

# THE OHIO STATE ENGINEER

Published by Ohio State University Students Since 1918

Autumn 2013 Vol.96 No.2

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# THE OHIO STATE ENGINEER

An Ohio State Publication Since 1918



Photo by Andrew Salt



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# Tell Me Something About Yourself...

FROM THE EDITOR

If you happened to have picked up this magazine and found yourself upon this page, I can almost guarantee that you are reading this to pass some time in your busy life as a student (or even as one of our dedicated faculty members!). You may have been perusing our website to take a breather from an online assignment, taking a study break in one of our many libraries on campus, or maybe you're passing time in your dorm or apartment before you have to head off to a meeting for one of the many organizations you hold membership. Whatever the case may be, I have no doubt in my mind that the life of an engineering student or of an individual in the sciences is a demanding one, and yet somehow we all manage to squeeze in some time to diversify our experiences at Ohio State.

The only explanation for these rare moments of solace without our noses in our textbooks must be due to magic - I'm convinced! Some days, I am truly not sure how I have time to attend classes, complete assignments, eat, plan my future, breathe, remember to tie my shoes, read all my emails, sleep... well, embarrassingly, sometimes I can't complete all of these tasks as often as I'd like. And yet somehow I have time to do things that I love, just like many of the thousands of students at this university! The community of engineering extracurricular involvement on our campus is astounding, even with so many academically motivated and successful students within the College of Engineering.

Diversity allows the many students at this large university to become more than just a number, and many organizations, classes, and activities based on such interests fuel our determination to truly stand out with confidence. These interests help us engage further in our work and find passion in our careers. You may be an Computer Scientist with an interest in anatomy and physiology, an ISE pursuing a business degree, or a Mechanical Engineer with a passion for dance. Whatever the case may be, skills are developed and specialties are pursued to inspire us all to innovate, research, design, and build. These "extraneous" facets to our lives may not be so crazy at all!

The Ohio State Engineer Magazine staff has been hard at work to produce our issue for Autumn all while immersing themselves into other activities and interests. Many articles provide a diverse focus on the impact of engineering in one's life, whether in the academic world or in the professional world. Opening our eyes to such potential in our futures is not only insightful, but fulfilling. We encourage you all to be inspired by your passions and leave just a little time in your busy schedules to enjoy these finer points of life so that you can confidently answer: "What makes you, you?"

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PLEASE RECYCLE

THIS MAGAZINE

# SECRETS OF THE FOUR-YEAR TREK

By Phoebe Low

## The Pre-Major Challenge

DESPITE THE FACT that our curriculum accounts for four years, you often hear people tell you that an engineering degree takes five years. Well, it usually does. Many people chalk it up to the fact that engineering students normally take a semester off for co-ops; however, engineers have a lot more room for error than a lot of other majors. Take for example the general engineering course requirements. Every engineering student usually goes through a combination of these three series during freshman year: chemistry, physics, and math – and not just any math either, but calculus. In other words, we take a slew of advanced courses whether or not they pertain to our major. If it's not bad enough, these courses make freshman year schedules very inflexible. As I said before, a lot of these courses are taken in series, which means they have to be taken in a certain order. To take the second course in a series next semester means that you must take the first course during this semester, no if's, and's, or but's. And if you are (or were) like me, you had to work part-time, which doesn't make your schedule any easier. If you can't fit everything in there in the year and a half that you're expected to complete the extensive pre-major course requirements, you might be in

college a semester longer than you intended. I'm not trying to scare you, but it is a fact.

As a graduating senior majoring in environmental engineering and minoring in both professional writing and environmental science, I'm proud that I managed to condense everything into four years. For me, my first year was the most challenging and I want to give a few words of advice before I depart with a diploma.

## Advice 1: Take Summer Courses

If you plan to stay in Columbus over the summer, I suggest that you look into taking classes at OSU. While many engineering courses are unavailable during that time, the university offers a large variety of GEs. It might not sound like much, but that would be one less art class that you have to worry about in the future.

*What if your scholarship doesn't cover summer semesters?*

If, for financial reasons, you cannot take summer courses through OSU, I would suggest that you take them at Columbus State Community College (CSCC). Not only is CSCC cheaper, but there are multiple branches within the Columbus region while the main campus is located in down-

Credit Hours	The Ohio State University			Columbus State Community College		
	Instructional Fee	Residential Total	Non-Residential Total	Resident Total	Non-Resident Total	International Students
1	\$369.00	\$458.00	\$1,078.50	\$129.25	\$286.25	\$343.50
2	738.00	890.50	2,131.50	258.50	572.50	687.00
3	1,107.00	1,323.00	3,184.50	387.75	858.75	1,030.50
4	1,476.00	1,817.00	4,299.00	517.00	1,145.00	1,374.00
5	1,845.00	2,249.50	5,352.00	646.25	1,431.25	1,717.50
6	2,214.00	2,682.00	6,405.00	775.50	1,717.50	2,061.00
7	2,583.00	3,114.50	7,458.00	904.75	2,003.75	2,404.50
8	2,952.00	3,547.00	8,511.00	1,034.00	2,290.00	2,748.00
9	3,321.00	3,979.50	9,564.00	1,163.25	2,576.25	3,091.50
10	3,690.00	4,412.00	10,617.00	1,292.50	2,862.50	3,435.00
11	4,059.00	4,220.75	11,670	1,421.75	3,148.75	3,778.50
12	4,428.00	5,277.00	12,723.00	1,551.00	3,435.00	4,122.00

\*Data reproduced from OSU's "Student Tuition and Fee Schedule Fees Per Semester" on Page 5 (available online) and CSCC's "Tuition & Fees" page on their website

\*\*Though cheaper per semester hour, CSCC will charge more at 12+ hours while OSU prices stay the same for 12-18 semester hours

town Columbus.

My suggestion would be to finish a course or two in physics, math, and/or chemistry. GEs are also available but I always tried to complete them through OSU to boost my GPA. However, this choice is completely up to you.

*Note:* If you follow this route, you are applying as a Transient Student. The application deadline for Summer 2013 is April 29, 2013 so apply as soon as possible.

