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MESSAGE FROM THE EDITOR

Dear Future Engineer,

Welcome to another issue of New Engineer! We would like to congratulate you on choosing a career in engineering - one of the fastest and hottest growing industries. You've taken the right first step in picking up New Engineer. There are a multitude of sectors and sub-sectors in engineering and to help you make the right choice, we will focus on one in every issue going forward. Our goal is to make it easier for you to figure out where your strengths and interests lie, so that you can choose a course of engineering study that will be a good fit for you!

The cover story Forward Thinking: Building a Future at Indiana University talks about the Intelligent Systems Engineering Program at the Indiana University School of Informatics, established in 2016, and describes the various engineering tracks available to students and the degree options available.

This issue also includes information on engineering project management which is in high demand, along with a look at industrial and systems engineering engineering, and STEM Vs. STEAM.

We hope you enjoy and learn from New Engineer as much as we did putting it together. Our goal is to make our publication an invaluable resource for you.

Look for upcoming issues to include more feature articles from engineering academics and professionals in their areas of expertise, expertise, engineering news and exciting field guides, resources and much more!

Go change the world!

Editor – New Engineer
Reading Between the Lines

What they *really* mean when they say...

**“SEEKING CANDIDATES WITH A WIDE VARIETY OF EXPERIENCE”**
You’ll need it to replace three people who just left.

**“REQUIRES TEAM LEADERSHIP SKILLS”**
You’ll have the responsibilities of a manager, without the pay or respect.

**“JOIN OUR FAST-PACED TEAM”**
We have no time to train you.

**“APPLY IN PERSON”**
If you’re old, fat or ugly you’ll be told the position has been filled.

**“MUST HAVE AN EYE FOR DETAIL”**
We have no quality control.

**“GOOD COMMUNICATION SKILLS”**
Management communicates, you listen, figure out what they want and do it.

**“MUST BE DEADLINE ORIENTED”**
You’ll be six months behind schedule on your first day.

**“SOME OVERTIME REQUIRED”**
Some time each night and some time each weekend.

**“COMPETITIVE SALARY”**
We remain competitive by paying less than our competitors.

**“NO PHONE CALLS PLEASE”**
We’ve filled the job; our call for resumes is just a legal formality.

**“JOIN OUR FAST-PACED TEAM”**
We have no time to train you.

**“REQUIRES TEAM LEADERSHIP SKILLS”**
You’ll have the responsibilities of a manager, without the pay or respect.
When the Intelligent Systems Engineering program at the Indiana University School of Informatics, Computing, and Engineering was established in 2016, the focus was on creating a forward-thinking program. The curriculum was designed from scratch—allowing for a blend of traditional engineering concepts and modern perspectives—and degrees were offered at both the bachelor’s and Ph.D. levels.

The gap between those two degrees has been filled. IU is now offering a Master of Science in Intelligent Systems Engineering degree, providing graduate students with the technical breadth they need for the fast-changing world of technology. The focus of the program is on intelligent, connected systems that are becoming ever more abundant, including the sensors that make our devices “smart” and the massive systems that analyze the flood of data all around us. The program also emphasizes artificial intelligence and machine learning that provide the underpinnings of the technology of the future.

“Our intelligent systems engineering program is unique because we’re so focused on how we can use technology to build the world to come,” said Raj Acharya, dean of SICE. “The addition of a master’s degree will allow us to build on the existing strengths of IU in science and technology, informatics and computing, biology, chemistry, physics, psychological and brain sciences, environmental science, health, and so many other fields to provide a quality, comprehensive education that will prepare our students for whatever career they may pursue.”

Students in the M.S. in ISE program have the option of selecting one of six tracks—including bioengineering, computer engineering, cyber-physical systems, environmental engineering, molecular and nanoscale engineering, and neuro-engineering—all of which provide the opportunity for cutting-edge innovation that will shape tomorrow.

Bioengineering

The bioengineering track meets at the intersection
of biology and technology, and it will help improve healthcare and provide a better understanding of everything from biological systems down to nanoscale devices.

Bioengineering at SICE also includes biomechanical engineering, which utilizes bioimaging and sensor devices in biomedicine and healthcare, and it focuses on the interface between biological systems that produce biochemical and optical signals, and electronic systems that deal with electrical systems.

**Computer Engineering**

The computer engineering track focuses on everything from building more efficient networks to making computer hardware smaller and faster. Creating more efficient software is also a goal.

