

Engineering Daily Tour Script - Fall 2019

INTRODUCTION

Expectations of tour guides

- Wear your TEAM polo, khakis (pants or shorts of appropriate length), closed-toe shoes, and nametag
 - Arrive at least 10 minutes early to the meet in 1200J Marston if you do not have class directly beforehand
 - For absences, notify your tour leader at least 24 hours in advance.
- If you are sick or have an emergency, please notify as soon as possible.

Introduction:

- *Clear the Welcome Area*
- *Welcome everyone to the tour*
- *Mention the WALKING tour and 13 different majors*
- *Introduce TEAM and guides*

Hello! If you are here for an engineering tour then you are in the right place! Thank you all for coming. The tour is about 50 minutes and we will be *touring different buildings on campus while we talk about the 13 different engineering majors offered at Iowa State.*

Before we get started, I'd like to take a moment to introduce ourselves. We are members of TEAM, or The Engineering Ambassador and Mentor program, which is a student organization here on campus. My name is ... (Name, year in school, major(s), hometown, fun fact). So that's just a little bit about us, it's an informal tour so if at any point during the tour you have questions please do not hesitate to ask any of us.

Are there any questions before we begin?

TOUR ORDER

Building	Topic
Marston Hall (Harpole Welcome Center)	Engineering Student Services: Undeclared, Int'l Programs Engineering Career Services
Hoover Hall (lobby near main stairs)	Materials & Industrial
Hoover Hall (near Boyd Lab)	Mechanical & Boyd Lab
Howe Hall (Entrance near VRAC)	Aerospace & VRAC
Sukup/Elings	Agricultural & Biosystems
Sweeney Hall	Chemical
Coover Hall (Outside, near moth statue)	Civil, Construction, & Environmental
Coover Hall (inside near stairs)	Electrical, Computer, Cyber Security & Software

Marston Hall (Harpole Welcome Center)

Engineering Student Services, Undeclared, Career Services, International Programs

The administrative home to the College of Engineering, Marston Hall, completed a \$27.1 million dollar renovation in 2016. In addition to state-of-the-art classrooms and student spaces, students can also utilize Engineering Student Services and Career Services here.

Engineering Student Services includes undeclared engineering advisors, and is located in 1300 Marston. Around 1/4 of engineering students come in undeclared. If you are not sure which engineering degree program you want to pursue, that's okay. As a part of the basic program classes in engineering, all first-year students in engineering take a class called Engineering 101. Undeclared Engineering students will be in a specific section which introduces all of the different engineering majors. Advisers will also work with you one-on-one to figure out what engineering major fits you best.

The Engineering International Programs office is located in 1300 Marston. They will help you find programs around the world that will have classes that can transfer back to ISU and count towards your engineering degree.

Engineering Career Services is located on the 3rd floor of Marston Hall. They are a wonderful resource to help you get an internship, co-op, or a job offer after graduation. They offer things like resume and cover letter workshops and mock-interviews. Engineering Career Services also hosts the fall and spring career fairs which take place in Hilton Coliseum and Scheman Building. The fall career fair is one of the largest in the nation and was recently split into two days to accommodate all employers. Additionally, more than 4,000 interviews are conducted on campus each year.

The office of the dean, Samuel Easterling, is located on the 4th floor of Marston Hall.

MATERIALS ENGINEERING

Materials engineering is the study of chemistry and physics as they pertain to the various properties and behavior of different types of materials, and how to optimize them on a molecular or atomic level for a variety of circumstances.

Hoover Hall

The undergraduate MatE labs are very modern and frequently upgrade to new equipment.

The MatE student room is a large room with a multitude of computers and group work space including tables, whiteboards and a printer. The room is known to be a place where students can collaborate on projects, homework, and meet other students from within the department. Only students in materials engineering have access to this room. A smaller “quiet room” is located next door that can be reserved for undergraduate students as well.

Emphases/focus areas/specializations:

- Metals (steel, aluminum, and titanium)
- Ceramics (porcelain, alumina, and glass)
- Polymers (rubber, Kevlar, DNA)

For each of these classifications of materials, materials engineers work to improve known materials and develop and perfect new materials, and research what factors (electrical, thermal, and mechanical) change materials and how they can predict those changes. Much of this work is done on an atomic or molecular level. Materials engineers also find ways to reliably and economically produce materials through synthesis and processing.

Undergraduate Labs:

Undergraduates gain experience with a variety of analysis instruments and the software that goes with them. Some of these include:

- Optical microscopy
- Scanning and tunneling electron microscopy
- X-ray diffraction

These labs focus on determining the mechanical, thermal, and electronic properties of the materials as well as other things such as failure methods and composition analysis. There are also synthesis and process labs where students learn how different types of materials are made.

Sample Career Fields:

Process control and engineering: This ensures that a manufacturing process will not damage a material and affect the quality of the final product.

Failure analysis: When parts break, a materials engineer will study the break and determine the cause and method of the break using microscopy and chemical analysis. This allows them to determine the cause of the failure and devise a solution.

Extraction: Metal does not grow in a pure form out of the ground, nor do polymers or ceramics. Materials engineers can help with collecting raw materials and extracting the pure material out of it.

Material Recycling: When a wind turbine blade is old and worn, what will be done with it? When parts are used and reach the end of their life, how will they be recycled, disposed of, or reused? Materials engineers work to find new and innovative ways to repurpose materials. Iowa State graduates have gone to work for companies like Caterpillar, Collins Aerospace, General Motors, Intel, 3M and more.

Materials Science & Engineering

Real World Applications/Examples:

Fiber-optic cables: Fiber-optics are used in a variety of applications, one of which includes medical imaging. The glass in old fiber optic cables had difficulty withstanding the high heat, so tiny glass shards would fall off the ends. These shards could get in the patient wounds, and slow down the healing process. Materials engineers redesigned the chemical formula of the ceramic in order to make the material more heat resistant and resolve this problem.

Airplane wings: Airplane wings actually contain polymer composites, which are designed with high strength capabilities in order to withstand turbulence. The incorporation of a polymer makes the plane much lighter and more fuel-efficient.

Jet Engines: Combustion engines are more fuel efficient the hotter they run. However, materials become weaker at these hotter temperatures. Materials engineers have been developing metals, called nickel super-alloys, which safely withstand hotter temperatures. The hope is to implement these super-alloys in airplanes, which could lead to billions of dollars in savings in fuel costs.

Truck beds: Think about the impact of throwing a heavy box of tools on both an aluminum truck bed, as well as a steel truck bed. While the steel frame can withstand the impact better than the aluminum, the added weight affects the fuel economy of the car. Metal material engineers investigate the properties of these materials on both a macroscopic and microscopic level, and can redesign these materials to get the desired properties.

Departmental Research:

There are various opportunities for research within the Materials engineering department, including the Ames Laboratory, Critical Materials Institute, and Center for Nondestructive Evaluation.

Dr. Dan Shechtman, a professor in materials science and engineering, won the Nobel Prize in 2011 for his discovery of quasicrystals, a new crystalline structure that changed ideas about matter and atomic arrangements.

Dr. Thomas McGee, Emeritus Faculty, invented artificial bone implants called osteoceramics. These are biological composite implants that contain calcium to spur bone growth and repair cracks. These bone implants have reduced the need for bone grafts from patients.

Iowa State faculty is working towards revolutionizing refrigeration by developing magneto-caloric refrigeration. This process uses magnetism rather than pressurized gas as a refrigerant, and reduces risk of toxic gas pollution. This has already been implemented in scientific processes in order to reach extremely low temperatures, and the goal is to be able to extend this process to household appliances.