*What if you are not staying in Columbus over the summer?*

Either look for other colleges within your area or take online courses through OSU. I would highly recommend this option if you are doing an internship in a new area; going to a college for courses would give you the opportunity to explore the new region and make friends. I also suggest that you apply to these other colleges as soon as possible because their submission deadlines for Summer 2013 are fast approaching.

To find a list of OSU-compatible schools and course equivalents, check the U.Select website ([www.transfer.org](http://www.transfer.org)) and look at Equivalencies by School. Or, better yet, call your local college and ask them for more information on being a transient student from OSU.

### **Advice 2: Transferring Credit During Fall or Spring Semester**

I took all of my physics courses through CSCC and I do not regret it a bit. Instead of large and crowded lecture halls, I found myself in rooms of 25 to 30 students. Everyone is different, but I always feel like I understand course material more easily in a small classroom environment. Plus, their schedules were usually flexible and had evening courses available. While I benefitted a lot from CSCC's courses, there was one definite downside: I had to commute downtown to their campus. Granted, it only took 15 minutes of driving (without traffic), but it can get tedious if you have to take the COTA busses. If you want to take these courses, be sure to factor travel time into your schedule. Also, it is very important that you speak to your academic adviser about these transfer credits before the semester starts. This will ensure that you are taking all the right courses.

### **Advice 3: Take Online Courses**

You will have an awful semester schedule at least once in your college career – no doubt about it. There might be some days that you take back-to-back classes for the entire day or maybe the entire week. If that happens, chances are slim that you can fit GEs into your schedule. If you see this when you're scheduling, try looking for online courses. The greatest benefit to these is

that the lectures are flexible and taken at a more leisurely pace. There are, however, a few downsides to this option. Firstly, they are a little more expensive. Secondly, it is easy to procrastinate or forget assignments if you don't have to face your professor every other day.

On another note, GEs are not the only online courses offered through OSU. There are engineering courses as well. For more information, please check The Ohio State University College of Engineering Distance at <http://elearn.eng.ohio-state.edu>. Note that these are non-credit seminars though they might contain topics that interest you or give insight.

To find available online courses, go on Buckeye-Link and use the Class Search function. After selecting a term, click on "Additional Search Criteria" and you'll find an option called "Mode of Instruction." Click on the drop-down bar and select "Distance Learning," click search, and you will have your list of options.

And yet another option is to take online courses through CSCC. Sometimes OSU does not offer a certain course online or the class list is full. In this case, it would be a good idea to look into what CSCC is offering for online courses. To check for course availability, go to their homepage [www.csc.edu](http://www.csc.edu) and check their course offerings for distance learning courses. Again, make sure that you check with your academic adviser and/or a CSCC adviser to make sure that your course credits would transfer.

#### **Advice 4: Consider EM Credit**

OSU's Credit by Examination Program is like a well-kept secret here in the university. This program offers the opportunity to test out of certain courses. In other words, the EM tests are the equivalent of high school Advanced Placement (AP) tests.

Basically, you schedule your exam date with OSU's Testing Center at [www.testing.osu.edu](http://www.testing.osu.edu) and pay a \$60 fee. This test is non-repeatable and they make one rule very clear: "Students taking an EM Test for a course in which they are currently enrolled must test within the first week of

the term." [1] Also, you can take up to 30 semester hours of EM credit!

Courses of interest: General Chemistry I & II, General Chemistry for Engineers, Calculus I-III, the physics series, GEs, etc.

For those of you who have a lot of time on your hands over the summer, this might be a cheap alternative to actually taking courses. For those of you who received a lower AP score than you anticipated, this is a chance to redeem yourself!

For more information on how to prepare for the exams and how to register, please check the university registrar's Testing Center page at (<http://registrar.osu.edu/testing/index.asp>) and look at their "Credit by Examination Programs" section.

#### **A Farewell**

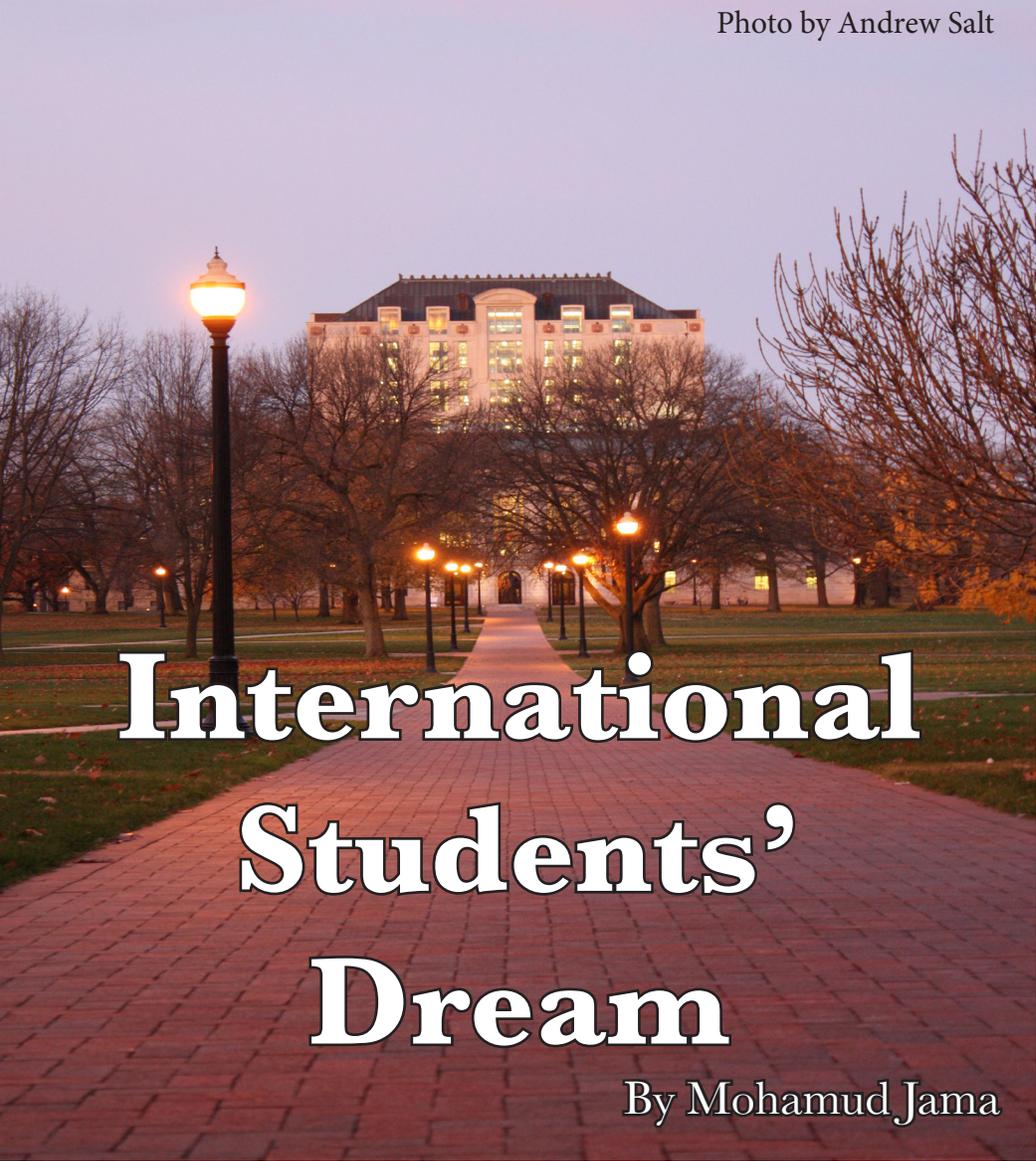
While it's difficult and expensive to pursue an engineering degree, these are some routes to make the course load easier. I am lucky that my mom is a very thorough person and looked for ways to help me during my years of college. Without her advice I wouldn't have had the time to squeeze two minors and a part-time job into my already hectic schedule. I hope that these four points of advice would help you in the same way that they helped me.