As computing needs expand, the improved use of resources is critical to allow private industry and academia to get the most out of their hardware and software. Computer engineers are in demand in many sectors, and developers of the embedded systems, computer architectures, computer network technology, power and energy usage for large-scale computing systems, robotics, and more are needed to meet the goals of users.

SICE already has a well-respected reputation in computing through some of its research centers, and students will have the opportunity work alongside Ph.D. students and world-renowned faculty to build a smarter and more mobile world.

**Cyber-physical Systems**

Students interested in cyber-physical systems track learn to combine physical components of computing with computer algorithms to create a seamless experience for users.

Most students and the general public are already familiar with cyber-physical systems, although they may not know it. Everything from using a GPS system for navigation to connecting to a Bluetooth speaker requires a cyber-physical system, but the field goes far beyond that. CPS is part of the Internet of Things, which allows sensors and smart devices to interact with our world while also providing the means for data to be collected and acted upon.

Cyber-physical systems form the basis for the development of self-driving cars, improved communication systems, more advanced touch screens, robotic and autonomous farming, and more. Cyber-physical systems are embedded in our daily lives, and students will gain knowledge and experience while positioning themselves on the cutting edge of innovation.

**Environmental Engineering**

SICE’s environmental engineering track brings together biology, chemistry, engineering, and technology to find solutions to some of the biggest environmental issues facing our world.
Studying the impact of global climate change is a focus, as is everything from using drones to measure concentrations levels of CO2 to finding more efficient methods of recycling to predicting environmental outcomes. Environmental engineers find themselves on the frontlines of studying the impact of pollutants on public health and the environment, and students use an interdisciplinary approach to combine technology and life sciences to improve outcomes for future generations.

Environmental engineers also find themselves in one of the most in-demand fields, and they can fill a variety of occupations that provide an opportunity to work both in an office setting or in the field studying the environmental conditions of wetlands, construction sites, forests, urban environments, and everything in between.

Molecular and Nanoscale Engineering

SICE’s molecular and nanoscale engineering track integrates concepts from materials engineering with nanoscience to prepare students to work with cyber-physical systems or other responsive intelligent systems that include nanoscale building blocks. The study of molecular and nanoscale engineering provides the foundation for the development of “smart” materials that can probe biological processes, improve food science, create new modes of energy production, and more.

It also teaches students how to translate advances in physics, chemistry, biology, and the computational sciences into functional tools. For instance, molecular and nanoscale engineering can create the methods and materials to fight disease at the molecular level, which can improve healthcare and create better and healthier outcomes for patients.

Both molecular and nanoscale engineers are in high demand, and they are needed in an array of industries. Research opportunities abound at SICE, and master’s students will earn the experience of working in a group setting on
projects that are designed to mirror a real-life work environment.

Neuroengineering

Neuroengineering is another track offered to M.S. in ISE students. This exciting field allows students to pursue the cutting-edge field of using technology to study living neural tissue and create technology to measure, repair, or replicate the functions of the brain.

For instance, neuroengineers could create micro-scale devices that can connect neurological functions to technology to allow sensors to detect impending seizures, or they can create systems to better understand the underlying foundations of memory creation and retention. Students will also learn the concepts that could lead to the physical repair of the brain or the development of replacement parts for the nervous system, which could lead to advances for patients suffering from neurological disorders or paralysis.

Flexible Degree Path

Students in SICE’s master’s in ISE program have the flexibility to create their path to a degree by following a selection of four paradigms on how they want to learn. They can focus on coursework, incorporate internships into their learning, focus on a project, and/or follow a research path that can build experience.

“There are a lot of options as part of the master’s degree,” says Paul Macklin, an associate professor whose focus is on understanding and modeling the behavior of cancer cells. “There are coursework options and thesis options for students. We involve students in research at the school all the way from a student’s freshman year, and our master’s students will certainly have the opportunity to benefit from the robust slate of research that is being conducted at SICE. It’s really up to the student to choose the path that best suits them.”

The program requires 30 credit hours and can usually be completed in two years. Students in the program come from all over the world, and some classes use streaming and online elements that provide some flexibility in classes.

“What’s special about our ISE master’s program is that it consists of such a wide range of specializations that allow students to mold their own path,” says Minje Kim, an assistant professor of ISE and one of the key advisors of the program curriculum. “Everyone isn’t taking the same classes to arrive at one goal. There is some freedom to where you want to go. You can become a certain level of expert in different fields, and you can make a real impact on the research that is being conducted in those fields.”