Unique Opportunities for Undergraduate Students:

Study Abroad: The Brunel program is an opportunity for freshmen in the Materials Engineering department to go to England for 6 weeks, and earn 6 credits at the University of Birmingham in London with Iowa State professors.

Major-affiliated clubs & organizations:

Material Advantage:

Material Advantage is a national organization for people involved in materials science and engineering.

Material Advantage organizes seminars and speakers, as well as outreach events. Members of Material Advantage are also allowed to attend the national conference every year and hear from a variety of experts. The Iowa State student chapter of Material Advantage has won the national chapter of excellence award for over a decade straight.

Glass Blowing Club (Gaffer's Guild)

The Glass Blowing Club provides a hands on way for materials engineers to apply the technical knowledge they gain from their courses related to glass science, while creating pieces of artwork

Metallurgica

Metallurgica is the newest club formed in 2017 by a group of materials engineering students that have an interest in expanding their experience learning about and working with metals.

INDUSTRIAL ENGINEERING

Industrial engineers work to design and improve various manufacturing and service systems. Examples of manufacturing and service systems can be found in automobile, agricultural machinery, aeronautics industries, healthcare, financial, and insurance industries, and governmental agencies as well as non-governmental organizations such as charitable foundations.

Black Engineering

Casting Lab, Computer Numerical Control (CNC) Machining Lab, Welding and Robotics Lab, Industrial Automation Laboratory, as well as Rapid Prototyping Lab allow students to put the theoretical knowledge from class into practice.

Emphases/focus areas/specializations:

Manufacturing

Learn how to design, analyze, operate, and control advanced manufacturing processes and systems. Develop plant layouts and new products, and oversee continuous improvement and quality control processes.

Human Factors (Ergonomics)

Learn about the interaction between humans and their work tasks and how injuries can be prevented. Work to make products more intuitive and comfortable and reduce risk of injury.

Operations Research and Analytics

Learn how to develop mathematical and statistical models to optimize processes and to make decisions about inventory control, scheduling, and production plans as well as transportation and logistics.

Systems Engineering and Engineering Management

Learn how to apply engineering thinking to business decisions. Work to manage technical teams for engineering projects in areas like production, quality, project management, and technical sales.

Enterprise Computing

Learn to integrate information within the functional units of an enterprise as well as among multiple enterprises. Learn to perform information/data analysis to forecast and drive decision making as well as to work with big data to identify patterns and trends.

Sample Career Fields:

Manufacturing Engineer: Plan, direct, and coordinate manufacturing processes in an industrial setting. Implement manufacturing techniques to reduce manufacturing costs, improve quality, and reduce cycle times.

Operations Research Engineer: Create new models and revise existing ones in order to improve overall operations performance and reduce operating costs.

Management Engineer: Manage and coordinate projects, manage research and development of technology, and lead process redesign efforts.

Sales Engineer: Use an industrial engineer's understanding of the technical aspects of a product to meet a customer's requirements and to enhance the business-to-business sales process.

Opportunities for Advanced Degrees: Use an industrial engineer's knowledge, skills, and capabilities in professional and graduate programs. Examples are advanced degrees in industrial engineering, business administration, systems engineering and engineering management. A master's degree in systems engineering will develop the analytical abilities needed to design, evaluate, and build complex systems involving many components and demanding specifications. A master's degree in engineering management will develop engineering, science and management skills to succeed in a technology driven environment.

Industrial & Manufacturing Systems Engineering

Real World Applications/Examples

Industrial engineers design and implement lean manufacturing processes and systems in agricultural machinery companies.

Industrial engineers analyze flight patterns in order to schedule how many flights airlines will make between certain cities daily. They also reduce the amount of time it takes a bag to get from a plane to a baggage carousel.

Express services have to deliver millions of packages a day and need industrial engineers to create efficient routes to get the packages to their destinations as efficiently as possible.

Industrial engineers improve the efficiency of the hospital environment by analyzing patient flow, staffing needs, and emphasizing patient safety by minimizing time patients spend on the operating table.

Industrial engineers design and develop new ergonomic hand tools and work methods to reduce the risk of injury to workers in the furniture manufacturing industry.

Departmental Research

Dr. Frank Peters is conducting research in the automated manufacturability of wind turbine blades in order improve processes to make the blades longer, lighter, stronger, and cheaper.

Dr. Matt Frank conducts research on advanced hybrid manufacturing techniques that combine traditional metal removal process (mills, drills and lathes) and additive processes (3-D printing).

Dr. Rick Stone works on research problems in the areas of biomedical, neurological, and force sensors. For example, biomechanics for improved sports performance and exoskeletons for military, law enforcement, and civil training.

Dr. Lizhi Wang is modeling the relationships between transporting energy, freight, and passengers in order to minimize cost and emphasize sustainability of infrastructure.

Dr. Sarah Ryan focuses her research on electric power systems and assembly systems, including a study on short term power system scheduling to accommodate renewable generation.

Major Affiliated Clubs

Institute of Industrial and Systems Engineers

(IISE): Professional organization for Industrial Engineers that provides networking opportunities and promotes interest in Industrial Engineering through campus and community outreach events.

The Institute For Operations Research and the Management Sciences (InFORMS):

Professional organization for industrial engineers who are interested in operations research and data analytics. It provides networking opportunities and promotes common interests in the areas of operations research and management science.

Undergraduate Labs

Machining Processes Lab: In this lab, students have the opportunity to work with equipment for metal machining, surface finish measurements, and metal cutting.

Computer Numerical Control (CNC)

Machining Lab: This lab gives students the opportunity to work with Computer Aided Design (CAD) software. The lab contains four CNC machines where students can fabricate their designs.

Welding and Robotics Lab: This lab contains equipment for a variety of welding techniques. Some of these resources include a robotic arc welding cell and a CNC plasma cutter.

Industrial Automation Laboratory: This lab is designed to prepare students for working with basic electric circuits, as well as a variety of sensors and readers. The lab contains several programmable readers, which are used in a variety of industrial applications.

Unique Opportunities for Students

Close to 15% of IE students take part in department sponsored research projects, working with professors to build their engineering, research, and professional skills.

Almost 25% of IE students study abroad.

One great opportunity we have for students is called the concurrent MBA program. This program guides students through earning their Bachelor's Degree in their engineering field and a Master's in Business Administration in just five years. Typically, the first three years are dedicated to the Bachelor's Degree, and the last two years will be a mix of finishing the courses for the Bachelor's and completing the MBA. This opportunity is available to almost all engineering majors. Also, the engineering sales minor is available to all engineering students. All of these programs are well integrated with the BSIE curriculum.

MECHANICAL ENGINEERING

Mechanical engineering is an extremely broad field that encompasses generation and distribution of energy, the control and automation of manufacturing, design and development of mechanical systems, processing and use of materials in manufacturing, and thermal fluid flow. This field is very multidisciplinary and mechanical engineers frequently work with other engineers, designers, financial and marketing specialists, as well as a multitude of other groups.

The Black Engineering building houses many lab spaces that allow students to have hands on experience with different manufacturing and computing technology.

Emphases/focus areas/specializations:

The practice of mechanical engineering focuses on one or more of the following five areas:

Design and Optimization

Designing a system or component of a system and maintaining it. This also deals with improving the overall efficiency of the system.

Materials and manufacturing

Manufacturing focuses on the processes and systems for making products with high-quality components most efficiently and with the least environmental impact.

Materials focuses on the strategic, efficient, and responsible use of material resources to build the things that make the society go.

Thermal and fluid processes

Predicting and analyzing the performance of machines using heat transfer, thermodynamics, fluid mechanics, and combustion.

Dynamic systems

Focusing on the principles and methods for designing and controlling engineered and natural systems.

Energy Conversion

Focusing on the conversion of physical work into usable energy and the conversion of electrical energy into physical work.