By the time you read this, I will have already finished my last finals or I might even be having my graduation party. For you, graduation can't come soon enough but don't worry – it will be worth it regardless of the route you take or the time it takes you. I wish you good luck during your years at OSU.

O-H!

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[1] The Ohio State University. Credit by Examination 2012-2013. N.p.: Ohio State University, n.d. Office of the University Registrar. Web. 1 Mar. 2013. <[http://registrar.osu.edu/testing/em\\_brochure\\_2012\\_2013.pdf](http://registrar.osu.edu/testing/em_brochure_2012_2013.pdf)>.



# International Students' Dream

By Mohamud Jama

ABOUT EIGHT HUNDRED THOUSAND international students attend United States' colleges (764,495 year 2011/2012). Most of these students are from China and India. These students study different disciplines but the majority study engineering, sciences, and health. They come here on student visas and spend thousands of dollars on their education, which is either paid for by their governments or comes out of their parents' pockets. They contribute billions of dollars to our economy, and after long years of hard work they graduate and go home with that education. One could think that

we are selling our education. After educating, we send these students to their home countries. Should we let opportunities leave home by sending these locally educated engineers and scientists away after they are educated?

The U.S. needs highly-educated people to work for our corporations. An international student who graduated from a U.S college has the qualification to do high tech jobs in demand. It is good idea to hire top students, and those who go back take with them knowledge and experience that will make their home countries better.

Notably, in his inauguration, President Obama emphasized that we need to invest in education to compete in today's economy and train people to obtain skills that will increase our production and economic growth. "Together we determined that a modern economy requires railroads and highways to speed travel and commerce, schools and colleges to train our workers. Together we discovered that a free market only thrives when there are rules to ensure competition and fair play."

Back to our subject, the Institute of International Education (IIE) reported that the number of international students increased 5.7 % from 723,277 in 2010/2011 to 764,495 to in 2011/2012. This percentage is driven by the Chinese students increase of 23%, and they bring more than \$ 21,000,000,000 to our economy through tuition and living expenses. The majority of the international students come from Asia. Some people say that they diversify the campuses and help out students excel in global communities, while some say it's economical. David Zaret, Indiana University's Vice President for international affairs, says "The school's interest in international students is educational, not 'nakedly financial.'" On the contrary, Kedao Wang, a current student at University of Michigan, says "Chinese students are under no illusions why they're recruited: it's a market economy. There are people who want this who are willing to pay." Whatever the case may

be, these students dream big once they find out they are going study in the world's leading nation, the United States of America. They dream to get an education, find a job, and settle in this great nation.

Their home countries have a dream too. They want their students to get an education in the United States and apply their education back home. Once they come back, they will take positions that require skills that the average person doesn't have and will contribute to the development of the public and private sectors of the country. Their parents have a dream that their children will get an education that will enable them to find a better job.

The United States college-graduated Chinese students get priority for Western companies in China; these students tend to have better spoken English and broader cultural knowledge than

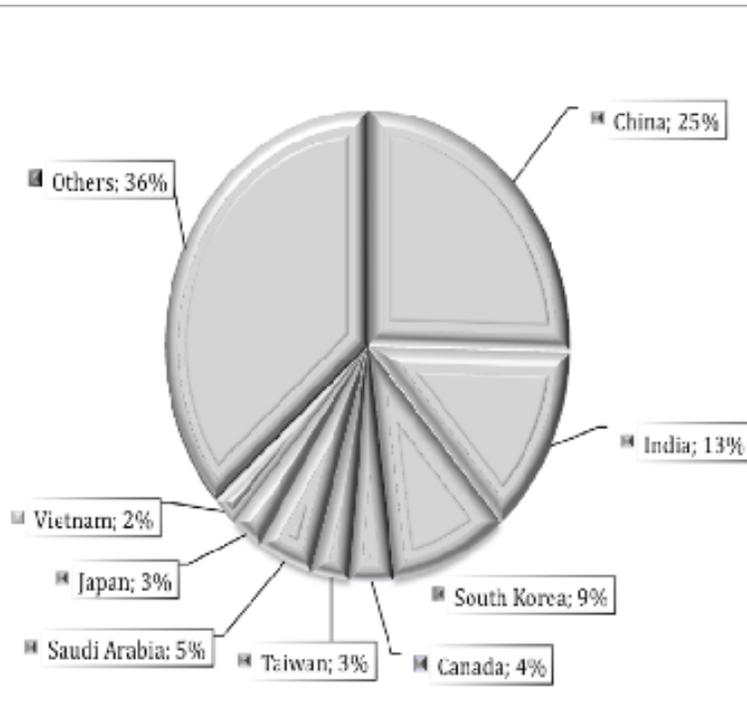
the Chinese elite university graduates. According to the National Journal, the Chinese call "Sea Turtles" to the Chinese students who graduated from the North American colleges and return home (this applies as sea turtles come back home to lay eggs). It is also very hard to get into local universities, and Chinese students work incredibly hard to prepare themselves for the "Gao Kao," a higher entrance exam, indicated by Helen Gao in The Atlantic.