State-of-the-art Labs

The various labs at SICE also afford students the opportunity to work with state-of-the-art technologies that will prepare them for their careers to come. Luddy Hall, SICE’s new $39.8 million home, features five labs dedicated to intelligent systems engineering, and the nearby Multidisciplinary Engineering and Sciences Hall is undergoing renovations to include more lab space for the program.

“Our research facilities at SICE are huge assets, and there are a wide range of them,” Kim says. “Students have access to a variety of resources as part of our courses, and it allows them to learn some hands-on engineering methods, techniques, and concepts. Our learning isn’t just in the classroom or as part of a book. Our curriculum allows students to learn by doing, which is one of the core concepts of the program. For instance, our students have access to some of our supercomputing capabilities, and they love the opportunity to use cutting-edge technology to work on research or even their homework. And our facilities are continuing to improve and expand. It’s a program that is really building for the future.”

Fishing for Toxins

Maria Bondesson, an associate professor of ISE, studies the environmental impact of toxic chemicals and compounds using zebrafish. Bondesson and her student use genetically altered specimens to study how the chemicals and compounds impact the development of embryonic zebrafish, allowing researchers to gain insight into how such substances interact with the environment.

“If you want to study things in the traditional sense using mice or rats, it’s going to take ages and cost enormous amounts of money,” Bondesson says. “That’s why there is a backlog in chemical testing. It’s too expensive and too low-throughput. We’re creating alternative screenings, such as fish or fruit flies or C. elegans, which is a small nematode, which allow us to build models to speed up testing. By creating a high-throughput study that is cheaper and faster, we can arrive at results that could alert people to dangers that might exist in some chemicals and compounds.”

Bondesson says master’s students in the bioengineering track will have the opportunity to play a role in critical research while gaining experience that will make a student more attractive to a potential employer or provide the foundation for future academic study.

“Master’s students can take part in one of the sub-projects we’re working on,” Bondesson says. “I have a Ph.D. student who came up with the idea of studying e-cigarette liquids in our fish to see what perturbations we see during their development. That is a small sub-project, but it’s an important one, and they can take part in such a study. They also could work on image analysis projects. It depends on if the student is more into bioengineering or computation. There are a lot of options.”
Many undergraduates may not consider a career as an Engineering Project Manager as they prepare to graduate since many are focused on finding a more traditional role within their chosen field of engineering. However, many, if not most, engineers end up working on projects of some type, whether they are relatively simple efficiency improvements, multiple-year, large-scale construction projects, or high-technology complex cell phone products. The author Hans Thamhain (2014) quotes Jeff Bezos, founder and CEO of Amazon.com saying "What gets us up in the morning and keeps us here late at night is technology, advanced technology is everything." Thamhain goes on to add "However, the vehicle for transforming this technology into marketable products and services is project management" (p. 19). Hence, longer term the challenges and rewards of engineering project management lure some engineers away from more traditional engineering positions. Yet, many undergraduate engineering degree programs don’t prepare their undergraduate engineering students to be project managers. Yes, they may get some ad hoc project management experience working on their school’s Formula race car team or concrete canoe team, but rarely do they receive any formal project management training.

Yet, many graduates find that as soon as they start their well-earned job with their first full-time employer they quickly get involved in projects. While their undergraduate education prepares them well to handle the technical aspects of their new position, they often find that they don’t fully understand why some projects seem to go well, while many others seem to founder, if not outright fail. Many organizations don’t provide any formal training to their young engineers on how to manage projects successfully. They are left to try to interpret their experiences, and their interactions with the more senior engineers that they work with, to discover what makes a project a success or a failure.

Results from a study by the Project Management Institute (2016) identified that $122 million was wasted for every $1 billion invested due to poor project performance in 2016 (p. 5). In this report, Bill Seliger, PMP, Director, Supply Chain and Project Management for a Fortune 500 manufacturing company stated: “Without a doubt, good project management drives more success, lowers the risk, and increases the chance of success for delivering the economic value of the project” (p. 8). The study also showed that organizations that invest in project management training see a significant improvement in project success (p. 11).

