The final meeting is your opportunity to discuss your Honors Thesis — both what you did and your final conclusions. You will also be presented with questions from your thesis committee members. This is your opportunity to demonstrate what you have learned from your honors thesis experience.

Remember, you're the expert on your Honors Thesis since you completed it!

Schedule the final meeting at least one week ahead of time. Tell your friends to attend, if they can, to provide some moral support to you. Provide final draft copies (the almost final version approved by your thesis advisor) of your Honors Thesis to your readers at least ten days ahead of the final meeting date.

Take a copy of this form to the final meeting. All the members of your thesis committee must attend this final meeting. If the thesis is approved, then have the faculty advisor and readers complete and sign the form at the conclusion of the meeting. If the thesis is not approved, discuss the necessary revisions for the approval of the thesis. The readers may: (1) sign the form with the knowledge that the advisor will oversee the revisions, OR (2) wait to sign the form until a revised and acceptable version of the thesis is provided. The faculty advisor signs the form last after all revisions have been made and approved by the readers.

During this meeting, you may also want to have your adviser and readers sign copies of the approval page that will be inserted in the final bound copy of your thesis.

Deliver the signed copy of the Honors Thesis Final Meeting Confirmation Form and the final bound and signed copy(ies) of the Honors Thesis to the UHSP Office by November 17, 2006 for December 2006 graduates or by April 27, 2007 for May 2007 graduates.

DO NOT MAKE "FINAL" BOUND COPIES OF YOUR THESIS TO BRING TO THE FINAL MEETING SINCE REVISIONS MAY BE NECESSARY AFTER THE MEETING.
MAKE YOUR FINAL BOUND COPIES OF THE THESIS ONLY AFTER IT HAS BEEN APPROVED VIA THIS COMPLETED AND SIGNED FORM.

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Engineering at Miami
Honors Thesis Title

EGB 262        May 1, 2007 3:30pm
Location of Final Meeting Date and Time

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Please print name and department

Readers:

Douglas W. Coffin (PCE)                  Signature  5/1/07
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Revised 8/9/2006
ACKNOWLEDGMENTS

For their input in my thesis meeting:

C.S. Chen, advisor

Douglas Coffin

Qihou Zhou

For their help with surveys:

George Huang, Wright State University

Teik C. Lim, University of Cincinnati

Steven Buchberger, University of Cincinnati

Carol Duhigg, Ohio State University

Susan A. Noble, Ohio State University

Robert Lee, Ohio State University

Professor Frank Meret, Case Western Reserve
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INTRODUCTION

This thesis explores Miami University's Engineering program in two ways. First, after reflecting about my own personal experiences in Oxford, I made a few personal suggestions for the School of Engineering and Applied Science. After that, I compare Miami's program to the University of Cincinnati, Ohio State University, and Wright State University in an effort to gain additional perspectives into the strengths and weaknesses of Miami's Engineering curriculum.
SECTION ONE: PERSONAL EXPERIENCE
HOW STUMBLED INTO ENGINEERING

My senior year I applied to Miami University as a Diplomacy and Foreign Affairs (DFA) major under the College of Arts and Sciences. How I ended up graduating with a Bachelor of Science in Engineering is still somewhat inexplicable to me. This paper will reflect on my personal experiences here at Miami in the School of Engineering and Applied Sciences. By reviewing my perceptions about the major and comparing my experiences with other engineering schools, I hope to offer suggestions for improvement to this school.

Coming off of a fun senior year of high school studying Government and Foreign Policy, I hoped to further my study in this area by exploring politics and foreign diplomacy here at Miami. I came down to Oxford in the spring of 2003 to shadow a freshman in the DFA department. Although I stayed less than twenty-four hours and attended only three classes with this student, I left feeling as though I needed a new major. In my naivety I assumed that I would be the crème of the crop, the change that I wished to see in American politics. . . As it turned out, there were at least a hundred other people with the same impression living together in the same dormitory. If there were that many people in the Foreign Affairs field here at Miami, how many more were there at all the universities across the country?
This statistic led me to switch majors before I even began at Miami. While registering online for Summer Orientation, I had the opportunity to choose a new major from a dropdown menu. After staring at the screen for an hour considering everything from Chemistry to Exercise Science, I narrowed it down to two: Education or Electrical Engineering. I had wanted to be a teacher since I was five, but I also really enjoyed the Electricity unit in my Physics class. Although I didn’t know what the “Engineering” title meant, it still seemed like a natural choice. The ultimate decision rested on my mother’s shoulders; as she strolled by the computer I asked her which major to choose, Education or Engineering. “Try Engineering, you can always switch into Education if you don’t like it,” she casually advised not knowing that I actually decided based on her comments. So it was settled. Electrical Engineering it was!

Three months later I found myself graduated from High School and on Miami’s beautiful campus ready to start another chapter of my life with Summer Orientation. After hearing an opening speaker, the large group of new students and their families broke down into the different schools. After hearing Business, Education, Arts and Sciences, and Fine Arts, finally Engineering was called and the 15 students left marched off to Kreger Hall for in introduction to
the program. It was intimidating being one of only two girls in the small group, foreshadowing into what was inevitably going to be a reoccurrence during all my college days. After a brief PowerPoint presentation, we moved on to academic advising with the whole orientation group.

While other students debated about which classes to take, I looked down at my eight-semester plan, seeing that with Calculus, Physics, Fundamentals in Programming and Problem Solving, Intro to Engineering Design, Physics Laboratory, and College Composition, I had no additional time for other classes. After scheduling, I went home and had two long months to wait before I stepped foot in my first classroom.

Time and time again I read the course descriptions of my fall classes and was terrified of the first Computer Science course. Terms like “Algorithm Development” and “Program Debugging” sounded like a foreign language. I signed up for Electrical Engineering so I could build circuits, not play with computers. I had never heard of computer programming or languages such as Java; let alone what a user-defined data type meant. Before even moving to Oxford, I doubted that Engineering would be the right major for me. After a few encouraging conversations from an orientation leader, who assured me that I did not have to understand the course description to succeed in the class, I stifled my fears and prepared for college.
Walking into each course on the first day was overwhelming. In my CSA class, I could barely decipher what the professor spoke about. I could not even open Eclipse, the platform that we programmed in. Luckily the students I sat by seemed to know more than I did and lent a helping hand. My first Engineering class, EGR 141, was a little more helpful. The first question the professor asked the class was: “What is an Engineer?” That was what I had been wondering ever since I chose Electrical Engineering as my major! I sat back and waited to find out what I was getting myself into. The class clowns were the first to chime in, shouting “Engineers can hold their liquor.” Needless to say, the teacher glared and ignored the statement. Leaving class that day, the resounding answer to that initial question was “Engineers are problem solvers.”

Our teacher emphasized that engineers use their backgrounds in mathematics and natural sciences to solve problems for people. That sounded good to me; if I wasn’t saving the world by creating world peace with a Foreign Policy major, at least I could solve the world’s electrical problems.

GOALS FOR THE MAJOR

To be honest, part of the reason I chose Engineering was to say that I was studying Engineering. Being the youngest child with two older sisters, I was accustomed to competing
with them for bragging rights on the sports field and in the academic arena. Each step of the educational ladder came with a “You can’t.” “You can’t get all A’s in middle school”; “You can’t graduate with honors in high school”; “You can’t survive four years in Engineering and live a normal life.” From the start, I desired to prove them wrong.

