio frequencies (Unicom) are congested. Their research required thinking through the problem statement, formulating and implementing an action plan, and ultimately applying for and successfully receiving a grant from NASA to acquire equipment to test their conceptual system.

This project is a follow-on topic to the Aviation Institute's 2009-2010 Design Competition submittal where X-band radar was proposed to serve as a foundational component of a concept to recognize potential conflicts between aircraft operating on and around an airport. This project was designed by the students to test the practicality of using X-band radar in an airport environment to identify and record aircraft operations. The students' research required them to consult with industry technical and professional people regarding equipment choices and to coordinate the application for an FCC license with FAA to legally operate the radar equipment on an airport. Coordination with the candidate airport's governing body was also required.

Given that two of the three members of the project team are graduating seniors and were working on other end-of-semester projects, participating in the Design Competition served as a capstone for their academic program and helped them overcome their shyness about cold calling and seeking information in the real world.

Was the learning experience appropriate to the course level or context in which the competition was undertaken?

The Design Competition Project was an excellent extension of the Aviation Institute's curriculum. The Institute's undergraduate academic course work involves airport planning and design but unfortunately does not provide many opportunities for applied research. By having the chance to participate in the Design Competition, it served to motivate students toward a real payoff as opposed to just doing projects for a grade. By examining in detail a "real world" issue such as quantifying aircraft at smaller non-towered airports, the students were able to apply much of what they learned in the classroom toward providing approaches for a solution to a real problem. The feedback they received from many of their industry contacts supported what they had learned from their classroom experience and served to reinforce the validity of their education.

What challenges did the students face and overcome?

Like most students, initial enthusiasm for participating in the project waned until the deadline for submission approached. Originally the project was designed to only be conceptual in nature. However, when to opportunity to apply for NASA grant to purchase equipment to test their concepts, the renewed energy (and short deadlines) forced them to move forward with a sense of urgency. This was in spite of other deadlines for papers, assignments and other responsibilities for their regular courses (not to mention two of the team members getting ready to graduate). The Project Team managed this challenge by distributing the workload among the members and regular meetings were held to review progress.

Another issue was their having to confront a federal bureaucracy (FCC and FAA) and their requirements for an experimental license to operate the radar unit. The Project team was required to explain their project concept to both FCC and FAA in order for the request to be forwarded for approval.

Would you use the Competition as an education vehicle in the future? Why or why not?

This is the second year I've been involved with the FAA University Design Competition at the University of Nebraska. I am still surprised to find a broad level of support for the program and the effort well respected (particularly when the team was invited to submit a grant request for funding the equipment).

I found this to be an excellent method for engaging students interested in airport issues into participating in a meaningful research/practice project. By making contact with industry experts (airport management, consulting firms, and equipment vendors), the students were able to appreciate the practical experience of seasoned professionals and to reduce the intimidation toward contacting experts for advice.

I also have encouraged students to participate not only for the academic experience but also to help build their resumes as they prepare to start their careers in the aviation industry. I intend to continue to be the academic advisor for future teams and already plan to lead another team next year.

Are there changes to the Competition that you would suggest for the future years?

I think expanding/enhancing the topics would be appropriate. Another idea is to create a phased approach for narrowing the field with better quality proposals. For example, Phase I could run during the Fall semester with the development of a refined problem statement, literature review, research approach, and status quo SMS review along with a Phase II proposal that would include a detailed research plan, budget, and schedule. After screening the proposals, the best three or four would be selected for Phase II to be conducted during the Spring semester. Perhaps Phase II selectees could be awarded a modest research stipend for travel and other expenses associated with their project.

Appendix F – Works Cited

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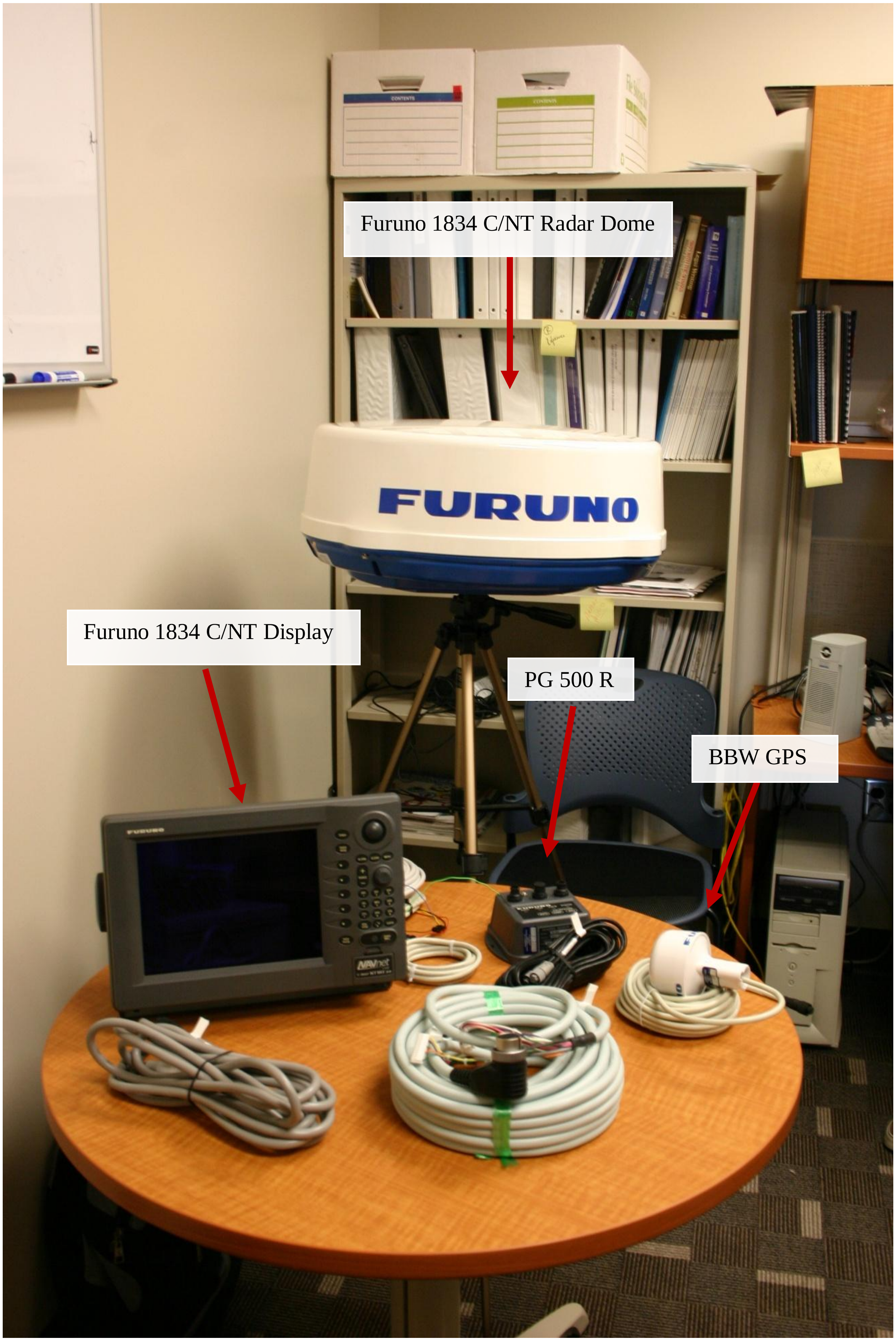
Appendix G - Photographs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FURUNO
Furuno 1834 C/NT Display
PG 500 R
BBW GPS