India is the second on the list of international students that are coming to the U.S. to get an education, South Korea is number three on the list, and Saudi Arabia is number six. Saudi Arabia's government had long been sending their students to the U.S through scholarship programs and increased the recipients within the past two years. Open Doors annually publishes inter-

manufacturing, healthcare, and many other areas as needed. If they stay, they will pay taxes, rent, and contribute to our economy, and looking around our campus, you may already have noticed the presence of large body of international students.

According to the U.S Department of State there are 2 types of student visas - F and

M - and the students apply to schools that are in the Student Visas Exchange Program (SVEB) before they inquire visas. The F-1 type is for University, College, High School, private Elementary Schools, language training, and the seminary. The M-1 type is for Vocational and other than a language nonacademic training programs. Once they are admitted to the school, they are enrolled in Student



Respective percentages of international student population per country (IIE)

national student data on November, and one can find more information of this regard at this website: <http://www.iie.org/en/Research-and-Publications/Open-Doors>.

It would be beneficial to our economy to hire the most advanced persons with the highest grades to make their dreams come true. If retained, these graduates will contribute to our economy in ways including research, design, development,

and Exchange Visitor Information System (SEVIS), and students must pay a SEVIS I-901 fee. Then the school provides form I-20 to go to the visa interview.

The intent of these types of visas is for educational purpose, and these students can't work while holding M-1 and F-1 visas, F-1 being the common type yet with strict rules attached. Students are expected to graduate upon the expiration

of their I-20, and they can only work on campuses fewer than 20 hrs per week. After completion of their education, F-1 students can work for 12 months under optional practical training (OPT).

There are ways currently allowing a few of the international graduates to work here and stay, upon job offer employers can sponsor them to get H-1B visas (visa for temporary employment for foreign workers). Immigration and National Act, section 101(a)(15)(H) allows US employers to temporarily employ foreign workers in specialty occupations. The maximum stay with the H-1B visa is three years, and extendable to six years. If the visa holder submits form I-140 (immigration petition for alien worker) or labor certification before their fifth year anniversary of their H-1B visa, they are entitled to renew their H-1B visa for one-year or three-year increments until decision has been made on their permanent residence status (Green Card).

After talking to some students that are currently studying here, I learned that they would prefer to find a job and stay here. After graduation, they have a dream to work and live here and establish a life for themselves, but that doesn't seem possible for all of them. The economic down turn also made it tougher for international students to get jobs within The United States, and American students are also experiencing the same difficulties.

<http://go.osu.edu/ose>

I have interviewed Taida Wang, a Chinese friend of mine who has recently received his green card (for permanent residency) through one of his parents who became eligible to get a green card. I asked Wang how he feels with the green card, and he said, "I am very excited" he continued, "I can work and reside in the U.S permanently".

I asked him what students do after graduation and he said, "Chinese college graduates go back home if they don't find a job here." He added, "People in China value American Universities very much, so they would probably want to hire someone with a degree from an American university."

The increasing number of international students attending U.S. Schools is very large, and they are a long way from home. Some have language barriers and are not familiar with the American customs. Our campuses are designed to be safe for all students. They receive guidance while attending schools from the school administration, staff, faculty, and students. We should be considerate and show them that we are glad they are here.

You may be wondering the reason I am writing this article, and the answer is that I can relate to these students in many ways. I am a naturalized US citizen (a citizen of choice/foreign born), immigrated to the US 15 years ago. I lived in Columbus, OH for about 13 years, and I love it. I am currently pursuing an ECE degree at OSU. Unlike

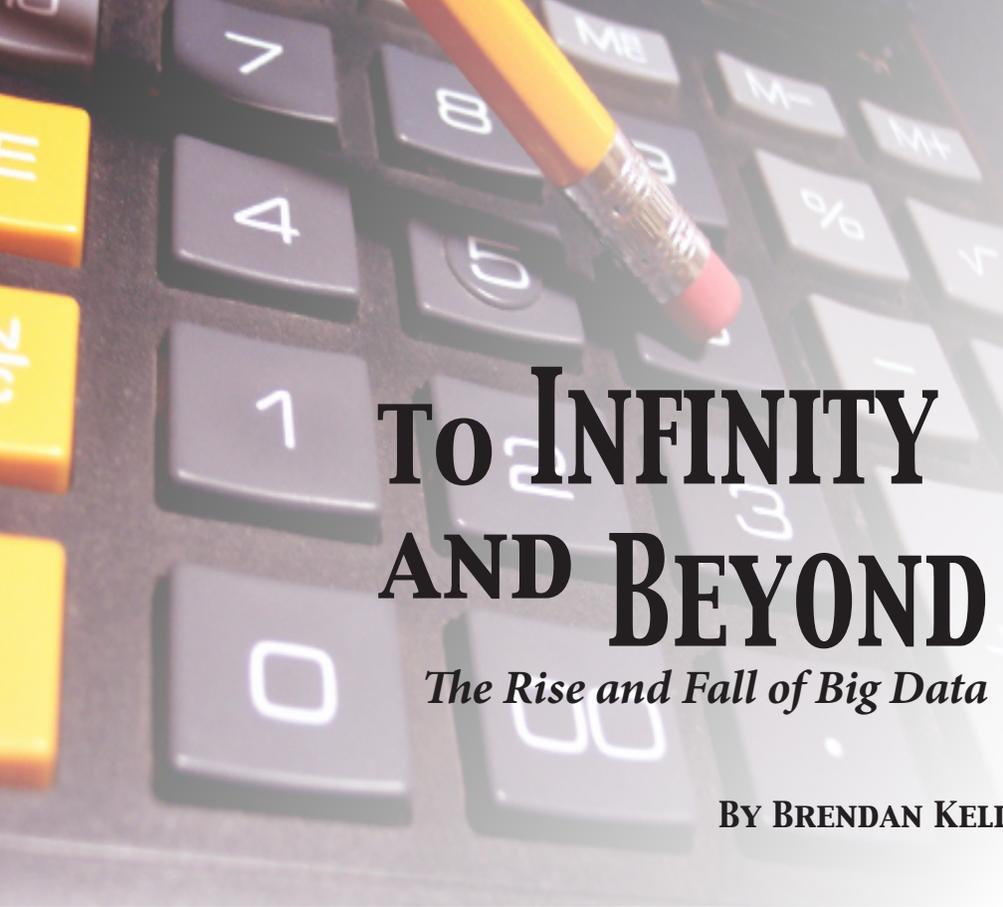
me, most of these students don't speak English. I needed to learn my ways around the city, make friends, work, school, and other responsibilities, and they have to go through that too. They come from different cultures, practice different religions, and have different customs. Similar to them, I came from other end of the world, believe in a different religion, and know that being away from home is not easy either. I feel how hard life can be on the international students, and their families as well. Not being able to work makes it harder. I have been in the education system most of my time, whether studying or helping students learn. I have noticed the growth of international students on our campus, and decided to write about it. My advice to the international students is to let someone know of their situation, for the communication is the best tool amongst us.