In addition to the boast that the Engineering title offers, I had also heard of the large need for engineers and the ease of finding a job upon graduation. Since I liked Math and Science, I jumped into Engineering. I did not know what careers were available to engineers or even what courses beyond Physics and Calculus I would be taking. I hoped I could design home security systems, since a similar project high school Physics was a driving force behind my choice of Electrical Engineering.

THE FRESHMAN CHALLENGE

The hardest adjustment to first semester courses was the overwhelming sense that everyone in my classes knew more than me. While I found myself prepared for college courses, I was utterly unaware of what an engineer was. Looking back to high school and even middle school, I had gotten A’s in every Math and Science course, yet no one ever mentioned what someone with
such strengths could go on to study. Everyone around me seemed to have taken Advanced
Placement Physics to prepare for the grueling demands of college Physics, or at least pursued
Computer Programming or other technological activities in their pastimes. I on the other hand
came into the major without any such preparation.

Classes did not prove to be the most challenging adjustment to college life; rather it was the
background knowledge that so many of my peers came prepared with. In High School, knowing
all the information that teachers covered in class was enough to follow lectures and understand
conversations about the subject with other students. However, I shortly realized that course-
specific knowledge was but one sliver of the big picture. While studying Java in my first
semester of college, my classmates would constantly raise their hands with questions about
C++, Perl or other complex applications. Did I miss the homework assignment where we
learned these things? Was I the only one in the class that had never heard of these topics? It
was intimidating from the start.

Since I could not follow these questions in class, I was positive that I would get the worst grade
in the class. I studied my Java book extra hard so I could keep up with the professor, the whole
time thinking that I was hopeless since my peers had so much extra knowledge. My first design project in Intro to Engineering Design furthered this feeling of inadequacy. Placed on a team of four and set to design an incline trolley for one of Cincinnati’s Seven Hills, I found myself unable to even participate in some group conversations. When it came time to decide how we would power the incline, I assumed gasoline would be the only option. Hydraulics, Electromagnetism, Batteries, I did not know where my group members came up with these ideas.

In addition to the conversations that went way over my head about our design project, I also had my first experience working closely with the opposite sex. Coming from a family with two sisters, I was prepared to deal with bad hair days and gossip, not the constant talk of sports and supermodels. Sitting at the computer, attempting to finish the EGR 141 design paper, I had never felt more helpless in my life. Not only did I not know why we were choosing one battery over another, but I had not idea how to drag the three other group members away from the sports game on the television to help me. This project alone made me want to switch out of Engineering.
Moving on to Physics, I was encouraged for this subject coming off of an A+ in high school.

Although there were only three girls in my class of forty-five, we all bonded and struggled through the first homework assignment together. However, this bond was broken in the second week of class when Kristin decided that Engineering was not right for her and dropped the class. Soon after, Jen also gave up on Physics and the homework problems that seemed impossible, leaving me to be the only girl and the only clueless one in the class, or so I thought.

Sometimes I am amazed that I survived the introductory courses. There was not a day that went by that first semester that I didn’t regret my decision to become an Engineer. Not only did I have to adjust to work on teams with polar opposite males, but I also had to learn that grade curves are essential in college classes. I remember checking my BannerWeb grades at midnight that first winter break, thinking that I was about to see my first C, only to find that I had received a 3.63 overall. How could I have felt so inadequate, so behind in every subject, and yet still average a 3.63 my first semester? I was in sheer amazement not only that I had passed every course but that I had also been utterly wrong in my personal assessment within the major.

**Most Rewarding Experiences**
Even into my sophomore year, I was still unclear about what Engineers do after graduation.

Luckily, I had become part of the Society of Women Engineers (SWE) and in the winter of that year, I toured the Avon Cosmetics factory. Seeing a real factory with automated machinery, a complex coordination of human workers, and all the precision equipment excited me! For the first time in the Engineering program, I could pick out a handful of different jobs that I could fill as a Computer Engineer in this one factory alone. Since then, I have also toured the Miller Brewery in Trenton, Ohio, which proved to be just as stimulating as the first plant tour.

Aside from plant tours, SWE helped me adjust to life as a female in Engineering. Although there were no other women in my year within the Electrical and Computer Engineering department (ECE), I cherished general engineering courses that SWE members were in. The upperclassmen in SWE were always available to discuss coursework or even give advice on what to take and which professors to look out for. Seeing women who had gone before me and survived the rigorous coursework motivated me to be in the next generation of engineers.

A great outlet that allowed me to pass this motivation on to other girls was through the annual Girl Scout Day put on by SWE. Each spring, one hundred 5\textsuperscript{th} to 8\textsuperscript{th} grade girls travel to Miami to
participate in Math and Engineering activities that earn them various Girl Scout badges. For two years, I worked with 25 girls as a tour guide throughout the Engineering building (and Kreger).

Each girl is introduced to Vibrations, Solar Energy, Paper Making, Code Deciphering, Computer Science, and much more. We hope that exposure to such material at a young age will keep the girls motivated to further themselves in Math and Science, and one day enroll as an undergraduate Engineering major. Hopefully they will know more about Engineering than I did prior to entering college.

Another great aspect of Engineering at Miami University is the small class size. Within the ECE department, thirteen other students will graduate with me this year. We have all helped one another out at some point, and it will be hard to replace the bond that we have created over the four years here. Specifically, after my junior year and Embedded Systems, Kreger lab will never be the same. About seven students would “camp out” in the building for what seemed like an endless amount of all-nighters spent soldering, wire-wrapping and programming.

Working on our microcontroller, we each had our own computer and were comforted at the support network around us. A simple mistake such as coding a 1 instead of 0 could lead to
hours of frustration but, since we were all there to help troubleshoot, such situations were avoided. From discovering that the problem of a blinking LED was due to poor soldering at six am the morning that the lab was due, to being amazed at how only eight lines of code kept us eluded for 15 hours, we were all in it for the long haul.

It was always fun to be at the soldering station as professors began arriving at 7 am, only to find that we had been there the whole night. This sense of community within the ECE department was definitely a large part of me getting through my major. While friends in other departments barely know the students in their classes, I honestly feel like I have a second family within ECE.

The only thing I had heard about engineering prior to college was from a Math teacher who said that for the year he was in Electrical Engineering, he had not met one friend or found any fellow students with a fun personality. Luckily I paid no attention to the statement, because I have found an amazing group of friends within our department.

My senior year has been a great wrap-up of engineering. I chose to take a majority of my required technical electives my junior year which left me with fundamental, required courses for my senior year. By taking Electronics and Circuits II my final year, I missed out on seeing the
connection between those and other courses. For example, if I had taken Circuits II before
Signals and Systems, I would have been able to understand important concepts better. This
semester, as I take my final courses, I enjoy seeing the overlap of concepts between classes. It
helps tie together all the small ideas from different realms and show us why they are important.