Sample Career Fields:

Mechanical engineers are employed in a wide range of industries; examples include agriculture, construction/heavy equipment, biomedical, consulting, computer-aided design, energy and power, manufacturing, robotics, and transportation.

Project Engineer

Liaison between the project manager and the general contractors on a project. Generally in charge of schedule preparation, pre-planning and accuracy of financial forecasts.

Design

Designing various types of systems in CAD software for a variety of commercial offices, industrial, retail/restaurant, or hospitality construction projects.

Quality Engineer

Researching and preventing unnecessary costs through lack of quality or lost production costs within the manufacturing field.

Safety Engineer

Protecting people, property, and the environment by anticipating and evaluating hazards, developing hazard control designs, and drafting future safety plans.

Unique Opportunities for Undergraduate Students:

Iowa State's Mechanical Engineering department is now the largest undergraduate Mechanical Engineering department in the nation, with over 2,000 students.

Design Expos for several Mechanical Engineering project courses are held each semester, and they allow students to showcase their projects as well as network with Iowa State faculty and industry professionals.

Mechanical Engineering

Undergraduate Labs:

The ME department utilizes many different lab spaces. Here are just a few examples:

MEtaL (Multimodal Experience Testbed and Laboratory) Lab: This lab creates a human-scale, immersive, virtual environment. It contains a 3-screen room and integrates haptic force-feedback with visual display, audio effects, and physical stimulation to create multimodal experiences.

Engines Laboratories: These spaces are used for several undergraduate laboratory courses and give students the opportunity to work with engine performance and optimization, investigate alternative fuels, and work with formula engine testing.

Boyd Fabrication Lab: This lab includes CNC (computer numerical control) machines, milling machines, drill presses, saws, welding stations, and cutters to assist students with the fabrication and creation of projects for various project based courses.

Manufacturing Lab: Students not only learn how to analyze manufacturing processes, but they actually perform these processes. Students use CNC machines, cast metal parts, and use welding equipment.

Sophomore Design Studio: Teams of students research a problem in a community in need somewhere in the world and design a solution to that problem using whatever resources may be available in that area. Examples include pedal powered clothes washers, hand crank peanut sheller, bicycle charged light, etc.

Senior Design: Teams of students partner with an organization or industry that has an engineering problem and are tasked with finding a solution. These students directly communicate with their company/organization for budgeting information and deadlines, as well as getting feedback throughout the semester on the group's performance. An example could be developing equipment for their manufacturing line.

Real World Applications/Examples:

Quality engineer for a baseball bat manufacturer to make sure the bats are made within the specifications (weight, uniform density, length, etc) and efficiently.

Design engineer working on valve tests to estimate their lifetime and be able to make the necessary changes to increase or improve their performance.

Designing computer components and cooling methods that can be used on outdoor, aboveground pipelines in either Alaska or the Saudi Arabian desert.

Designing the structure of wind turbines, as well as seeing out its manufacturing and implementation

Departmental Research:

Professor Pranav Shrotriya works with the mechanical response of micro/nano scale structures. A tool that he uses often is the atom probe microscope, which analyzes crystal structures and characterizes how atoms make up a certain space. His research involves using this tool to characterize material transfer through the rubbing of objects and develop lubricants to reduce friction and wear.

Major-affiliated clubs & organizations:

American Society of Mechanical Engineers (ASME): The Iowa State University chapter of ASME is completely student run. It provides student members with the opportunities to grow beyond the classroom. The section has many activities throughout the academic year that are geared towards extended learning. These include industry sponsored meetings, professional discussions, and design contests. Globally, ASME has more than 125,000 members and more than 400 chapters.

Women in Mechanical Engineering (WiME): WiME offers free events to all women studying ME at Iowa State to foster a sense of community through social and professional events. The group also hosts outreach events for K-12 girls to teach them about what mechanical engineering is and encourages them to pursue careers in the fields that range from biomedical applications to sustainable energy systems to virtual reality.

Cardinal Space Mining: This is an interdisciplinary organization where students design and build a robot that simulates mining on Mars. It is a great opportunity for students to develop hands-on experience with design, manufacturing, and electronic aspects of Mechanical Engineering. The team then goes on to compete in the NASA Robotic Mining Competition each May.

Team PrISUM: Team PrISUM is an interdisciplinary team that designs and builds a solar car that advances alternative energy technologies. They participate in several races each year including the American Solar Challenge, the World Solar Challenge, and the Formula Sun Grand Prix. These challenges evaluate the car's success in speed, handling, braking, and acceleration.

AEROSPACE ENGINEERING

Aerospace engineers enable machines that move through a fluid or have a fluid flowing around it, such as air, water, or even the vacuum of space.

Emphases/focus areas/specializations:

There are no specific focus areas within aerospace engineering. All of our aerospace engineers will study fundamentals that include: Aerodynamics, Propulsions, Flight Controls, Flight Dynamics, Structural Mechanics & Design and Systems.

Howe Hall

Wind Tunnels:

Howe Hall contains five wind tunnels with a range of sizes. One is so small that it can reach speeds of Mach 3 (three times the speed of sound), and another is large enough that it can hold a full scale Volkswagen Beetle. Students have the opportunity to use these wind tunnels in lab classes or as a part of undergraduate research work.

Icing Tunnel:

Wind tunnel that simulates what happens when ice forms on objects immersed in flow.

Tornado/Micro-burst Simulator:

This simulator has capabilities to produce a micro-burst jet or a tornado-like vortex that can be used for model testing, for instance on a small scale model of a city or landscape. The vortex can reach up to speeds of 55 mph.

Airplane:

The student group AirISU built the airplane, the Zodiac XL, at the West end of the atrium from scratch in 2013.

Undergraduate Labs:

Flight Simulator Lab: This lab contains six desk top simulators that provide students with a detailed, immersive, and challenging flight experience.

Hands on Lab: This lab gives first-year students hands-on experience in the fundamentals of aerospace engineering. Students work in teams to create lighter-than-air vehicles that they fly in a competition at the end of the semester.

Structures and Composites Lab: This lab allows students to look at new ways of minimizing weight and still maintain strength for structural components with the use of products such as carbon fiber weaves.

Rapid Prototyping Lab: Students use a computer-controlled foam cutter to make airplane wings. They also build real tires directly from a computer drawing using a plastic prototype.

Unique Opportunities for Undergraduate Students:

Opportunities to get hands on experience using resources like wind tunnels and tornado simulators.

Clayton Anderson, an Iowa State Aerospace Engineering graduate, went on to work for NASA and became an astronaut. He went on several missions, and worked aboard the International Space Station. He often comes back to give special presentations or lecture a class to share his experiences with Aerospace students.

Senior Design Challenge: The Senior Design challenge gives seniors the chance to put what they have learned to the test as they work in groups to design aircrafts. Students collaborate with engineers at Boeing as they build and fly their aircraft.

Aerospace Engineering

Sample Career Fields:

Aeronautical Industry: Boeing, SpaceX, NASA, Lockheed Martin, etc.

Automotive Industry: Testing and design of aerodynamic chassis for vehicles

Manufacturing, Analysis and Design: Parts manufacturing, 3D computerized modeling and simulation

Real World Applications/Examples:

In a world where over 100,000 planes are in the air each day, companies need people to design planes, cockpits, engines, and interiors.

UAVs: Unmanned aerial vehicles are playing a larger and larger role in our society. Moving food deliveries, packages, and even people around, our skies could look very different within the next 10 years as UAVs become more integrated.

Space Exploration: As humans turn more attention to the stars, private space exploration as well as a trip to Mars is now on the horizon.