The PMI Talent Triangle™ identifies three areas of expertise that are required for effective project management: technical project management, leadership, and technical project management, leadership, and technical project management, leadership, and technical project management, leadership, and
strategic and business management. The PMI study stated that when organizations focus on all three areas 40 percent more projects meet original goals and busi-
ness intent. In addition, improvements in managing budget, time, scope creep, and projects deemed failures are also realized (Project Management Institute, 2016, p. 10). Engineers can learn some of the technical project management skills by working with experienced senior en-
ineers, but they are much less likely to learn solid leadership and strategic and business management skills. Unless the senior engineer has received formal proj-
ect management training, they are also less likely to learn about all of the project management tools that their projects could potentially benefit from.

During the early portion of my career, I managed many small projects, from short, one-month projects to improve the quality of a part that we were purchasing from a supplier to many month projects to introduce new test fixtures to reduce testing time on our assembly line. I sure would have benefitted from project man-
agement training. Unfortunately, I was never offered any training and project management training wasn’t nearly as readily available back then as it is today. While many of the projects that I worked on were successful, they certainly could have been done more efficiently and others might have been more successful if I had known about the tools and tech-
niques available by using a formal project management process. In particular, my projects would have benefitted from a more formal communication plan, better stakeholder identification and manage-
ment, and some thought about risks, risk management, and risk mitigation. I have found that many organizations don’t have any formal process to address project risks, yet the unidentified risks on a project are often the cause of failure on a project.

Think about the projects that you have done as part of your undergraduate pro-
gram. Did you formally address the risks associated with your project? Were you successful in finishing each of your proj-
ects on time, on budget (at least in terms of how much you had to put into them), and at the quality level that you, and your professor, were satisfied with? If not, then you might want to seriously think about taking some formal training in the field of project management. The skills and knowledge that you gain will help you bridge the fields of engineering, technol-
gy, people, and business to successfully deliver projects for your new organization.

So where can engineers receive formal project management training? First, as an undergraduate student watch for an opportunity to take an introductory project management course as part of your degree program. Some schools may even offer an intersession course in project management. Once you start your new job ask about whether or not your new organization offers any project management training. If they do, sign up for what is offered as soon as possi-
ble, as the earlier that you receive formal training the sooner your career and your organization will benefit from it.

If your new organization doesn’t offer any formal training, then you will have to look for other sources. Local colleges and universities may offer training in project management, either as a grad-
uate degree program, a certificate pro-
gram, or through continuing education offerings. A number of high—quality online project management degree and certificate programs are also available through colleges and universities. Check out whether or not your new employer offers any tuition assistance and what courses/programs they will reimburse for. Many companies will only provide tuition reimbursement for an approved degree program, but others will pay for certificate programs or individual cours-
es as well. There are also many other sources of project management training available, but I would recommend that you do some research before signing up for one to make sure that you are enroll-
ing in a high-quality program. It would be wise to look for a program with qual-
ified instructors, particularly those with lots of experience in applying project management principles to real-world projects. You should also look for a pro-
gram that offers flexibility in the format and availability of courses, one that uti-
izes well-respected instructional mate-
rials, and one that offers the opportunity to interact with other students and the instructors. This last point is important, even though the quality of the instructor and instructional materials is important; in a high-quality program you will also learn a considerable amount from your interaction with the other students as they share their experiences and appli-
cations of the principles that are studied. Also, check out your local chapter of the Project Management Institute, as most local chapters offer various profes-
sional development opportunities and they also offer many opportunities to network with other project managers.

Congratulations on your upcoming graduation, it is well deserved given the hard work that you have undertaken to earn it. Good luck in your new organiza-
tion as you embark on this exciting new chapter in your life. I will leave you with best wishes for many project successes throughout your career.

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THE TOP 18 GREAT ENGINEERING ACHIEVEMENTS OF THE 20TH CENTURY

1. Electrification
2. Automobiles
3. Airplanes
4. Water Supply and Distribution
5. Electronics
6. Radio & Television
7. Agricultural Mechanization
8. Computers
9. Telephone
THE TOP 18 GREATEST ENGINEERING ACHIEVEMENTS OF THE 20TH CENTURY

10. Air Conditioning and Refrigeration
11. Highways & Bridges
12. Spacecraft
13. Internet
14. Household Appliances
15. Health Technologies
16. Petroleum & Petrochemical Technologies
17. Laser & Fiber Optics
18. Nuclear Technologies

THE 20TH CENTURY
SC Viterbi Professor of Industrial and Systems Engineering James E. Moore, II has served as a Department Chair, Vice Dean, and as President of the Institute of Industrial and Systems Engineers (IISE), the field’s lead professional society. He agreed to answer a few questions from New Engineer about the field of industrial and systems engineering, and the opportunities it presents for students.