**MOST APPLICABLE SKILLS**

The past two summers, I interned in two different fields: Electrical Engineering and Information
Technology. In my first internship, I worked with Electrical Engineers to create circuit diagrams
in a blueprint for a multimillion dollar hospital. When I first arrived at the job, fresh off of Electric
Circuit Analysis, I hoped I would utilize Kirchoff’s Voltage Law or Thevinan’s equivalent circuit in
some way, shape, or form. I soon realized, however, that in the contracting field the purpose is
about abiding by Federal Building Requirements and ensuring that special purpose receptacles
are accounted for. I was amazed at how seventy percent of the work I assisted with could have
been done by any trained person, not specifically an engineer. Part of the reason was because I
was not yet a licensed engineer, but it still opened my eyes to the fact that college is not in fact
exactly like the working world.
One of the most important skills that I mastered in college was the ability to work in teams of diverse people. Formal projects in courses such as Technical Writing, Static Modeling of Mechanical Systems, and Electric Circuit Analysis II helped teach me how to distribute work, monitor progress, and deal with conflict. Whether a group member was not meeting deadlines or needed help with proofreading and editing, I am comfortable in many situations thanks to these projects. As I took my second internship, I was responsible for a Database reporting tool that met a customer’s need. Working with a new technology and in a large pharmaceutical company seemed overwhelming, yet by applying the group strategy techniques learned at Miami, I completed the project on time, as requested.

Simply by creating an organized plan and communicating with other team members, I was able to track the progress of my project, while relying on experienced team members to impart their wisdom to me. Too many times to count in the past four years, projects have been assigned that seemed beyond comprehension and way out of my reach. At the time I absolutely detested them, but looking back, it was during those projects that I gained all the skills that I will take with me into my career; during those projects that I learned the most and overcame what I thought was impossible.
Another important skill that I have learned throughout my undergrad experience is the ability to work under pressure and in a time crunch. While the stress of most majors is to deal with writing lengthy papers, in Computer Engineering, you must complete a project and get it to work properly. Instead of turning in a paper that could have been better, in engineering there is no such luxury. When a computer program is due, it must be working to receive credit. There is no half way; either it works or it does not. Knowing this, I have trained myself to not stop short of what I am working towards. Whether it means putting up with an all night work session or seeking out additional help, I have acquired the trait of not settling for mediocrity when it comes to important projects. I am confident that this new skill will carry over into the working world as it has during my internship. While preparing for my final presentation last summer, I comfortably stayed late at work night after night to ensure that I was well prepared to present to a mixture of managers within the company.

**PERSONAL SUGGESTIONS**

Upon reflecting over the past four years, there are a few things that I would change. First of all, do not assume that freshman know much about engineering. While the introductory classes
have changed since my freshman year, more one-on-one contact would help keep students in the program. I remember the professor of my EGR 141 course saying that it is ok to not have knowledge about engineering coming into the program, but I still felt like the only clueless student. The first semester of a freshman's college career should be one of constant reassurance that they can get through the basic courses and they have a chance at surviving the engineering major.

My freshman year was a difficult time of adjustments, and I could have used more meetings with professors to calm some of my fears within the major. Now I know that the open invitation was there; but my freshman year, I did not know how to even find an ECE professor, let alone know how to set up a meeting. While I remember the ECE pizza picnic at Western Lodge, it was a time to mingle and meet students but not a time to expel the fears of a new major. The department, on top of organizing a Welcome Back Picnic, should offer an open house sometime towards the end of the fall semester. During this time, students will be encouraged to sign up for fifteen minutes with one of the faculty members and ask about any questions they have come across. It is often intimidating to ask a question as simple as “What kind of job can an Electrical Engineer have after graduation” in a large introductory class. It would be far better to have this
brief one-on-one time to allow those who want it a chance to learn the fundamental points of the major.

Additionally, this meeting could serve as time when faculty members can give the students an overview of the next four years at Miami. The reason I almost dropped out of Engineering was because I thought the content covered in Physics would be exactly what Engineering courses were like. If a brief overview of some of the ECE classes was offered, student would have a concrete idea of what to expect from the major rather than believe the perceptions that they came into school with or those that they picked up in the first few months of school.

As mentioned, I did not see the “whole picture” of how each ECE course is intertwined until my final year at Miami. In order to help students see this sooner in their undergraduate career, I suggest that each course be introduced within the larger picture of the major. For example, the description of Signals and Systems from the syllabus was “to expose students to the theories and concepts of both continuous-time and discrete time forms of signals and systems, as well as applications of the theories and concepts in communication systems, control systems, and signal processing” (Sahin). Coming into the course without much knowledge of what signals
really were, I think the description is intimidating, a feeling that stayed with me throughout the

course. If a notion of how important the concepts learned in this 300-level course was apparent,

I would have been motivated to master the signal analysis techniques. If the following sentence

was added to the description, it would help show what is associated with this skill: “Signals will

also be studied in Electric Circuit Analysis II and Electronics, in conjunction with A/C power

analysis and Digital Signal Processing, for example with voice recording and playback”.

Introducing fundamental courses as precursors to the future classes will help create a cohesive

feel to the major.
SECTION 2: COMPARISONS
DATA ACQUISITION

In order to get a complete picture of Engineering at Miami, I decided to survey my peers within Miami’s School of Engineering and Applied Science, as well as those at other universities in Ohio. I created a two-page, eight-question Word document survey. In it, I ask students to rank their incoming knowledge about engineering prior to college, analyze their Introduction to Engineering courses, address the problem of students switching out of Engineering, and discuss the overall strengths and weaknesses of their school’s program.

MIAMI UNIVERSITY

Here at Miami, I printed fifty hard copies of the survey to distribute directly to students. Since emails are easily ignored, hard copies are the most effective way at getting students to participate in a survey, but only logical when surveying students in Oxford. I distributed thirty surveys to an EAS 102 Problem Solving and Design class, and about twelve surveys to upperclassmen engineering students working in the ECE Labs.

OTHER UNIVERSITIES

My first step involved researching Engineering chairs and administrative staff at the University of Cincinnati, Wright State University, University of Toledo, Ohio State University and Case
Western Reserve University. I then sent out seventeen emails to various school administrators asking that they forward the survey on to their Engineering students.

The Word document containing the survey that I created was dispersed to:

- Seniors in Civil and Environmental Engineering at UC
- Mechanical, Industrial & Nuclear Engineering students at UC
- Electrical and Computer Engineering students at Ohio State
- Mechanical & Materials Engineering students at Wright State
- Electrical and Computer Engineering students at Case Western Reserve

Thanks to professors and administrators at University of Cincinnati, Ohio State, Wright State, and Case Western Reserve, I received 64 completed surveys from Engineering students all across the state. Each student downloaded the Word document attached through the email from their professor and then forwarded the final document to my address. Upon receiving each email, I downloaded the Word document into a survey-devoted folder and sent a reply email thanking each person. Unfortunately, all five of the surveys completed by Case Western
students came two weeks past my deadline, and since there were only five replies from the whole school, I did not include them in my study.

DATA

This section will highlight the results found in the ninety-eight completed surveys. Full results can be found in Appendix A where the Excel spreadsheets of the analyzed data are located or in Appendix B where a hardcopy of each survey is located.

QUESTION 1: Prior to entering school, how would you rank your knowledge about Engineering (knowing what classes you would take, potential careers, etc)?

I graphed the data from this question by the percentage of students from each school who answered at each level. For example, two out of forty Miami students scored a one, so the percentage graphed is 1/20th or 5%. Questions 3a and 3b are graphed similarly.
Figure 1. Results from students at all four universities in response to question 1.

<table>
<thead>
<tr>
<th>School</th>
<th>Mean</th>
<th>Total Responses to this question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami</td>
<td>4.6</td>
<td>40</td>
</tr>
<tr>
<td>Ohio State</td>
<td>3.56</td>
<td>16</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>5.33</td>
<td>18</td>
</tr>
<tr>
<td>Wright State</td>
<td>4.81</td>
<td>24</td>
</tr>
<tr>
<td>Overall</td>
<td>4.61</td>
<td>98</td>
</tr>
</tbody>
</table>

Table 1. Mean response from each university to question 1.