Missile Defense Systems: With the increase in large and nuclear weapons, aerospace engineers are continuing to work on missile defense systems that can detect, track, intercept, and destroy attacking missiles. They have developed ways to carefully calculate and predict the path of the incoming missile in order to determine the characteristics (speed, direction, etc) of the defensive missile launch.

Departmental Research:

Dr. Hu is currently researching wind energy and wind turbine aeromechanics, and the physics behind the icing of wind turbine blades in order to investigate potential anti-icing/de-icing technology. His laboratory often utilizes the icing tunnel.

Dr. Sharma is researching nocturnal owls and their wing structures to understand what makes them so quiet during flight. He is then using these findings as inspiration to develop nearly silent aircrafts and wind turbines.

Major-affiliated clubs & organizations:

Iowa State Space Society:

A group for space enthusiasts who learn about high-power rockets, stargazing, and the exploration and development of space. They offer astronomy nights, rocket building projects, and also host industry speakers.

American Institute of Aeronautics and Astronautics (AIAA):

The student branch of national professional society leads a whole variety of events to get our students interested in aerospace. They compete in competitions and also take trips to Washington D.C. as well as California to visit aerospace manufacturers.

Make to Innovate:

A class where students work in teams to solve real-world problems. Students get to build and fly things, including real student-designed spacecraft, an autonomous unmanned airplane, or a rover that can scout the surface of Mars.

VRAC

Iowa State University's Virtual Reality Applications Center is an interdisciplinary research center focused on the intersection of humans and technology. VRAC is utilized by faculty and student researchers from various Iowa State colleges, several federal agencies (such as the Department of Defense) and numerous industry partners (such as John Deere and Boeing).

Unique Opportunities for Undergraduate and Graduate Students:

VRAC offers a graduate major in Human Computer Interaction (HCI), which has become the largest graduate major on campus.

VRAC faculty employ many undergraduate research assistants.

SPIRE-EIT Research Experience for Undergraduates (REU) program.

Real World Applications/Examples:

- John Deere has software developed at VRAC to redesign their tractor cabs, ensuring that the cab controls and design are fully functional for their entire user demographic. They have the ability to project their code into the C6, and then make minor changes to the prototype. This saves them time and money because they don't have to make a physical prototype.
- Medical doctors are using tools created at VRAC to see 3-D models of their patients before conducting surgery.
- The psychology department did a study where they immersed subjects in a video game and found how it affected their violence levels.

Research:

VRAC has a variety of research projects that receive funding from commercial and government agencies, some of which include:

Training Environments:

VRAC was approached by the Department of Defense to develop a new type of military simulation that combines live, virtual, and constructive (LVC) training. Live is represented by the trainees themselves, the equipment they use, and human actors in the physical combat environment. Virtual is humans interacting with the trainees through the technology, and constructive refers to the simulated forces (similar to video game enemies). Trainees also wear a vest that buzzes the spot where he or she was hit. The LVC is a flexible and versatile form of training, because new simulation scenarios only take about 30 minutes to construct.

Intelligent Tutoring Systems (ITS):

ITS provides a way to train employees or team members without the instructor having to be present. The ITS presents a particular scenario depending on the environment that the trainees are being prepared for. It monitors the behavior of the team members and will give each member in the simulation individualized feedback depending on their actions. This allows the instructor or teacher to dedicate their time to higher level training.

HomCam:

HomCam is a helmet with four cameras positioned around it. It allows user to record and stream 360 degrees of video. This technology has a range of applications which include military, (having someone remotely monitor all of a soldier's sides and communicate directly to the soldier) to construction sites (having video display the current state of a building project) to education (having students take a virtual tour of an attraction halfway around the world).

Virtual Reality Applications Center

Emphases/focus areas/specializations:

VRAC includes a variety of different tools such as:

C6

- The world's highest resolution, fully immersive virtual environment.
- 10 foot cube with 24 projectors that produce images on all four walls, the floor and the ceiling. In total, these projectors produce more than 100 million pixels.
- Has a 48 node computer cluster including 96 high end Nvidia graphics cards to drive the simulation.
- Contains a variety of speakers, which add to the environment through surround and localized sound.
- Participants can interact with the environment using smart phones and game controllers, which provide the ability to manipulate aspects of the environment and move within the simulation.

Consumer, Low-Cost VR Devices

Not everyone can afford a multi-million-dollar virtual reality cave. VRAC also develops scenarios using commodity VR such as the HTC VIVE, Oculus Rift, and various HMD technologies such as the Google Daydream.

Augmented Reality Devices

Augmented reality merges the digital world with the real world to provide information relevant to a scenario that may improve learning speed, cognition, memory retention, etc.

VRAC is currently experimenting with devices such as the Microsoft HoloLens and has built custom augmented reality solutions as proof of concepts for the factories of the future.

User Experience Equipment

At VRAC you will find state of the art equipment that can be used to measure every aspect of the human experience. We have the technology to measure the following data:

- **Biopac:** Can measure physiological biomarkers, including heart rate, skin conductance, and blood pressure. We are using this data to change or value the impact of VR simulations based on the results we get from the physiological data. The data collected allows us to quantify the state that the user is in whether this is information about cognitive load, stress, or decision making.
- **Cognionics Dry EEG:** Allows us to non-invasively measure brain activity.
- **Empatica E4 bands:** Allows us to do real-time stress measurements from EDA/GSR sensors anywhere. We can use this data to determine cognitive load while using a given computer control system while operating a task and help to produce the best interface.

3D printing

Since the beginning of 3D printing, VRAC has been experimenting with this technology. Not only does VRAC have multiple 3D printers and experiment with different printing methods, but you can actually use an application in the C6 which acts like the magic school bus and lets you explore 3D printing while you are the size of an extruder.

Employers:

Iowa Companies

- Mechdyne
- Workiva
- John Deere
- Principal Financial
- Rockwell-Collins
- Vermeer
- BodyViz

US Companies

- Apple
- Microsoft
- Boeing
- Intel
- Facebook
- Dreamworks
- Disney
- Garmin
- Amazon
- Raytheon
- Lockheed-Martin
- Electronic Arts (EA)
- Google

Agricultural & Biosystems Engineering

Biorenewables Complex

The Biorenewables Complex, which opened in the summer of 2014, has a LEED-Gold certification under U.S. Green Building Council's Leadership in Energy and Environmental Design

There are small grasses and plants on the roof of the Biorenewables Complex that absorb rainwater, which is used to run the toilets in the building.

The atrium artwork "Floating World," tells the history of Iowa Agriculture, and is a tribute to the state of Iowa. The medallions on the floor are a progression from a single atom, all the way up to our entire solar system, with the gold speck indicating your current location.

The building contains five computer labs, all with dual monitors.

Elings Hall (south building – pronounced ee-lings). Classrooms and office space for the department of Agricultural and Biosystems Engineering.

Sukup Hall (west building – pronounced soo-cup). Research laboratories, teaching laboratories, student workshops, research workshops, student teaming rooms and student computer labs for the department of Agricultural and Biosystems Engineering.

Biorenewable Research Laboratory (north building – usually called BRL). Office and laboratory space for the Bioeconomy Institute and the Center for Biorenewable Chemicals. Using biomass (organic material of recent biological origin) for energy, chemicals, and materials.

The three buildings, along with the Sukup Atrium, is called the Biorenewables Complex.

AGRICULTURAL ENGINEERING

Agricultural Engineering is a diverse engineering major that prepares students to work hands-on in the field of agriculture through the design and development of advanced machinery systems, soil and water conservation systems, food quality systems, and animal production systems.

Emphases/focus areas/ specializations:

Power and Machinery

Design, innovate, and test advanced machinery systems focused in modern-day precision agriculture. These engineers work with a range of agricultural equipment and other off-road vehicles that include tractors, combines, ATVs, and mining equipment.