What is the field of industrial and systems engineering about? What kinds of problems do industrial engineers solve, and for whom?

The Institute of Industrial and Systems Engineers defines the field as “the design, improvement and installation of integrated systems of people, material, information, equipment and energy. It draws upon specialized knowledge and skills in the mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.” This is the long answer.

The short answer is that industrial and systems engineering is a blend of engineering and management science.

Other engineering disciplines are known for the products they design. Industrial and systems engineers are known for the systems they design and improve. These system improvements tend to increase quality, reduce costs or both.

Can you provide some examples of the problems and the sort of work in which industrial and systems engineering graduates become involved?

The field is versatile with respect to the nature of work done and the industries in which it is done. Industrial and systems engineers are in demand in almost every sector of the economy, but most strongly in sectors involving large-scale integrated systems, including logistics and distribution, hospitals and health。“NO ENGINEERING FIELD CAN CLAIM AN INTELLECTUAL MONOPOLY ON SYSTEMS OR SYSTEMS THINKING...”
care, enterprise resource planning, aviation, aerospace, energy and resource extraction, manufacturing, the military, and other systems-oriented activities. There are also excellent opportunities for industrial and systems engineers in consulting and engineering services, information technology, research and development, and nonprofits. The sort of job activities in which industrial and systems engineers might be involved include risk assessment, process validation, project engineering and execution, systems integration, instrumentation, quality and reliability, facilities layout and design, or any aspect of process improvement.

Are industrial engineering and systems engineering different, and if so how?

No engineering field can claim an intellectual monopoly on systems or systems thinking, and the “industrial and systems engineering” label does not imply one. Most engineering activities pertain in some way to the creation, improvement, better understanding of or use of a system—some set of elements that operate collectively to produce specialized outcomes. Systems engineering, in the broadest sense, focuses on enabling the successful functioning of a system, and in this sense any engineering project in any discipline might qualify as an exercise in systems engineering. There is in the Department of Defense arena a fairly narrowly defined version of systems engineering that focuses on a development cycle for systems acquisition, including software systems. It is more meaningful to think of systems engineering as an interdisciplinary, integrative activity, most often team-based, that defines the process for bringing a successful system to realization.

Industrial and systems engineers are as interested in the system itself and its functions as in the nature of the process that brings it about. Industrial engineers and systems engineers both rely on a systems point of view that emphasizes understanding and managing trade-offs associated with system design, but a purely systems engineering approach is more likely to be driven by functionality requirements, with top-level functions taken as given requirements and the resources necessary to produce a validated system capable of executing these functions treated as an internal result. Industrial engineering approaches are more likely to treat resources as given constraints, because they are scarce; and system performance as an internal function of design; and focus on maximizing performance. Both approaches involve a refined capacity for systems thinking. Industrial and systems engineering is a powerful blend of these complimentary approaches.

When was the field of Industrial and Systems Engineering founded?

The first academic department of industrial engineering in the United States is Penn State’s Marcus Department of Industrial and Manufacturing Engineering, which was established in 1908. This was a pioneering step. The Institute of Industrial and Systems Engineers was not established until 1948. There were no doctorates granted in the field until Purdue University granted the first two in 1949.
You said industrial and systems engineering is a blend of engineer-
ing and management science. Isn’t management science part of
business administration?

Management is an important business function, but management ex-
tends beyond business. All scarce resources are subject to management
by the decision makers in charge of them, environmental quality, public
health, infrastructure, information, intellectual property, capital (financial,
human, social), inventories, supply chains, distribution networks, physical
plant facilities, productive capacity... The list is endless.

What are the differences, then, between an industrial and systems
engineering degree and a degree in business administration?

There are some schools where industrial and systems engineering is ac-
tually embedded in a business school, but this is not ideal. The difference
between these degrees is mostly one of methodological depth versus
breadth, and of focus. An undergraduate degree in industrial and systems
engineering is methodologically deeper and narrower than the curricu-
num for an undergraduate business degree. An ISE degree is an engineer-
ing degree with all of the basic science, math and engineering science
content typical of any undergraduate engineering degree. The two years
of calculus that undergraduate engineering students complete are lever-
aged rather heavily in the more advanced courses in industrial engineering
programs, which typically place a strong emphasis on statistical thinking,
systems modeling and reliability, simulation and optimization. The math
sequences for industrial and systems engineering and computer science
students often include an elevated emphasis on discrete mathematics,
because both fields include a focus on algorithms.