**QUESTION 2: Where did you learn about engineering prior to beginning college?**

This question allowed students to respond with multiple choices. Graphed below are the percentages of students, at each school to answer with the given response. The graph will not be out of 100% since some students answered in multiple categories.
QUESTION 3A: How effective were your Intro courses at informing you of the Engineering major and preparing you for future coursework?
Introduction to Engineering Course

Figure 3. Results from question 3A.

<table>
<thead>
<tr>
<th>School</th>
<th>Mean</th>
<th>Total Responses to this question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami</td>
<td>6.2</td>
<td>40</td>
</tr>
<tr>
<td>Ohio State</td>
<td>5.81</td>
<td>16</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>5.5</td>
<td>18</td>
</tr>
<tr>
<td>Wright State</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>Overall</td>
<td>5.29</td>
<td>95</td>
</tr>
</tbody>
</table>

Table 2. Mean response from each university to question 3A.

**QUESTION 3B:** Topics covered in this Introduction to Engineering course:
QUESTION 3C: Were you satisfied with this Intro class? What could be done to improve it?

Data that was either second hand as courses had changed since the survey responder was in the class, or that which was deemed irrelevant (three word answers) were excluded. Some responses have been condensed with care to keep the original context, and multiple responses were not included.

MIAMI

A. More introductions to possible careers would have been nice.

B. It could do a better job explaining what life as an engineer is really like.

C. Making engineering less generalized would improve the class.

D. It was boring and had very little to do with ECE.

E. EAS 101 could have been a little faster and EAS 102 could have been a little slower.
F. The EAS 101 mainly seemed like a waste of time and a lot could be done with it, but 102 is fairly challenging.

G. It was okay but knowing how some of the stuff is going to apply to my major would be helpful.

H. I was a little confused all the time.

I. Talk more about possible careers and what can be done with your degree. Also, have more exposure to each engineering major so that you can see which you like best.

J. More specific coursework instead of the wide-ranging ideas.

K. More hands on work and less work on the computer.

L. EAS 101 should be more like EAS 102. I’m satisfied with second semester but really disliked first semester introduction.

M. More information about careers and different types of engineering.

N. Maybe less overkill with math skills.

O. It covers a lot of engineering basics but I don’t think it helps enforce the engineering principles very well.

P. More explaining of work, as opposed to assuming we know everything.

Q. More setup for future classes.

R. I would like more realistic examples about “real-life” problems. Perhaps more specialized introductions for specific engineering fields.

S. The material was too broad.

T. I thought the class was (at times) needlessly difficult, while being irrelevant. To improve the class I would teach actual concepts that we will use.

U. Possibly more explanation as to how the methods would be used later.

OHIO STATE
1. I was satisfied; it covered a broad range of engineering disciplines.

2. I took the fundamentals of engineering honors set of courses. They were great at giving you an intro of every part of engineering and different engineering disciplines.

3. It was mostly a drafting/intro computer class. It was fine provided that they tell students that it is not an “overview” of all the engineering majors. I am an EE and it provided no help/guidance at all.
4. I was not satisfied with the set of three intro classes. They were a lot of work, and not equally applicable to all engineering fields. For instance, we spent weeks practicing 3D modeling software such as Autodesk Inventor, but this software rarely applies to my chosen field, ECE. I recommend shorter experiences with more varied software. These courses seemed to me too focused on career-related skills such as teamwork and report writing, and rarely had a focus on learning or understanding principles.

5. I was satisfied; however I would have liked to know more about the major I was pursuing rather than just engineering in general.

6. They could have done a better job explaining the coursework and what to expect in each major. Groups of students were to give presentations on different engineering disciplines but the presentations were brief and were not able to give any advice from personal experience.

7. The intro courses were amazing and well-planned. I felt prepared for continuing coursework. However, it did not fully prepare me for the difficulty and the technicality of future courses.

8. The intro class was kind of weak. It was more an orientation to OSU rather than a class to teach about engineering.

9. We did many various labs that concerned many of the major fields in engineering. I met other students who were interested in the same but also different fields of engineering. We did extensive lab work and worked in groups. It was definitely the best introduction to engineering I could have ever imagined. The course workload was probably 5-8 times what your typical base level class is and does a great job of preparing you for the hard work you will need to put into engineering.

10. Programming is covered so quickly (in about 8 weeks) that it is difficult for students to get a good grasp of it.

11. One thing the department has been trying to improve is the variety of engineering disciplines introduced in the program. Fall quarter focuses primarily on Mechanical Engineering, while winter quarter covers Electrical and Computer Science. New design projects have aimed to be more Chemical and Civil/Environmental related. Only one assignment is related to the other fields (Aero, Industrial, Food/Ag/Bio, and Welding).

12. I felt the series of three intro classes were a waste of time. I felt it would have been much more beneficial to have a course or series specifically for EE’s. Why does an EE need to know how to make an Orthographic drawing?

13. There could have been a better description of subfields in each discipline. For example, I thought EE was just EE, but right before I had to start picking classes for specializations in the field did I learn there actually existed subfields.

CINCINNATI
1. Pointless but created unity in the freshman Mechanical Engineering class. Taught by our future academic advisor and helped us adjust to college, not necessary Engineering.
2. Showed a realistic side of engineering, how hard it is, how you have to play rough to stay in it. Could have had more classes so it wasn’t like high school and the cycle of cram, test, cram, test.

3. It was a regurgitation of basic engineering concepts that students should already be aware of prior to entering the field. If students could test out of or allow it to be an optional course, it would be much more effective.

4. I was satisfied with the class. I especially liked how they prepared us for typical problem solving solutions and made suggestions to solve engineering problems for the future.

5. They need to try to go into more detail about engineering itself. Our professor talked more about the college and how the system was set up. This really didn’t do any good.

6. It taught us basic information about engineering. It was mainly a class that showed us what to expect in the future.

7. I would like more information on the courses to come and scope of work we would be doing during the entire college course load.

8. It could have described possible career opportunities and the differences between different types of engineering (design/manufacturing).

9. I feel the professor took too much time warning students about the hardships of engineering rather than concentrating on how we can overcome them. He explained the background of engineering and the co-op at UC and doing a few problems. Unfortunately these problems included course work that we don’t approach until the second or third quarter so it felt pointless many days.

10. It would be far more useful to have a professor who has spent many years in industry before entering the teaching profession. Giving real world examples and learning from the field is much more useful for an introduction to engineering course.

11. It was informative in describing the different types of career paths for Engineers. It could have been improved with guest speakers of actual descriptions of what those specific engineers did in various fields.

WRIGHT STATE

Inconclusive. Most students mentioned that the introduction course has now been changed and some explained what they had heard second-hand was being taught. There were not enough informative responses to take into account Wright State’s Introduction courses.

QUESTION 4: What, in your opinion, are the biggest reasons students switch out of Engineering at your school?
Trends for this question were similar throughout each school and were combined into one data set. Figure 4 shows a graph of the percentage of all students surveyed that responded with each answer. Most students responded with multiple answers.