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[1]Institute of International Education. (2012). "Top 25 Places of Origin of International Students, 2010/11-2011/12." Open Doors Report on International Educational Exchange. Retrieved from <http://www.iie.org/opendoors>

[2]"President Obama's second inaugural address transcript." Washington Post. (01/21/2013): n. page. Web. 29 Mar. 2013.

[3]Pop, Justin. "Diverse Issues in Higher Education." Surge of International Students on U.S. Campuses Pays Office Diversity, Revenue. N.p., 13 11 2012. Web. 29 Mar 2013.



# To INFINITY AND BEYOND

*The Rise and Fall of Big Data*

BY BRENDAN KELLY

## BIG DATA

MUCH OF THE WORLD is beginning to operate on a computerized infrastructure. The result is massive amounts of data mirroring the actions of our physical world within the context of a digital one. A galaxy of numbers contains undertows that are secretly driving our world beneath a shroud of complexity and sheer magnitude. There is a growing market of companies piercing the veil for the hidden insights and advantages. This industry is referred to as “big data”.

## THE POWER

The use of data and statistics is most familiar through the world of sports. Teams meticulously track every relevant parameter of their game in or-

der to discuss, understand, and improve their performance. Without data, every impression and evaluation would be limited by the small scope of what you saw or remembered. Also, your opinion of the team would sharply influence your view of their performance. This demonstrates the two limitations that impede our ability to make sound, logical decisions: our lack of holistic knowledge and our personal views. In the world of sports and business, every decision is critical and needs to be the best possible, therefore unclouded and all inclusive. Data provides a concrete representation of what is really going on, by representing its scale and lack of bias. If our decisions are to sculpt the real world, the

assumptions they are based off must as close to the real world as possible. Big data is the answer for this need, and more and more companies are scrambling to obtain this insight and edge.

## THE MECHANICS

This data originates from the back end of the applications and computers we use every day. This information is easy to track, unlike rebounds, because the actions already occur in the digital realm. The result is massive caches of data being generated that need to be stored and analyzing.

Handling and understanding the massive data sets requires software that can store, cleanse and make sense of the massive caches of information. There are varying scales of data storage methods, from good old fashioned Excel sheets through massive, temperature-controlled data centers housing thousands of servers. Typically, information is stored based by defining parameters in large matrices called tables. These tables are then interconnected through common elements such as company, customer or visit i.d. Code scripts called queries crawl through the tables and pull the information based on the necessary criteria such as date or product type. There are many programs designed to utilize this data at different scales and purposed. Microsoft offers the most read-

ably available options used in corporations. Excel offers the ability to store and analyze data and typically serves as the platform for reporting and making sense of the data. It is however limited in its ability to store large amounts of data. Access allows the user to build large tables and user friendly queries to pull the data out. Access works well for medium to large datasets, however it fails when the tables and queries become very complicated and large. The next step up is SQL (Structured Query Language). This allows the user to effectively store and analyze massive data sets. Microsoft also provides SRSS that sits on top of the SQL databases and reports the data in an automated, user-friendly interface. The industry is expanding to provide more specific programs based on the growing number of applications.

## IN MARKETING

Companies have long attempted to understand the customer in order to sell to them more efficiently. The internet provides both the data necessary to pinpoint customers and the medium to project their message. Social media, e-commerce transactions and general web usage inform advertisers of ideal customers to target. The highly targeted ads on the side of your Facebook can be unnerving, but consider the billions wasted on futile advertisement.

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Marketers use big data to understand not only how to reach the customer, but also to understand what products they want. Immense data from how customers use products to what customers tweet about gives designers insights into the needs of the market. Instantaneous data cuts the timing lag of market movement and producer response to fill the need. An example is Netflix's use of big data to create *The House of Cards* Netflix original show. They analyzed data to pick the English T.V. show to base it off, the director, and even Kevin Spacey. The data showed that users had these overlapping interests, making the new show a great success.

## IN MANAGEMENT & OPERATIONS

Big data is used in other ways on the other end of the spectrum of business. Large corporations operate on massive scales, making management difficult without being able to see operations and performance directly. Big data provides the solution by giving management an understanding of their organization through the aggregation of low-level parameters such as quality, customer satisfaction and efficiency. This allows upper management to have a finger on the pulse of their colossal organizations. This particular application of data, deemed Business Intelli-

gence, is an exploding field as companies require data to manage and steer their companies.

My personal background in operation research and improvement relies heavily on data to understand, analyze and improve how companies manufacture products. Computer controlled machines are spitting out information about how long the process takes and the parameters, such as temperature and pressure of the operation itself. Industrial engineers are trained to test this data to determine the optimal settings, layout and usage of these machine to maximize profit while meeting demand. They can also match this data with defect information to reduce capital wasted on rework and market share lost to defective products reaching the customer.

## THE FUTURE

The amount of data expands constantly as more of the world operates on a digital infrastructure. Massive corporations and startups alike are fighting to keep pace. Both the applications and the mechanics alike are being innovated. The industry is primed for innovation by those willing to bridge the chasm between technical and business prowess.