Animal Production Systems

Design and develop environmentally and economically sustainable animal housing & waste systems, as well as improve quality of life for rural communities. These engineers often work on agricultural animal production facilities and/or animal environmental control systems.

Land and Water Resources

Evaluate, model, and design systems for sustainable agriculture to help improve soil and water resources. These engineers typically work with water quality and natural resource management systems.

Unique Opportunities for Undergraduate Students:

Iowa State's Agricultural Engineering department is ranked #1 in the nation for both undergraduate and graduate studies.

Students take a project management class as sophomores to get experience working in a team-based setting

The student to faculty ratio within the Agricultural Engineering department is 20:1

Sample Career Fields:

- Designing and managing food production systems
- Protecting surface and ground water quality
- Designing natural resource management systems
- Developing and managing bioprocessing systems
- Designing off-road vehicles & agricultural equipment
- Designing animal production facilities and environmental control systems

Real World Applications/Examples:

In hot Iowa summers, it is important to keep animals cool so that they don't overheat. Agricultural Engineers often analyze wind patterns in areas where animal confinements will be located. This way, these buildings can be oriented so that doors can be opened, and natural wind can be used to cool the animals. This also leads to savings in electricity costs.

Eroded soil, with its associated nutrients and agricultural chemicals, is the largest pollutant in our water systems. Agricultural engineers have developed solutions such as terraced farming in order to physically stop this soil runoff.

Diesel engines are a major component of agricultural machinery. Agricultural engineers are looking for alternative fuels to power these engines without compromising efficiency.

Undergraduate Labs:

John Deere Tractor Lab: In this lab, students study diesel engines by disassembling them piece by piece. Halfway through the semester, students are tasked with putting the engines back together. They are evaluated not only if their engines will start, but if they run as efficiently as they did before.

ABE Student Innovation Center: This lab contains the ABE Waterjet, which is a computer numerical control machine that uses pressurized water to cut out designs in a variety of materials ranging from steel to wood. Students have the opportunity to create a design, and then actually manufacture their prototype.

Other labs include: fluid mechanics lab, water quality lab, control measurement and sensors lab, electric power and electronics lab, grain quality and handling lab.

Departmental Research:

Dr. Harmon and Dr. Hoff are evaluating building ventilation leakage and investigating a new pressure dependent ventilation system in order to improve air quality on farms.

Dr. Soupir's research focuses on reducing chemical and soil run off into water bodies. In particular, she has investigated the effectiveness of woodchip bioreactors in improving water quality from row crop field drainage.

Dr. Darr is working with unmanned aerial vehicles, which offer farmers a way to evaluate and manage crop production on a plant-by-plant basis. His research group is primarily focused on applications such as crop scouting, machinery management, and terrain mapping.

Major-affiliated clubs & organizations:

American Society of Agricultural and Biological Engineers (ASABE): Professional organization for agricultural and biological engineers that gives students the ability to network with faculty and professionals.

Cyclone Power Pullers: A group of Iowa State students that designs, builds, and tests a ¼ scale tractor. Each year, the organization takes their tractor to compete in the ASABE ¼ scale tractor student design competition. Tractors are judged based on their cost, design, and pulling power.

AirPad (Aerial Imaging Reconnaissance Program for Agricultural Development):

Student members of AirPad design, build, and test unmanned aerial vehicles for use in agricultural remote sensing, land/crop surveying, and monitoring.

BIOLOGICAL SYSTEMS ENGINEERING

Biological Systems Engineers work towards sustainability through the conservation of natural resources (like air, water, and soil) and the conversion of bio based resources into useful products.

Emphases/focus areas/ specializations:

Bioenvironmental

Using chemical or biological methods to improve and protect soil, air, and water quality.

Biorenewable Resources

Improve economic and environmental sustainability of biorenewable resource production systems. A large portion of this work is involved in alternative energy, including biodiesel and ethanol production.

Food Engineering

Design and operate food-processing systems, particularly in grain processing and handling, food engineering, and food processing.

Pre-Professional and Pre-Graduate

Focuses on preparing students for graduate school.

Sample Career Fields:

- Creating and researching renewable fuels
- Optimizing food processing systems
- Maintaining clean air and water systems
- Government agencies that test our environment to determine what levels of pollution are being put out by the industry.

Unique Opportunities for Undergraduate Students:

Iowa State's Biological Systems Engineering department is ranked #1 in the nation.

Undergraduate research includes opportunities in sustainable biomass production, processing systems, and biogeosciences.

Real World Applications/Examples:

Biosystems engineers have re-purposed bio-based materials to create biodegradable materials. One example is biodegradable packing peanuts, which are made out of starch from potatoes and corn. They are non-toxic, do not hold static charge, and naturally decompose.

How do we have fresh fruit in our grocery stores even in the middle of the winter? Biosystems engineers work to transport food, flowers, etc. around the world for consumer availability year round without contaminating the destination environment with foreign bacteria, viruses, or insects.

Ethanol is an important biological based product. A large percentage of ethanol is produced in Iowa because it is made from the kernel of the corn. This is a competitive source, as it can be used as either a food source or a fuel source. Biological systems engineers are working to utilize other portions of the corn, such as the stalk or the leaves. They are also doing research in the Center for Biorenewable Chemicals (CBiRC) to use algae as a form of fuel.

Undergraduate Labs:

The CBiRC (Center for Biorenewable Chemicals) is a great resource for students. The center's vision is to decrease our reliance on fossil carbon sources and build a foundation for a more sustainable future by the innovation and development of biorenewable chemicals.

Land and Water Resources Laboratory exposes students to hands-on experiences related to conservation engineering practices.

Grain Handling and Processing Laboratory allows students to gain hands-on experiences related to best practices for handling and processing grains

Departmental Research:

Dr. Howe is developing biosensors for looking at antibiotic resistance in the environment.

Dr. Brumm is working to understand and implement improvements in post-harvest systems in developing countries in order to help ensure food security.

Dr. Rosentrater conducts research in finding new methods to utilize biofuel co-products by using alternative recycling and reprocessing strategies and developing usable alternative products.

Dr. Misra has developed a device to precisely measure the flow of seeds and grains to more accurately get a reading of the quantity and condition of the seeds. Current work is being done to adapt, build, and install the device in a seed facility.

Major-affiliated clubs & organizations:

ISU Biobus: The Biobus club recycles excess vegetable oils from Iowa State dining centers and converts it into biodiesel fuel to power a CyRide bus. They have their own laboratory space, located in the Biorenewables lab.

American Society of Agricultural and Biological Engineers (ASABE): Professional organization for agricultural and biological engineers that gives students the ability to network with faculty and professionals

Biological Systems Engineering (BSE) Club: A professional organization that connects biological systems engineers and allows students to network with both industrial and academic professionals. One event that they hold is an industry night that allows BSE students to prepare for the career fair.

Chemical & Biological Engineering

CHEMICAL ENGINEERING

Chemical Engineering combines chemistry, math, and biology to convert raw materials to items that benefit the world. Chemical engineers are responsible for taking a product or system developed on a lab scale, and sizing it to a large scale production level.

Emphases/Focus Areas/Specializations:

Chemical Engineering doesn't have specific focus areas within the curriculum, but you can tailor your interest in various career fields by taking different technical electives.

Undergraduate Labs:

We are standing outside of the Herbert L. Stiles Undergrad Teaching Laboratory, also known as the Unit Operations Laboratory. All undergrads take two lab courses here, during their junior and senior years. Much of Sweeney Hall's lab equipment is the same as what is found in "the real world," giving students excellent professional-level experience before leaving school.

Study Abroad:

There is a five week intensive summer program in Spain taught entirely in English that replaces the two semesters of senior unit operations labs. Scholarships offered to all students on this program from chemical engineering.