![Why Student Drop Out of Engineering](image)

**Figure 5.** Results from question 4.

**QUESTION 5: During what year do you first meet with your Engineering Academic Advisor?**

<table>
<thead>
<tr>
<th>School</th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
<th>4th Year</th>
<th>5th Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami</td>
<td>53.8%</td>
<td>25.6%</td>
<td>17.9%</td>
<td>2.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Ohio State</td>
<td>77.8%</td>
<td>22.2%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>61.5%</td>
<td>23.1%</td>
<td>7.7%</td>
<td>7.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Wright State</td>
<td>52.4%</td>
<td>33.3%</td>
<td>9.5%</td>
<td>0.0%</td>
<td>4.8%</td>
</tr>
</tbody>
</table>

**Table 3.** Results from question 5.

**QUESTION 6: What is keeping you in the Engineering major?**
This question was thrown out upon looking over the variety of responses from each student.

The motivations for staying in the major are vastly different and do not serve as examples for how to keep students in the major, as desired. Examples of responses that did not serve the preferred purpose are:

- For my son
- To prove my parents wrong as they did not believe in me
- To make money and buy cars

**QUESTION 7: What are the strengths of your school's engineering program?**

**MIAMI**

- Professors with industry experience. Most professors are real cool.
- The professors enjoy their jobs. I feel that the engineering school wants to do its best.
- Professors are helpful.
- New Engineering building.
- Small class size.
- Building personal relationships with faculty.
- Ability to do high-level research.
- Professors are smart and always there to help when needed.
- Has all the proper tools to help a student become a great engineer.
- Very close knit program
- There seem to be a lot of hands on activities, extra-curricular activities related to Engineering, and many other opportunities.
- Small departments make it easy to meet and get to know people, also to get help from professors.
- Speakers and other opportunities to learn about the real world applications of Engineering.
OHIO STATE
A. Rigorous coursework. Professors who speak English (so far). Accessible computing resources.

B. Large program with many helpful and knowledgeable professors. Many projects that students can get involved in outside of class such as research and engineering design teams.

C. The program has been around for a while and works like a well-oiled machine. There are many outlets so no one should be left out in theory. They understand where most students have problems and emphasize this to students before they experience trouble themselves.

D. Our EE program is ranked up near the top.

E. Once in the Engineering major, the program is flexible. There are many specific areas in ECE and we can always take additional courses as desired.

F. Lots of connections to companies

G. OSU is always researching and growing.

H. It’s a well-rounded program with lots of interesting labs. The projects make the major interesting.

I. ECE degree specializations will help me be more attractive to companies.

J. Freshman Honors Engineering program has caring professors and small classes so you get personal attention.

K. Career services office is wonderful and helps students find internships, co-ops and post-graduation jobs.

CINCINNATI
A. All 18 students mentioned the Co-op as a strength in UC’s engineering.

B. Good professors who seem to care.

C. Good connections to the industry, allows for better networking with potential employers.

D. The school is large enough to offer an expert on almost any topic in engineering, allowing students to experience a community of innovation.

E. Large research facility.

F. One hundred years of engineering education.

G. It offers a wide range of majors and degrees.

H. UC practices Six Sigma.

WRIGHT STATE
A. Teachers are willing to go the extra mile to ensure that you learn the material.
B. The research is a strength. Students can participate or read about it to increase their knowledge.

C. Professors assign computer programming project which is a helpful skill to have.

D. Dean’s Student Ambassador Program, where 15-20 students meet with the dean and a leader in the industry for a presentation, networking, advice, etc.

E. Small class sizes and professors always have office hours and are able to help you.

F. Professors have real world experience.

G. Job fairs and other announcements help students find internships.

H. There are many fellowships for continuing education and opportunities to work with Wright Patterson Air Force Base.

I. Labs and equipment are a strength of our program.

J. Adjunct professors from Wright Patterson Air Force Base are experienced and give practical view.

K. Very good senior design program.

L. Industry connections are nearby and contribute to the program.

M. Well known – Despite mediocre rankings, I have had trouble getting accepted into grad schools.

QUESTION 8: What are the weaknesses of your school’s engineering program?

MIAMI

A. Some professors who can’t teach well or have little industry experience.

B. Lack of Masters Programs.

C. Not enough acclaim, Miami is not known for Engineering.

D. Not exposed to cutting edge research.

E. Too small, not enough classes offered.

F. Lack of Co-Op program in ECE.

G. EAS 101.

H. Some majors are very new.
I. Computer Science Intro (CSA 174) scares away students.

J. Some classes seem pointless to the Engineering field.

K. Lack of some Engineering majors, i.e. Biomedical Engineering.

L. There are only a few ABET accredited majors.

M. Lacks an overall cohesion; it’s constantly changing.

OHIO STATE

A. Advisors who don’t explain the complexity of scheduling courses. It is hard to figure out what courses are required or elective and which direction to take, when to take each course, etc.

B. Classes are big at times, and you don’t get to take anything related to you major until your second year.

C. Too many classes taught by TAs.

D. Some buildings and equipment are outdated.

E. It takes students more than four years to complete an undergraduate degree.

F. Some classes lack in practical usage. Too much time is spent on theory and not enough real-world work.

G. The undergraduate program seems to be secondary to research and graduate programs. Some of the professors put their classes second to their research and other professional duties.

H. Most of the classes seem to move at a rather fast pace and the workload is usually very large.

I. Due to the quarter system, some of our classes are unable to cover all the material that is required in that course because of the short amount of time.

J. No community feeling.

K. Sometimes poor teaching.

L. Too many professors who speak very poor English and are unable to effectively communicate with their students.

M. Not enough staff for all of the students (especially advisors).

N. The introductory program that is required has almost no relation to the individual majors. Now that I am in my major, I rarely employ the skills I supposedly gained in the intro program. The classes were only a delay, and part of the reason why engineers here take five years to complete their degrees.
O. General requirements such as math should have separate engineering sections to emphasize practical uses rather than theory.

P. Some departments have more up-to-date facilities than others. I.E. Brand new Mechanical Engineering building whereas others such as Civil and Electrical are located in outdated buildings.

Q. Our school needs more introductory classes that give a hands-on approach to engineering as opposed to just teaching theory.

R. Within the ECE department there should be more mentoring and care for the students. Many other engineering departments have gatherings outside of class for the students and professors to get to know each other.

CINCINNATI

A. Five students mentioned that teachers are more interested in research than students.

B. There are not too many classes that actually help with technical information work. Maybe a little too much theory.

C. Sometimes the co-op is a terrible job and you must stay with it for two quarters minimum.

D. Some professors do not all agree and it causes rifts within the university. Some teachers talk bad about the problems around the university causing them to be distracted from class.

E. The class sizes are too large and scheduling is not flexible.

F. The Physics department.

G. Some of our professors need a guideline for their classes. Two classes with different professors may learn totally different things.

H. Could use additional funding for graduate research.

I. The program is so large that it is easy for kids who aren’t pro-active to get lost in the chaos.

J. Quarter system makes it difficult to easily teach a course without feeling so stressed by the end of the quarter.

K. The Engineering school does not receive the special treatment that it deserves from the university as a whole. It has the potential to be as great as MIT but is brought down by budget cuts and by the university not realizing that it needs more than the business school monetarily to maintain labs.

L. Need to change curriculum to adapt to the changing needs of today’s society utilizing all forms of technology.
WRIGHT STATE
A. Poor ranking in US News and World Report.