THE IMPORTANCE OF DNA is widely understood and accepted as one of the macromolecules responsible for all forms of life, but recent research by Nick Goldman and Ewan Birney of the European Bioinformatics Institute could change the way we think about the uses of DNA [2]. Since its discovery in 1869, DNA has been the focus of many scientific endeavors aimed at understanding the formation of life on a cellular level. Due to exponential growth in technology, researchers are now looking beyond the biological applications of DNA's structure-advancing their understanding of its many functions, specifically the area of information storage.

The founding fathers of DNA's double helix discovery, Watson and Crick would never have dreamed of something as surreal as using DNA to store the data from a million CDs in a space approximately the size of a pinky finger. Even more impressive is the concept of manufactured DNA which could fit all of the world's digital information in the back of a pickup truck [2]. This dream is be-



# Redefining

coming reality. On January 23, 2013, researchers successfully encoded and decoded five computer files including all of Shakespeare's 154 sonnets, a photo, a twenty-six second MP3 excerpt of Martin Luther King's "I have a dream" speech and a PDF of Watson and Crick's famous publication describing the structure of DNA [2,3].

## Why Use DNA to Store Data?

The world currently  
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contains an incomprehensible amount of digital data (an estimated 1 Zetabyte  $\approx 10^{21}$  bytes) and the amount is constantly increasing [1]. With the massive amount of digital information available, current data storage devices are unable to meet the desired long term digital archive needs of society. Students are familiar with the progression of portable information storage from floppy discs to CDs and then flash drives, but most  
The Ohio State Engineer

# DNA

## Digital-Nucleic-Archive

By Cecylia Daab-Krzykowski

have not used them long enough to experience the degradation of digital information contained within them. Frequently CD's stop working because they get scratched, while flash drives become corrupt and fail to function. Most students have forgotten a flash drive (or two) on campus and felt the frustration of losing irreplaceable digital information. Although these are all valid forms of failure, they are not directly

related to the life expectancy of the digital storage device. The most common causes of failure in materials can be generally described by oxidation, corrosion and denaturation of chemical bonds. These conditions can dramatically influence the life expectancy of any device and requires careful consideration for the long term storage of information [1].

There are three basic electronic/digital technologies utilized in data storage

including magnetic tapes/hard-disk drives, solid-state flash memory and optical CDs, DVDs and Blu-ray discs. Each of these technologies has varying life expectancies depending on the temperature, humidity and exposure to light during storage. The average life expectancy of a magnetic tape is 10-50 years while the life expectancy of a flash drive is 10-12 years. A CD has an expected lifetime of anywhere from 1-25 years which makes it an impractical media for long term digital archives [1].

The introduction of a fourth technology utilizing the complex structure and function of DNA could allow for an infinite amount of storage which would be preserved for centuries. There are many reasons why DNA is an attractive medium for digital archive storage including its compact size, the stability of its chemical bonds, and the universal language of nucleotides which allow for information retrieval. The compact packaging of DNA in cells is one of the natural wonders of life which is often unnoticed, but the hu-

man body actually contains enough DNA to stretch approximately 610 times from the earth to the sun. The coiling of DNA into a compact puzzle of information makes it attractive for archival storage because, while information is infinite, physical storage space is not.

The stability of chemical bonds in DNA is optimum when stored in a cool, dark, dry environment. Recovery of DNA from woolly mammoths and Neanderthals indicates it has a life ex-

pectancy of thousands of years which far surpasses the lifetime of any storage device on the market. Another attractive feature of DNA is the sequences are composed of four chemical bases which allows for infinite combinations of base pairs. The base patterns are easily read by a DNA sequencing machine and are the means by which digital information is converted from chemical information. Utilizing binary computer code and converting to

tertiary format, the code of zeros, ones, and twos coincide with one of the bases in a strand of DNA [2]. The DNA is manufactured to encode the computer data and can then be decoded with relatively little error.

### What's the Catch?

As with all new technologies, the main disadvantage of utilizing synthesized DNA for data storage is the cost. This technology currently cost millions of times more than it would to write the same information to a magnetic tape or about \$ 12,400 per MB [2]. Time is also money, and it took researchers two weeks to reconstruct the five files contained in the DNA. Although the process can be made more efficient using advanced equipment, the reality is DNA storage will not be replacing the hard drives or flash drives utilized daily for information storage needs. It is possible that, "Within the next decade consumers will be able to store information

they want to have around in 50 years, like wedding photos for future grandchildren" as Dr. Goldman stated in an interview with Fox News [3]. Longer storage lifetime makes DNA an attractive option for massive archives which are less frequently accessed such as the data collected from the Large Hadron Collider near Geneva, Switzerland.

Technology is shaping the events of everyday life but DNA will always be at the core of life itself. The most fundamental structure of human existence can also be used to improve the long term transmission of information. Dr. Goldman summarized, "So long as life- and biologists endure, someone should know how to read it" [2].

**...The HUMAN BODY actually contains enough DNA to stretch approximately 610 times from the earth to the sun**

[1] Lunt, Barry M. How Long is Long-Term Data Storage. Informative. Provo: Brigham Young University, 2001.

[2] Nature. "Storing information in DNA, Test-tube data." The Economist (2013): 3.

[3] Mritter, Malcom. FoxNews.com. 23 January 2013. 20 February 2013 <<http://www.foxnews.com/science/2013/01/23/potential-dna-for-storing-digital/>>.

# The Wright Flyer Monument

By Timothy Hendrickson

NEARLY 52 MILLION CARS travel through the Interstate 70 and Interstate 75 interchange every year in Dayton, Ohio [1]. With such high visibility by passing motorists, the members of The Wright Image Group agreed that this location was perfectly suited as the construction grounds for Ohio's newest and largest monument.