Unique Opportunities for Undergraduate Students:

- The department includes more than 47,000 square feet of modern laboratory, office and teaching space where 28 faculty teach and perform research in traditional and emerging areas of chemical engineering.
- One of that largest Chemical Engineering departments in the country.
- Specialties include things like petrochemicals and gas, agricultural products, biomedicine, pharmaceuticals, and foods and beverages.
- Students also use a chemical engineering degree as a springboard to engineering graduate school, medical school or law school.

Orland Russell Sweeney, Department Head of chemical engineering at Iowa State from 1920-1947, is known for having said "Chemical engineers can solve all the world's problems".

Real World Applications/Examples:

Developing many materials that impact our everyday lives like the adhesive on sticky notes, cosmetics and medicines, oil and gas for our cars and motorcycles, and better asphalt roads for them to ride on.

Formulating ingredients and standardizing large-scale recipes and production methods for processed foods (fruit snacks, cereals, yogurts, etc), personal care products (deodorants, shampoos, cosmetics, etc).

Major-affiliated clubs & organizations:

American Institute of Chemical Engineers: One component of the club is a competition team that builds a car that runs off chemical reactions.

Omega Chi Epsilon Chemical Engineering Honor Society

Chemical & Biological Engineering

Departmental Research:

The CBE Department spends about \$9 million in research per year. Areas of specialty include biorenewables, renewable energy, advanced and nanostructured materials, catalysis and reaction engineering, health care technology and computational fluid dynamics.

The department features unique and advanced research labs used by both undergraduate and graduate students, including equipment and procedures such as:

- Atomic force microscopy
- Infrared spectroscopy and microscopy
- Scanning electrochemical microscopy
- Protein separations
- Cell and tissue cultures
- Gene delivery
- Stereo and high-speed particle imaging
- Lazer-induced fluorescence
- Particle size analysis
- Spectroscopic techniques
- Fluid separations

Specific research projects

Dr. Shao and Dr. Tessonier are working to develop a way to produce biorenewable nylon from genetically engineered yeast.

Dr. Bratlie is researching improved monitoring and treatment of diseases like diabetes and cancer, and using polymers to improve how medications are delivered into the body.

Dr. Cochran is creating a new process for using vegetable oils as feedstocks to create a substance that improves roadway asphalt.

Dr. Narasimhan is leading a national initiative with researchers from other ISU departments and other U.S. chemical engineering researchers to develop nanovaccines, which will revolutionize the delivery of medication and treatment of disease worldwide.

Sample Career Fields:

Chemical engineers are employed in a wide variety of industries. Countless products we use every day come from the work of chemical engineers, including:

- Petroleum and gas, chemicals, minerals and metals
- Glass and ceramics
- Plastics and resins
- Soaps and detergents
- Cosmetics
- Rubber and tires
- Food products
- Fertilizer and agricultural chemicals
- Nuclear energy
- Photographic products
- Microchip manufacturing
- Missiles and space exploration
- Synthetic fibers and textiles
- Paint, paper, and cellulose
- Pharmaceuticals

Additionally, chemical engineers are involved in areas such as private consulting, government, higher education, applied physics, manufacturing, applied mathematics, biochemistry, medicine, patent law, food processing, pollution monitoring and prediction, sales, and industrial management.

CIVIL ENGINEERING

Civil engineers design, build, and maintain the infrastructure of our modern society. Geotechnical engineers look at the foundations of buildings, while those with a structural emphasis are more interested in the loads placed on a bridge or building. Transportation engineers not only design our traffic patterns and roadways, but also are also looking to the future and considering how to integrate things like autonomous vehicles. The other area of specialization within this major is environmental engineering, which is essentially working to keep our air and water clean and safe.

Town Engineering

Town Engineering has a number of hands-on labs, all of which are utilized by students. One of the structural labs is large enough to hold industrial-sized steel beams for real-world research. Our computer labs have collaborative space for group study and ISU CCEE-specific software.

Kiewit Student Study Center

- Student study spaces with group study rooms available
- CCEE-specific software uploaded on all computers!
- 74 computers with great room for group work (the computers swivel on a rotating arm to aid with group work)
- Plotter printers for large projects (drawings, engineering plans, posters, etc.)

Emphases/focus areas/specializations:

Structural:

Design various structures (buildings, bridges, dams), taking into account practical, innovative, economical and safe design. Consider geographical location and natural forces to make sure those structures can withstand hurricanes, tornadoes, and even heavy snow and extreme temperatures.

Transportation:

Determine ways to meet the increasing transportation needs of people and goods on land, in air and water. Design travel systems to accommodate traffic flow. Branching out into exciting fields like multi-actor traffic study and automated vehicles.

Geotechnical:

Evaluate ground conditions and plan support systems for buildings, bridges, dams, and pavements. Design necessary concrete and asphalt mixtures for foundations, and monitor the quality and stability of various mixes. Find innovative solutions to support system challenges, like offshore structures and slope stability.

Environmental:

Manage water systems to improve water quality and ensure that we have a clean and sustainable water source. Analyze the environmental impact of our infrastructure and how we can solve various environmental challenges.

Real World Applications/Examples:

Structural

Building "green buildings" that are ecologically friendly and reduce pollution. Developing taller, more efficient wind turbines. Structural sensing technology to pinpoint problems and avoid deterioration and collapse.

Transportation

Many of the roads on campus and throughout Ames include bus pull-offs so that stopped buses do not hinder the flow of traffic. Civil engineers can calculate the flow of traffic to determine how many lanes of traffic are needed on a roadway segment.

Geotechnical

Ever driven through a tunnel or seen a levee? Geotechnical engineers work with systems that are made of or supported by soil or rock. At the newly-constructed Student Innovation Center right down the road, engineers used geofoam blocks during the foundation phase to add stability and to make sure surrounding structural foundations didn't experience shift.

Environmental

When you drink from a water fountain, you just assume that the water will be safe to drink. Civil engineers make sure that we have access to a clean and reliable water source while our contaminated water safely leaves the building to be properly treated or discarded. Also, civil engineers develop methods for supplying safe water to remote areas and third-world countries where clean water is a rare resource.

Civil, Construction, & Environmental Engineering

Sample Career Fields:

Transportation Consultant: Work for a local/state/regional government to plan, develop, operate and maintain transportation systems and services.

Project Management: Prepare construction plans and specifications for various projects. Evaluate the additional infrastructure needed, as well as the impact on current roads, sewer and water systems.

Design consultant: Design structures, develop cost estimates and evaluate the feasibility of the design while meeting proper specifications as well as the needs of the client. Historical building preservation as well.

Water resource engineer: Work with municipalities. Mitigate the effects of wildfires, hurricanes, tornadoes and other natural disasters on population water sources.

Departmental Research:

Transportation:

Associate Professor Anuj Sharma and his team of academic and student researchers are studying the systems required for future electric and driverless vehicles. Professors and their research teams are currently working on projects under the Strategic Highway Research Program to analyze roads where crashes and near crashes have occurred. They are developing a model to predict both the driver's speed and their position on the road.

Environmental:

Professor Kaoru Ikuma is working to implement microbial organisms as a way to remove contamination in wastewater. This eliminates the need for harsh chemicals for water purification and could possibly be utilized in third-world countries.

Geotechnical:

Professor Chris Williams is investigating additives to asphalt pavements to improve the pavement's performance in different environmental conditions, such as extreme cold climates. Fun fact: Dr. Williams designed a pink asphalt mix for the White House driveway at the request of Barbara Bush.

Structural:

Associate Professor Simon Laflamme is researching the use of smart sensors for the monitoring of structural health. This new technology could detect whether a building, bridge or even aircraft is suffering from structural fatigue. Professor Sri Sritharan is exploring the potential for taller, more energy-efficient wind turbines.