B. Large class sizes, some lower level classes have 200 students.

C. There is a lack of interaction with other schools and professional organizations.

D. Students spend the first year with the Math and Physics department rather than the Engineering department.

E. There is not enough interaction with the faculty and staff, also I am unsure what resources are available to me as a student.

F. Advisors do not help here.

G. Professors will not relate topics to real world practices.

H. Some professors care more about their research than helping students.

I. Poor faculty advising within the Engineering school; they all seemed too busy and had no clue what I needed to do to graduate.

J. Students who cheat and try to get by easy.

K. The Math program at Wright State.

L. The programs are disjointed and we need a more structured curriculum.

DISCUSSION OF DATA

Although the amount of surveys from each school is but a small percentage of the overall student body, they represent a wide variety of opinions about their programs. The fifty-five surveys received from other universities will serve as a comparison to Miami’s Engineering program and will provide additional ideas for improvement.
The data shows that there is no real trend in the engineering knowledge that students enter college with. From the responses, some hear first hand about the profession from a relative while others do not know what they are getting into. On a scale from one-“No Clue” to ten-“Expert”), 24 out of 95 surveyed associated their knowledge of Engineering before coming to school with a three. This was the most popular response among students. Staying with the low end of the scale, over 42% of those surveyed ranked their knowledge with a score of one, two or three. A total of four people recorded a nine or above, one from Cincinnati, one from Wright State, and two from Miami.

When looking at where this previous knowledge came from, there is one clear response that students from all schools chose. Most students stated that High School experiences and classes were the main source of engineering knowledge prior to college. At Miami, the second most common source responsible for engineering background were family members who provided 32.5% of students with additional knowledge.

Moving on to the Introduction to Engineering course at each school, the rankings are similarly across the spectrum. Miami University ranked the highest in the effectiveness of EAS 102 with a
mean score of 6.2 on a scale of (one-“Useless” to ten-“Effective”). However, there are still a
significant amount of Miami students that thought of the introduction course was not effective
with 32.5% scoring the class below a five. At Miami, no students ranked EAS 102 below a
three.

Continuing with the content of each introduction course, the most Miami students compared to
all other schools felt that effective problem solving methods and engineering design principles
were taught. On the other hand, Miami ranks the lowest in the number of students who felt that
the introduction course offered an explanation of future coursework, and coverage of possible
career fields. Thirty-one percent of Cincinnati students felt that possible careers were covered in
their introduction course compared to only 18% of Miami students. This statistic is reversed
when looking at engineering design principles, as 31% of Miami responses felt that this topic
was addressed verses only 17% of Cincinnati responses.

When asked what could be done to improve the Intro to Engineering course, the overall tone of
Miami students was “do not focus on broad ideas the whole semester”. Some specifics that
convey this tone are: point (J), “More specific coursework instead of the wide-ranging ideas,”
point (S), “The material was too broad,” and finally point (T), “I thought the class was (at times) needlessly difficult, while being irrelevant. To improve the class I would teach actual concepts that we will use.”

Responses from Ohio State suggest that there are three Introduction to Engineering classes, one for each quarter of freshman year. These courses divide up popular engineering disciplines (Mechanical, Electrical, Civil, etc.) throughout each of the three quarters and assign labs to work with each discipline. The most common complaint at OSU is that an unequal amount of time is spent on each discipline, causing some to count the courses as useless to their specific field. Most students from Cincinnati desired less teaching of basic engineering concepts and more background on future coursework, engineering disciplines and industry experiences. One student suggested bringing in guest speakers from different areas of Engineering to shed light on current happenings in the field. Wright State responses to this question were not analyzed due to recent course changes.

While addressing dropout rates of undergraduate engineering students, responses from all four schools were similar. Eighty-three percent of surveys cited Difficult Coursework and Not Willing to study enough as causes. Fifty-eight percent of those surveyed also chose Did Not Enjoy the
Major as the third cause. Rounding out the reasons why students do not continue with their engineering pursuits were: Lack of Professor mentoring with 20% and Lack of Upperclassmen mentoring with 19%.

Academic advising at each school begins for the most part in the student’s first year. Cincinnati responses showed an interesting trend with over 27% of students leaving this question blank. An overwhelming 87% of Ohio State students noted that they met with their academic advisors their freshman year.

The strengths and weaknesses for each school are varied yet some trends can be seen between the larger Engineering schools. For instance, many Miami students replied that small classes and programs were a strength of the school, while students from Cincinnati, Ohio State, and Wright State all commented that large class sizes are one of the weaknesses. Most Miami students say a weakness is that some programs are not accredited, and that it is constantly changing which lacks cohesion. In contrast, the other three schools find weaknesses in the fact that professors value research over their undergraduate students.

**ADDITIONAL RECOMMENDATIONS**
Since freshman come to Miami with varying amounts of background knowledge, designing an Introduction to Engineering course that is of value to each person is extremely difficult. From the data, it is clear that Miami students are being taught, more than other schools, proper engineering design principles and problem solving methods. However, ending up with the lowest coverage of possible career fields and an explanation of future coursework are two areas that I would like Miami to improve in.

By giving students better ideas of what engineers do after graduation, I am confident that students will be encouraged in their studies. Since this is part of the goal of EAS 101, I am confident that by making a few course changes, we will give freshman the additional knowledge that they need to succeed throughout the Engineering curriculum.

Changes

The three main changes for EAS 101 are the addition of three lectures and three labs devoted to each engineering department and two lectures dealing with the new final design project.
The lecture devoted to each department will consist of one upperclassman student and one
guest speaker from that field. The upperclassman will speak first and give students an overview
of the falsehoods that they believed as freshman and what things really are like. They will talk
about the coursework that each freshman will take, and give a few words of advice about
surviving the major. Next, the guest speaker will describe their profession and what they do from
day to day. If possible, this speaker will talk about other possible careers for an ECE major as
one example. Then there will be a Question/Answer session where students have the
opportunity to ask both the professional and the upperclassman questions.

During the three weeks that these speakers visit a lecture, the labs will be devoted to that
department, for example, ECE. As a homework assignment for these labs, each student will
bring in an article and summary to class that pertains to ECE current events. The class will
discuss the articles and if time permits, a short lab project will be completed to complement that
department.

CONCLUSION
Comparing the responses of Miami’s engineering students to those at other universities is a
great way to look for improvements on our program. One problem that comes with this
evaluation is the fact that the four schools are not of the same size, funding, or focus. At Miami,
post-graduate research would never come before undergraduate students as it does at other
schools. Additionally, it will be impractical to think that we will be able to offer the same
multitude of engineering specializations as Ohio State. Weaknesses that Miami students shared
about the overall program were, for the most part, products of a small engineering school. At the
same time, strengths that came up consistently such as small class size, close relationships
with faculty, and class unity are also reliant on being a moderately-sized engineering program.