The Wright Image Group, based out of Dayton, Ohio, is non-profit organization created

<http://go.osu.edu/ose>

in 2006 with one goal: To commemorate Dayton as being a world leader in aviation science. The architects, engineers, pilots, aviation enthusiasts and other volunteers that comprise the group recognize the immense influence that the aviation industry has had on the state of Ohio. Global business leaders such as General Electric, Timken, Parker Hannifin and over 1200 other companies maintain huge operations in Ohio, providing over 100,000 jobs to residents. According to Ohio's

Dept. of Development, “Ohio leads the nation in aircraft engine manufacturing and development, military aeronautics acquisition, and research and development.”[2]

Aviation has had a long history in Ohio. In fact, in 2003, Ohio was officially named the “Birthplace of Aviation” by the US Senate, ending decades of debate between the states of Ohio and North Carolina (where it was argued that powered flight was born in Kitty Hawk)[3]. Despite the controversies between the states, it is inarguable that Dayton, Ohio was a crux to the aviation revolution. The Wright Brothers, famously known for their early research into powered flight, resided in Dayton, Ohio. Recognizing the impact the Brothers had on the aviation field, The Wright Image Group decided to build the monument resembling one of their earliest aircraft in Dayton.

The monument is currently poised to stand over 250 ft. tall, with a scaled replica of the 1905 Wright Flyer sitting atop a lattice of support wires (See image below). The monument’s flyer is over three times the size of the real 1905 Wright flyer, with a wingspan of 120 ft. (comparable to the Boeing 757). The estimated cost of constructing the monument is over \$12 million.

### The Engineering Challenge

Planes are designed to fly. When wind blows over the airfoil of an aircraft’s wing at a positive angle of attack, the airfoil creates lift. Now imagine taking a plane, with a 120 ft. wingspan and attaching it by one shaft to the supporting structure. If there are any wind gusts across the aircraft, the monument will want to essentially take-off. This situation provides a very unique challenge to the engineers and designers of the monument. The challenge: Design a monument structure that prevents an aircraft that wants to fly, from flying.

At minimal wind speeds, the monument will not encounter very high aerodynamic loads. The structure will only have to support the static loads and moments that the flyer creates sitting atop a supporting shaft. However, if the monu-



Artistic Illustration of Proposed Monument by Architect Steve Brown

ment were to encounter large wind speeds, say from a F3 strength tornado (wind speeds of 220 mph), the flyer could create thousands of pounds of force and huge torques on the supporting structure.

The designers of the monument want the lifetime of the structure to be centuries long. The chances that tornado force winds could hit the monument are relatively high (over several hundred years). To prevent a possible catastrophe, the structural engineering firm leading the project, Shell & Meyer Associates, plan to design the structure to withstand the possible forces created by an F3 strength tornado. The Wright Image Group initially contacted the University of Dayton Aero-

space Engineering Department to acquire initial estimates on the potential forces the structure would see at the 220 mph wind speeds. The research task was undertaken by a group of UD students as a capstone project and initial results were obtained. The students concluded that in order to more accurately approximate the aerodynamic loading at such high wind speeds, much higher Reynolds number flows would have to be tested. It was recommended to test in a much larger wind tunnel, at possibly the NASA Glenn Research Center in Cleveland. Testing in one of the tunnels at NASA's Research Center can cost tens of thousands of dollars. The Wright Image Group needed a more cost effective option.

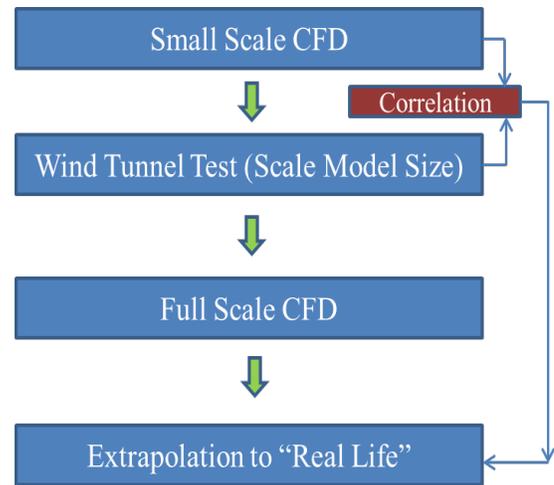
Queue: The Ohio State University Aerospace Engineering Department.

The Wright Image Group contacted Professor Mike Benzakein, Director of Aerospace and Aviation Collaboration Programs at Ohio State for help. Benzakein held onto the project for several weeks until a group of four senior aerospace students approached him for ideas for their AAE 4510/11 senior capstone project class. When the project was described to the students, they enthusiastically accepted the proposal. They would have a similar task as the UD students: to obtain load estimates on the flyer for 220 mph wind speeds.

### The Capstone Project

The Aerospace Department recently added the AAE4510/11 Projects class to the senior curriculum as part of the switch from a quarter to semester system at the university. The four seniors were among the first class to participate in the new course. As part of the project, the seniors had to design a sensible way of obtaining the load estimates. It was quickly realized by the students that obtaining the Reynolds number high enough to accurately match the monument given its size and wind speeds would be impossible given the size of the wind tunnels that OSU has. Instead, the students decided to combine the experimental aspect of wind tunnel testing, with computational

fluid dynamics (CFD) estimations, to extrapolate to wind speeds of 220 mph. The students summarized their project design with the following flow chart.



Flow chart of OSU students' Capstone Project

### Phase 1: Small Scale CFD and Small Scale Wind Tunnel Test

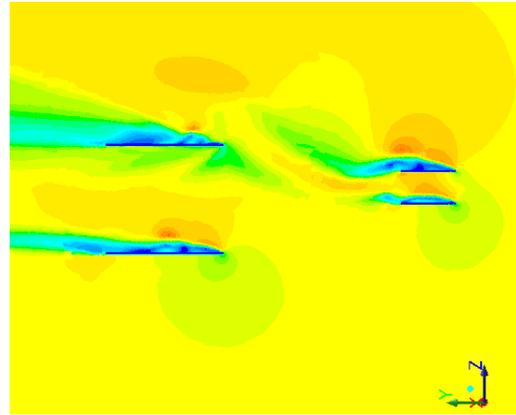
The students decided that the first phase of project would be to perform wind tunnel tests on the monument flyer at the highest possible Reynolds number that could be obtained. The solution was to use Ohio State's 3' x 5' wind tunnel at the Aeronautical and Astronautical Research Laboratories. This allowed the highest possible Reynolds number of approximately 500,000, given a wing-span of maximized chord length of 7.75", and wind speeds of 100 mph, with standard atmospheric conditions at sea level.