Major-affiliated clubs & organizations:

American Society of Civil Engineers (ASCE):

A professional civil engineering organization that sponsors speakers, field trips, and informational meetings about different aspects of civil engineering.

Steel Bridge Competition

Students must design and construct a bridge that fits the criteria specified by AISC (American Institute of Steel Construction). They are judged based on display, construction speed, lightness and stiffness.

Concrete Canoe Competition

Students create a canoe entirely out of a concrete based material, and race it in a competition against other universities.

Transportation Student Association (TSA)

TSA is the parent organization of the Iowa State chapter of the ITE, or Institute for Transportation Engineers. This organization hosts multiple events, including national conferences and volunteer activities. The group has even helped at STEM learning programs for elementary students at the Iowa Science Center.

Earthquake Engineering Research Institute

(EERI): Members compete at the yearly Undergraduate Seismic Design Competition. In previous years, this group traveled to such cities as San Francisco to test their building model in the national competition!

CONSTRUCTION ENGINEERING

Construction engineers are able to interpret design plans and bring them to life. If you have a building emphasis, you concerned with keeping projects on time and on budget. This includes coordinating schedules of people and materials so resources are most efficiently used. Heavy highway engineers are similar to civil engineers in transportation, except they are more concerned with projects that involve a lot of heavy earthwork. Those with a mechanical or electrical emphasis will be experts in heating, ventilation, and air conditioning systems or electrical systems within buildings.

Emphases/focus areas/ specializations:

Building: Manage and construct commercial and residential buildings.

Mechanical: Design, manage, and construct mechanical systems including heating, ventilation, air conditioning, and plumbing systems.

Electrical: Manage installation and construction of electrical systems associated with project. Learn about the allocation and distribution of energy, and how to construct electrical systems.

Heavy/Highway: Construction of highways, bridges, airports, water/wastewater plants. Heavy earthwork emphasis because of extensive excavation needed for many of these projects, so this requires knowledge of geology and soil mechanics.

Sample Career Fields:

General Contractor Project Manager:

Responsible for total project performance including budgets, schedules, client contracts and purchase orders. Is the main contact between a client and a designer (architect or engineer).

Superintendent:

Responsible for day-to-day scheduling and supervision of construction operations. Monitors quality, enforces safety policies, and evaluates the performance of subcontractors.

Electrical Engineer:

Design, model and then go on-site to monitor the construction of light systems. Especially crucial to construction of highly detailed systems like hospitals and schools.

Precast: producing construction site materials in a controlled environment where quality is monitored more easily and weather cannot slow construction. Works especially well for tight deadlines and confined spaces.

Departmental Research:

Major-affiliated clubs & organizations:

Associated General Contractors (AGC):

This professional organization allows students to hear about job opportunities, go on tours of construction sites, participate in community service, and connect with other construction engineers at social events. AGC goes on a semester break community service trip every fall and spring. They have visited areas in Tennessee, Oklahoma, Illinois and Texas.

National Association of Home Builders: The students of this NAHB chapter donate more than 400 hours of students' time to give back to the community. They work closely with the City of Ames to assist in building homes, park shelters, etc.

National Electrical Contractors Association Iowa State University Student Chapter (ISU NECA)

Five-time champions of NECA Green Energy Challenge. This organization competes to design sustainable updates to real buildings in the Ames community and the state.

Civil and Construction Undergraduate Labs:

Jellinger Laboratory

This teaching lab is used by the department's capstone courses, which provide practical, hands-on course work for both construction engineering and civil engineering students. The technology in the Jellinger Lab provides virtual site tours as well as building information modeling. The lab is open 24/7 for student use.

Sanders Structural Engineering Laboratory

Contains an 80 by 24 foot reaction floor with 300,000 pound capacity loading points. A 15-ton overhead crane places tall loads. Currently being used to conduct minimal reinforcement studies.

Anderlik Environmental Engineering Laboratory

The lab deals with different kinds of chemical analysis to evaluate materials and their makeup.

Portland Cement Concrete Research Laboratory

Concrete processing and manufacturing, as well as mechanical testing of hardened concrete to evaluate durability.

Real World Applications/Examples:

- U.S. Bank Stadium - Iowa State construction engineering alumni helped engineer this structure
- Marston Hall Renovation
- Mall of America
- Ames Wastewater Treatment Plant

Moth Statue Transition

Moth Statue

Did anyone notice the three piece statue outside of Coover? Any guesses on what it is?

Did you know, during the early history of computers, computer scientist Grace Hopper discovered something unusual between a relay in the machine. The team had discovered a moth trapped in the computer. In her log book, she wrote, "First actual case of bug being found," and it was the first time someone had used the word "bug" to describe a computer glitch.

Electrical, Computer, Cyber Security and Software

Coover Hall

TLA (Transformative Learning Area)

Contains Windows and Linux operating systems. Also includes basic lab equipment (oscilloscopes, voltmeters) for students to use to complete labs or work on assignments. Arcade games located in the back of the lab were past student's senior design projects.

Union Pacific Multimedia Wall, nicknamed Cyrus (interactive touch screen)

CYBER SECURITY ENGINEERING

Our newest major, Cyber Security Engineering, is one of the few in the country.

This degree program stems from our belief that cyber security can no longer be an afterthought or an added layer; it must be an integrated component throughout the four-year curriculum. The major is new, but Iowa State has been teaching and researching cyber security since 1995, making it one of the oldest programs in the country. Students will gain a strong foundation in computer engineering concepts while applying engineering methodology to solve complex cyber security problems.

Cyber security engineers work on cyber systems found in cars, computers, digital clouds, and other areas by thinking like a hacker to keep data systems intact and protect confidential information. These professionals must keep in mind the software, hardware, networking technology, and users of these systems.

The Internet-Scale Event and Attack Generation Environment (ISE AGE) is the world's first virtual cyber security laboratory of its kind. The lab houses a group dedicated to researching, designing, and testing cyber defense mechanisms. They created a virtual Internet to simulate a real world environment where they can research different attack and defense strategies.

ELECTRICAL ENGINEERING

Electrical engineers create the foundation for all of our electronic based devices by dealing with the more physical components such as chips and processors. The scale of their work can range from nanotechnologies, all the way up to a large power grid.

Emphases/focus areas/specializations:

Communications & Signal Processing: Working with various kinds of signaling (Bluetooth, Wi-Fi, telephone signals, etc.).

Electromagnetics, Microwave, &

Nondestructive Evaluation: Investigating how energy travels through and around different mediums.

Electric Power & Energy Systems: Efficiently delivering electricity around the globe and improving how that electricity is generated.

Microelectronics & Photonics: Very small electric and light systems.

Systems & Controls: Working with communication between different structures or models in a system.

Very Large Scale Integration (VLSI): Making technologies smaller while either maintaining or increasing the processing power. For instance, computers used to take up entire rooms, but now we can hold them in the palm of our hand.

Real World Applications/Examples:

Energy creation and distribution

America has the highest population density on the coasts. The windiest areas of the US are in the Midwest and down to Texas. Electrical engineers can design new additions to the power grid and modify the old grid to make sure new wind generated electricity can get to where it is most needed.

Photonics

Lasers can be used during surgery instead of scalpels. Laser eye surgery is a good example. Electrical engineers have to be careful with designing these lasers because they need to be more powerful than a laser pointer, but not so powerful that they can cause damage during surgery.

Cell Phone Signals

When you're talking on the phone and go from one cell tower signal to another, your phone doesn't drop the call and then reconnect. Electrical engineers develop signaling technologies that allow your phone to automatically detect signals without dropping your call.