Data about Introduction to Engineering courses is the most probable place to make
improvements in Miami’s school of engineering. Reaching out to freshman will also have a large
impact on the retention rates of engineering students. In 2005, Semiconductor Industry
Association (SIA) studies show that only 50% of students who begin in Electrical Engineering
stuck with it. They even went so far as to fund projects devoted to encouraging students to stay
in the major (Business Wire). How great would it be to see the Introduction to Engineering
course itself keep students motivated to stay in the major.
SECTION 3: SENIOR DESIGN PROJECT
PREFACE

This Senior Design Project began in a course designed to meet Miami University’s capstone requirement. I completed it with a group of two other Computer Engineers, Kelvin Corbin and Adam Davis, and the help of my advisor, Dr. C.S. Chen. The goal of the capstone project at Miami is to integrate liberal arts learning with specific knowledge to investigate a problem. My project allowed me to do that because I was able to apply all four liberal arts education goals, Critical thinking, Understanding Contexts, Engaging with other Learners, and Reflecting and Acting, into this project. To begin, my group was faced with an engineering problem: how to control the interior temperature of a car using solar energy. Following our research and critical thinking, we were able to generate a wide variety of solutions. However, after understanding the context of the problem that our solution needed to be user-friendly and adhere to our low power input, we were able to eliminate many proposed solutions.

The final two liberal education goals, engaging with other learners and reflecting and acting were visible in all parts of this project. From my experience in the workplace, engineers must not
only have specific knowledge to succeed but also have the ability to encourage others and help solve problems together. When entering this project, I was fearful that my lack of experience with solar energy and cooling applications would hurt the team. However, the first week of the project I ran into one of my group members who was already bursting with ideas. What a relief! This really showed me how important group work is. In one area someone might be lacking but the team as a whole can always push through.

Finally, reflecting and acting took place throughout the project as we continually ran into road blocks and challenges. Initially we thought the Peltier cooler would perform perfectly in our small application. However, following testing, we were forced to throw out that idea and use a ventilation design. Additionally, our final testing proved to be lacking with respect to the amplifier circuit. We researched the circuit and its components and found the op amp was limiting our current output. Upon this reflection, we were able to make suggestions for future work on this system. In real world applications there are always small deviations from design to construction that must be dealt with on the spot.

With respect to the engineering design process and modeling techniques, I found our specific project to be somewhat lacking. Especially with a team of all Computer Engineers, we came into
this project with very little knowledge of cooling or thermodynamic principles in general. Our
research centered on the specific parts of the device rather than how to create an efficient
cooler as a whole. A more diverse team or additional advisor from this area from the beginning
would have been helpful. Once we sought out help from the MME department, we were already
so far along in our design that it was difficult to use the knowledge that we gathered. This is one
way that our project does not resemble professional work. At a company, there will be
specialized team members from the start who each have backgrounds in related fields, rather
than each person starting from scratch. I do think this project was a great learning experience,
just not very similar to a work experience.

Reflecting on the project as a whole, I am glad that I was able to experience new topics outside
of Computer Engineering. At times I wonder if it would have been more applicable to work on a
project that would have incorporated computer programming into the project. While
programming is something that I would have been more qualified in before starting and would
have be applicable in my career, it is fun to learn something completely new. I feel like this
project helped me apply concepts studied in both Circuits I and Circuits II directly, and taught
me new engineering topics outside of my major. The following paper is the professional paper
written by my group, the Solar Powered Car Cooler team from ECE 448/9. Enjoy!
When a car is parked and turned off during the summer, the sun can heat the interior to temperatures in excess of 120° F. Researchers from the Stanford School of Medicine recently discovered that even on a cool day with temperatures around 70° F, the interior of a car parked in the sun can rise to life-threatening levels (Spector). Testing the temperature rises within a vehicle as exterior highs ranged between 72°-96° resulted in the vehicle's interior increasing by an average of 40° F in the first hour, regardless of ambient temperature. Eighty percent of the temperature rise occurred in the first thirty minutes. The current market for solar powered car cooling does
not satisfy consumer needs. Our team’s objective was to find an efficient way to use solar energy to keep car interiors comfortably cool while parked in the sun on a hot day. Following the engineering design process, our paper outlines our final process regarding the design of our car cooler. Our best option was to use solar cells to power a ventilation system which is an improved variant of the existing product on the market. All other solutions were ruled out due to the limited power supply at current solar cell technology and/or customer usability. This semester, we worked on the Embodiment Design process which includes: acquiring materials, building our prototype, and testing its capabilities. Upon final testing, our system did not meet expectations due to insufficient sunlight as the cells produced only half the rated current output, and inefficient amplifier performance.

Introduction

Our senior design project team’s objective was to create a device that uses solar energy to maintain a comfortable temperature in a parked car during the summer. If the device proved to be successful, cost-effective, and efficient, we hoped to commercialize our device as well. Potential customers for the cooler would be car manufacturers or the public depending on the overall price of the device as well as the ease of installation into the automobile.

Professor C.S. Chen, our team’s advisor, was the first to brainstorm this project after purchasing a solar powered ventilation system, the Auto Cool, and being disappointed with its performance. The team consisted of Adam Davis, Bethany Sloan, and Kelvin Corbin. Each member is a senior majoring in Computer Engineering, with Adam Davis also majoring in Systems Analysis. Each member believed that working on this project would be fun, educational, and give us experience that would be valuable in our future endeavors.

We considered four methods for maintaining the comfort of the vehicle. Method One involved using a powerful fan to improve the existing design of a product on the market, the Auto Cool. This method would be inexpensive to implement and could compete alongside existing products. Method two centered on using Peltier chips to cool the car. Peltier chips use electricity to make one side of the chip hot and the other cold. Using a heat sink we could pipe the hot side outside of the car and continuously cool the inside of the car as a thermoelectric cooler. Method Three involved using solar energy to power the existing air conditioner inside a car. This would provide
a sure-fire way to ensure the temperature of the car would remain cold. The Fourth method involved using solar energy to power our own small Freon compression device.

Last semester in ECE 448, we focused our attention on the research and evaluation of each of the above-mentioned types of cooling. Following a multitude of communication with experts in the cooling industries as well as engineering analysis techniques, we generated a final design schematic. The limited power supply of solar cells at current technologies proved to be the determining factor when choosing our final design. Manufacturers in the Freon compression industry did not have a system that could operate at or under the maximum output of the solar cells chosen for our application, 3.3 Watts. Additionally, an in-car air conditioning system would require power from fifty solar cells, ruling out this option due to cost and usability. Finally, the Peltier chip was proved to be inefficient at cooling with low power input during experimentation. This led us to choose the ventilation design for our final plan.

We decided to use the air outside the car to cool the air inside of our car. Our team recognized that the air outside the car would always be cooler than the air inside the car. If this were not the case, then customers would feel no difference in temperature when they entered their car. This fact means that there is an abundant source of free energy that we could use to offset our power restrictions. We felt that it would be best to use our solar energy to power two individual fans that will circulate air flow inside and outside the car. One fan could be used to bring air into the car while the other fan would be used to cycle the hot air out of the car.

**Final Design Implementation and Testing**

Our team focused fall semester on defining the problem of cooling a hot vehicle parked in the sun on a summer day. Upon investigating other solar powered car coolers, we concluded that all available products approach the problem from a ventilation point of view. Trying to provide better results than existing products, we gathered information about two areas of interest: solar energy and cooling techniques. As noted in the previous section, through experimentation and
vendor contact we determined that ventilation was indeed the best option to cool the car at the given constraints. Figure 1 shows a sketch of our final design from the fall.

![Figure 1. Design Schematic from ECE 448.](image)

This spring, we broke down the task of making our prototype into three separate areas: solar cells, fans, and an amplifier circuit. Each team member took control of one section and ordered necessary components and researched additional topics related to their part.