The wind tunnel test was conducted over a very expansive test envelope of 35 different orientations and 8 wind speeds, creating 280 test points. It was assumed when creating the envelope, that the full scale flyer would not see wind gusts at incident angles of over  $\pm 15$  degrees, and that only one half of the flyer needed to be tested due to a plan of symmetry about the longitudinal and vertical axes of the model.

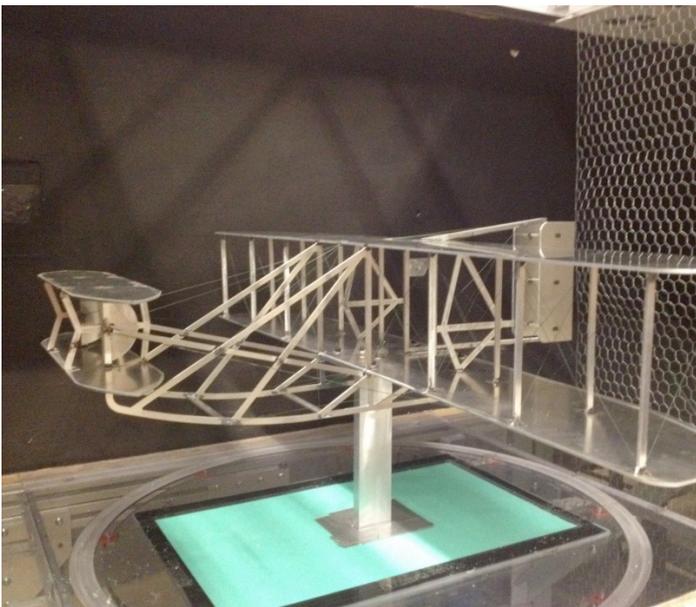
After successful completion of the wind tunnel test, the students were tasked with correlating the experimental data with estimations from

CFD analysis of the wind tunnel model. Computational fluid dynamics is a numerical method that uses flow values at discrete points in space, to iteratively calculate how those points are affected by varying boundary conditions and flow obstacles. In the case of this project, the boundary conditions are changing wind orientation and speed, and the flow obstacle is the model of the flyer. CFD analysis ultimately results in estimations of forces and force distributions of the flyer. Ideally, the CFD force values should correlate very closely with the force values of the experimental test. After preliminary analysis, the students saw great CFD results.

expect to have final results by the end of Spring Semester 2013.



Preliminary CFD Results of Flyer at 90 mph at 10 degree Angle of Attack



Wright Flyer Model in OSU's 3' x 5' wind tunnel during testing.

### For More Information...

For more information on the Wright Monument, please visit [WrightMonument.org](http://WrightMonument.org).

For more information on the results of the Ohio State student's capstone project, please contact the team's advisor, Professor Mike Benzakein at [benzakein.2@osu.edu](mailto:benzakein.2@osu.edu).

### Phase 2 and Phase 3: Full Scale CFD and Extrapolation to "Real Life"

After completion of Phase 1, the students plan to run full scale CFD testing on the flyer. The correlation that was determined through Phase 1, will then be applied to the full scale CFD results to extrapolate to what is expected in real life.

Through their capstone project, the students ultimately hope to accurately predict the forces that this monument may see. Their contributions will be very valuable in the design process of the supporting structure. As of March 31st, the students were in Phase 2 of the project. They

[1] "Wright Image Group." National Aviation Heritage Area: Come.Discover.Fly! National Aviation Heritage Area, n.d. Web. 01 Mar. 2013.

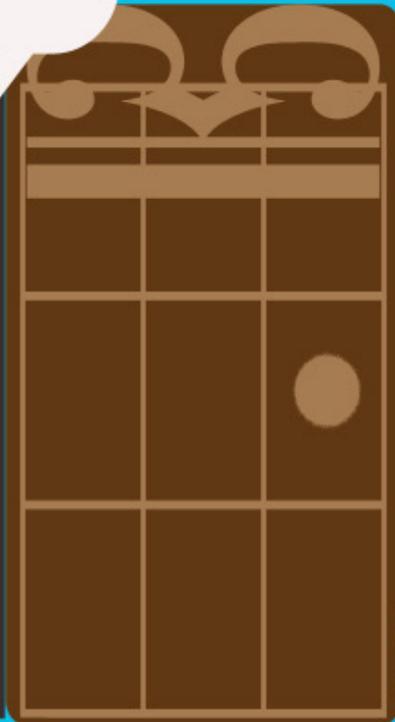
[2] Ohio Department of Development. Ohio: Aerospace, Aviation, and Defense. Columbus, OH: Ohio Department of Development, n.d. Propelling Innovation (Brochure). JobsOhio, 2011-2013. Web. 1 Mar. 2013. <<http://jobs-ohio.com/images/Aerospace-Brochure.pdf>>.

[3] Gannett. "It's Official: Ohio IS the Birthplace of Aviation." It's Official: Ohio IS the Birthplace of Aviation. Cininnati.com; A Gannett Company, 14 June 2003. Web. 01 Mar. 2013.

Knock-Knock..

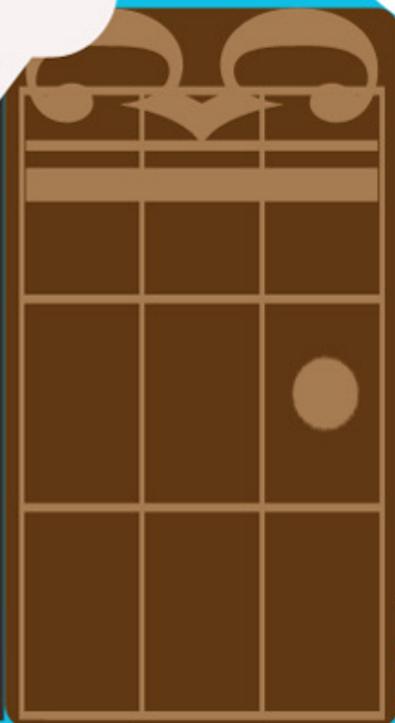
Who's There?

Engineer..



Engineer  
who?...

Engineer...Here  
to fix the broken  
door bell..



T · H · E  
OHIO  
STATE  
UNIVERSITY

Non Profit Org  
US Postage Paid  
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Columbus