Sample Career Fields:

- Work with energy availability and distribution by developing wind, solar, and traditional energy systems. This can range from energy distribution in a building all the way to a large power grid.
- Design controls and communications systems, which can help doctors perform surgery with smarter robots.
- Enhance image processing and make better instruments to help diagnose and treat diseases.
- Develop nanotechnologies to help scientists study microorganisms.
- Design computer circuits to improve and speed up networks and processors that operate your smartphone and other electronics.
- Improve battery technology for use in electric-powered cars, which helps power military equipment.

Departmental Research:

Dr. Meng Lu is working in the field of photonics to develop a sensor that detects certain biomarkers within a drop of blood to better identify the presence of cancer.

Dr. Liang Dong is working to develop a "greenhouse on a chip" to enable plant researchers to monitor and control precise growing conditions and analyze plant behavior due to these conditions.

Dr. Zhaoyu Wang specializes in power and energy systems. He is currently working with the Department of Energy to develop more economic and efficient techniques for power restoration.

Iowa State professors are working to develop a tool to detect malware within mobile device applications. The project is funded by the US Government's Defense Advanced Research Projects Agency.

COMPUTER ENGINEERING

Computer Engineers make hardware and software components of electronic devices work together as one cohesive device. They solve problems in hardware, software, systems, and networks to ensure that computerized devices work properly. This can be developing new technologies as well as making current devices faster, smaller, cheaper, smarter, and safer.

Emphases/focus areas/specializations:

Embedded Systems: Hardware/software integration at the low level, usually associated with devices that we wouldn't typically consider computers.

Examples of these devices include remote controls, microwaves, or even anti-lock brakes.

Networking: Controlling connections between groups of computers in various settings, which may include a building, office, or college campus.

Information Security: Finding and preventing potential security flaws in a system. Students have the opportunity to learn how to break into systems to better understand how to defend them.

Big data: Computer engineers can help with the data collection by creating devices that collect and process data.

Robotics: Integrating hardware and software to automate systems and improve processes.

Sample Career Fields:

- Work with the government in security and digital forensics to prevent and catch criminals.
- Work to improve internet security to help protect online databases such as medical records and company or government secrets and make it safer to buy things online.
- Design faster processors to improve TV and gaming experiences.
- Develop biomedical systems to help monitor the condition of patients in hospitals.
- Study, create, and implement complex sensor networks to make robots more human-like.
- Work to help develop autonomous mining vehicles for space, deep water, or caves.

Real World Applications/Examples:

Touchscreens have limited physical buttons. A computer engineer can work with touch screens to connect where a person is touching the screen to what action needs to be completed.

This field works with big data. For example, a toothpaste manufacturing plant has miles of pipes used in the manufacturing of the products. A computer engineer can design sensors placed on these pipes that collect temperature, pressure, flow rate, etc. This data can be processed to help quality and quantity of the product, safety of the workers, and reduce energy usage, waste, and cost.

Departmental Research:

5 focus areas of research:

- Bioengineering
- Cyber Infrastructure
- Data, Decisions, Networks, and Autonomy
- Energy Infrastructure
- Materials, Devices, and Circuits

The Developmental Robotics Lab, which centers around research in Artificial Intelligence being conducted by Dr. Alexander Stoytchev, is trying to create autonomous robots that can think and learn. The hope is that these robots will be more intelligent, adaptable, and versatile than current robots. Their approach is to teach the robots to learn the way a child learns, by observing the world around them and drawing conclusions. Their robot has demonstrated learning in telling apart different objects, finding buttons, and working with water.

SOFTWARE ENGINEERING

Software engineers use math, algorithms, and problem solving skills to design, develop, and evaluate software systems.

Emphases/focus areas/specializations:

There are no official specializations in software engineering, but students will learn about different aspects including:

Lifecycle Development: Thinking about how to make a product that can be changed over time to meet industry and customer demands.

Teamwork and Collaboration: Working with other developers as well as marketing and business teams to ensure a smooth development process and successful product.

Adaptation: The ability to adapt quickly to technological, environmental, and organizational changes.

Real World Applications/Examples:

Every time you open a certain app on your phone, it crashes. You can submit a bug report, which goes to software engineers. Software engineers need to take that feedback from customers about what's working and what's not and make changes to the code. Then the user can download the updated version and their product works again.

GPS units triangulate location based on satellite readings using complex tables and equations. Software engineers have worked to develop and advance GPS systems and implement them in various forms of devices and systems.

Sample Career Fields:

Conduct software developing and programming for GPS systems to help develop systems for autonomous machinery such as lawn mowers and tractors. These systems can also assist with things such as plane tracking.

Develop apps for construction companies to plan how they will execute different construction work and actually use the app to control the equipment. This is good for visualization, particularly with underground projects that are hard to see.

Design operating systems for computers to advance features, keeping in mind an easy user interface. This also involves debugging or solving glitches or issues in the system.

Working on video game design and development.

Departmental Research:

Professor Tirthapura is working with a research team to develop large scale data analysis algorithms. His goal is to apply these data analytics to improve cybersecurity and transportation.

The laboratory of Software Design has a team of researchers that are looking into better ways to design software so that systems can be larger and more intensive, cheaper to implement, and portable across devices and platforms.

Electrical, Computer, Cyber Security and Software

Unique Opportunities for ECpE Majors:

Iowa State hosts a national competition called the **Cyber Defense Competition** multiple times a year. Typically, over 75 students will participate. It's a great environment for students to learn about Information Security from older students, teachers, and even industry professionals.

Hackathon competitions: Open-ended and great practical experience. Over 36 hours, teams of up to 4 students create a useful project (usually hardware or software based) with NO restrictions. Examples of projects made in the past include: blinkers on backpacks for bikers at night, automated drum set that plays automatically (students wrote a program to tell sticks when to strike drums). HackISU is the ISU sponsored hackathon. It is hosted one time each semester.

The department holds a **Seminar Series** where various instructors will talk about their interests and the research that they are currently involved in, and students have the opportunity to attend these seminars.

Clubs/Organizations for ECpE Majors:

Computer Science/Software Engineering (CSE): A resource and network building club. Students interact with peers and with potential employers in a casual environment.

Institute of Electrical and Electronics Engineers (IEEE): The world's largest technical professional society, which works to advance the theory and application of electrical engineering. Students have the opportunity to network with faculty and industry professionals, and get involved in group projects.

Information Assurance Student Group (IASG): An Information Security club for students interested in learning more about firewalls, secure coding, network design, or social engineering.

Digital Women: A supportive network to encourage female participation in Computer Engineering, Electrical Engineering, Software Engineering, Computer Science, and Management Information Systems (MIS).

ISU Robotics Club: Gives students the opportunity to get involved with learning about and building robotic technologies.

Critical Tinkers: Allows students to think critically and have the opportunity to design, build, and test various projects. In the past, they developed their own plasma speaker.

Game Development Club: Students interested in game development can explore new tools, techniques, and processes while learning from their peers.

A variety of clubs that utilize computers in devices (the solar car team Team PriSUM, the Formula car design team, the Cardinal Space Mining team).

Undergraduate Labs:

CPR E 185: Students learn C coding in class and have a weekly lab working with an Arduino. They incrementally learn how to interface with the Arduino and use the programming language. One of the projects involves putting the Arduino inside a foam football and dropping it from the top of Coover atrium. The program measures how far and fast it fell, displaying information for a user to easily read.

CPR E 288: Students modify and program Roomba vacuums to autonomously navigate a maze.

The **iCUBE Sensors Application Laboratory** was created to allow students to investigate wireless and sensor networks and their applications. It includes both a sensor network testbed as well as a Wi-Fi test bed. Students have the opportunity to create and test various network prototypes.

Many labs use high quality electrical instruments like oscilloscopes, function generators, and ammeters.