Solar cells proved to be a complicated area for our project. Silicon Solar, a manufacturer based out of New York, offered the specific solar cells we desired at the lowest price. We ordered three solar cells, two to power the input and output fans, respectively, and one additional cell for testing. Upon arrival, the cells were surprisingly larger than expected. Due to a small discrepancy in labeling online, we assumed the cells would be approximately 2” x 3”. However, the cells are instead 6” x 6”. This should not have much effect on the overall design since we have yet to craft a fiberglass case for the end product. Another obstacle with this component is that the cells are very brittle and one cell broke while being soldered. In order to protect the cells, we built a Plexiglas case to aid in system testing.

These cells did not include any specifications or instructions, which created a large problem since none of our team members had previous experience with solar cells. We were able to get in contact with a technician through email. The technician informed us how to connect the two cells
in series and that the only method of obtaining a voltage through artificial light was through the use of a 500 Watt halogen light bulb. Even with this powerful light source, he mentioned that we will not see the full power output of 6.3 Amps and .5 Volts. When our team tested the cells under the suggested conditions, we saw .5 Volts and 0 Amps. This experiment allowed us to test the four terminals on the cells to see which provided the correct output, and showed us that we would have to wait for natural sunlight to get the full output of the cells.

Next, we obtained the fans that were to be used in our final design. They are 80mm fans that run at 12 Volts and .26 Amps. They are designed to move 49 Cubic Feet per Minute of air. We chose these fans because they have a power input that is slightly below the optimal output of the solar cells. These fans have also been tested and found to be capable of working at one-fourth of their rated input, which will allow them to work within a varying number of solar conditions.

Although the fans could run at less than 12 Volts, the airflow would be optimal when provided with 12 Volts. For this reason, we needed to convert most of the input current received from our solar cells into voltage to run our fans at optimal capacity. After discussing our options with various companies and teachers, we concluded any circuit design would have potential problems with power conservation. For our specific requirements, we did not find any readily available passive converters for purchase. We concluded that the best option was a non-inverting amplifier circuit, though it did have a few obstacles. The op amp used in the circuit required +12V and –12V external as a reference voltage to function, which we cannot supply from the solar cells. Since op amps do not require much amperage, we decided powering our op amps with 6V batteries in series would be the most efficient option. This allowed us to give the fans all the voltage they needed for optimal airflow. The next obstacle of this circuit was keeping the batteries from quickly running out of power. This issue can be addressed by keeping the batteries detached from the circuit and installing a power switch to the device that automatically turns the circuit on when it is placed in the window of a vehicle.

Testing the configuration of our fans was essential to make sure we had proper airflow into and out of the vehicle. We designed an experiment that made air currents in the vehicle visible in order to ensure that the interior air was properly mixing with the outdoor air. First we set up a
prototype of the product inside a vehicle powered directly by a 12V power source. In order to make the air visible, we first attempted to fill the car with CO\textsubscript{2} gas by using 30 lbs of dry ice. Unfortunately, it was difficult to get the vehicle full of CO\textsubscript{2} vapor as planned so we went with a backup approach, two sulfur-based smoke devices. These smoke devices successfully filled the vehicle with thick smoke, allowing roughly two inches of visibility. Next, we let the smoke sit for one minute to check for leaks and settling, and then turned on the ventilation prototype. Within roughly two minutes and 30 seconds, the smoke had cleared to allow full visibility through the vehicle. As the smoke cleared, air currents were distinctly visible through the vehicle, showing us that the fan configuration was optimal and that the fan positioning did not create a circular airflow. With the success of the test, we concluded that the original design and fan configuration would work well in our system.

The first attempt at bringing together our three components led to a disappointing result as our prototype did not work. Our circuit sacrificed a large portion of the input current in the process of amplifying the output voltage. Originally, we believed that this was because we were attempting to power our prototype indoors with the 500W halogen bulb. We discovered, however, that we had equally disappointing results when we tested our product outside as well. Additionally, our solar cells were producing 25-50% of the amperage that the manufacturer specifications gave. Two possible causes for the poor solar cell performance could be the sun not yet shining at full summer strength, or a defect in the solar cells themselves. The amplification circuit is also hindering our testing of the cooler. While our circuit design was sound in theory, our actual implementation lost a majority of the system’s power. One potential cause is the lack of proper components rated for high capacity amperage. Our circuit got roughly 11V output as desired, but lost 90% of its wattage in the process, resulting in an output current of .027mA. This loss of power can be attributed to current limitations of the individual components, specifically the op-Amp which was rated at a maximum current output of .025mA, which is roughly what we saw. With an op-Amp capable of higher outputs, we are confident that the current drop would be greatly lessened and we would be able to properly power our fans.
Conclusion

Our ability to test the system was limited because of weather conditions throughout the semester. It was difficult to completely test our product without direct sunlight and warm weather. Our solar cells are capable of supplying 6-6.6 Amps and .55 Volts of energy. We used the recommended 500 Watt halogen light bulb to test the cells indoors but did not see maximum output, specifically with the output current. Unfortunately we have not had appropriate weather for testing and thus have not seen the expected solar output. If this still proves to be difficult, we will contact Silicon Solar technicians with more concise, detailed questions. It is imperative that we use the cells with correct techniques so that we see the maximum power output. Since artificial light will not allow us to see the maximum output, we might consider indoors testing of our prototype with a separate power source to simulate the solar cells in an outdoor setting.

The next step with the fans will involve airflow testing. We will do calculations when possible to determine general airflow, as well as actually testing the fan configurations. Ideally testing would be done in a test environment, such as an actual car, with a smoke generator so that we can see the airflow as it happens. Based on the results, we will adjust the fan configuration until we feel we have the best possible airflow that will still work within our design parameters. Once we have our final fan configuration, we will have a casing for the prototype molded out of fiberglass for further testing.

There are various paths that we can follow when it comes to finding the right circuit to convert our 6.3A into 12V. One flaw of our previous circuit designs was that we had to find a way to amplify .5V into 12V which is an amplification factor of 24. One thing we can do to shorten that is put two of our solar cells in series to shorten the gap that must be overcome. Since we have seen our fans function with as little as 3V, having a starting voltage of 1V would be encouraging towards getting our fans to function. Next, we plan to talk to various companies that work with equipment that uses smaller voltages such as Tyco and Fisher-Price to brainstorm ways of optimizing our solar cells. Another path that may be taken would be to put the two solar cells in parallel, doubling their Amperage. This would be beneficial if our amplifier circuit converts amperage. Our approach towards placement of the solar cells would depend on the circuit that
would be used. However, we feel confident that we will have a circuit complete and built before the time comes to experiment with our prototype.

Once we finish creating our prototype, we have reached an agreement with Kyger’s Chrysler Car Dealership to test our product with the company’s cars. This will prove the effectiveness of our product since we can have two identical vehicles, parked side by side, exposed to the same heat on the same day. One car will serve as the control vehicle while the other will test our product’s ability to cool the interior of the vehicle. If the initial prototype does not perform as expected, we can reevaluate and try again.

WORKS CITED


APPENDIX A
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**Legend**
- A: Explanation of future coursework/purpose in major
- B: Possible career fields
- C: Effective problem solving methods
- D: Engineering design principles

### Question 4: Causes for students to drop out of Engineering

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**Legend**
- A: Difficult coursework
- B: Not willing to study enough
- C: Lack of mentoring from upperclassman
- D: Lack of mentoring from professors
- E: Did not enjoy the major

### Questions 5: During which year did you begin meeting with your Engineering Academic Advisor

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