An undergraduate business curriculum is less invested in the use
of mathematics to structure approaches to important problems, and
includes coursework relating to business functions that an ISE program
typically would not, such as marketing. While industrial and systems
engineering programs tend to be narrower and deeper than business
programs, they also tend to be broader than most other engineering
programs, typically including coursework in areas such as economics,
industrial psychology and organizational behavior.

Industrial and Systems Engineering is at its core a set of engineer-
ing methods applied in the context provided by of a systems view of
process design, improvement, and control; and this perspective takes
the field in directions that a business program typically would not go.
For example, human factors engineering, cognitive engineering, hu-
man/computer interfaces, ergonomics, product design and manufac-
turing are all problem areas within industrial and systems engineering
that typically would not be represented in business curricula at either
the graduate or undergraduate level.

Is the industrial and systems engineering major popular?

It is relatively popular. The American Society for Engineering Education
reports that, nationally, the field produced just under 5,700 bachelor’s
degree graduates in 2016, a total just a little lower than biomedical
engineering, and about 50% higher than aerospace engineering, the
next largest discipline. Many of these graduates transferred into the
field only after starting college.
Why do you think so many undergraduates gravitate toward ISE?

The ISE cohort at most schools grows as undergraduates gain academic experience and refine their judgements. Engineering is defined by very strong undergraduate programs. I think engineering education is the best undergraduate education that universities offer. Engineering programs are defined by the various department faculties. These scholars are deep experts in their respective fields, and the programs they create are excellent options for any qualified student. However, there is no reason to expect that every new undergraduate who starts engineering as a freshman will really know enough about the array of options available to him or her to have made the best choice of major on the first try, regardless of how conscientious, intelligent, or motivated he or she is.

College is about growth and developing an understanding of the world and oneself, and this is naturally going to lead most students to examine and possibly reconsider their academic paths at some point. Because industrial and systems engineering is the broadest of the undergraduate engineering majors, every student who explicitly considers the trade-off between breadth and depth and concludes that a better education favors breadth is going at least consider making a transition into industrial and systems engineering.

Some adjustments are inevitable, and so the field of industrial and systems engineering is made up mostly of intellectual immigrants. This demonstrated capacity to recognize when an adjustment is needed and what it should be helps make industrial and systems engineering graduates consummate economic competitors.

Is the field attractive at the graduate level?

Industrial and systems engineering is particularly attractive at the graduate level. There are really two relevant graduate degree categories, industrial and systems engineering, including operations research and manufacturing degrees; and engineering management degrees. Engineering management stands alone as a graduate option at a few institutions, but most often the degree is mounted by an industrial and systems engineering department, typically as a terminal professional degree. If you combine the number of masters degrees awarded nationally in these two areas, the total is just slightly below the total number of master’s degrees awarded in mechanical engineering, and 25% than the total number of masters degrees awarded in civil and environmental engineering combined.

Students pursuing graduate degrees in industrial and systems engineering or engineering management very frequently have undergraduate backgrounds in technical areas other than ISE. This is useful, because it keeps the discipline intellectually vibrant and interdisciplinary as graduate students drawn from outside the field infuse industrial and systems engineering methods into new kinds of problems.

This situation also persists in part because engineering management degrees are a very compelling alternative to the MBA degree for engineers who want to pursue management responsibilities in a technical arena. Graduate degrees in engineering management typically are only half as long as an MBA program.

Do you have any closing thoughts?

There is only one person in the audience when a student chooses an academic major, him- or herself. A student has absolutely no one else to answer to in this choice, no one else to be accountable to, because it is the student who will live his or her life. Recognizing the need to make an adjustment if and when the need emerges is not evidence that prior decisions were in any way inferior. A capacity to adjust is part of the capacity to succeed.

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The World’s Strangest Laws

In Vermont, women must obtain written permission from their husbands to wear false teeth.

In Alabama, it is illegal for a driver to be blindfolded while driving a vehicle.

In San Salvador, drunk drivers can be punished by death before a firing squad.

In Florida, unmarried women who parachute on Sundays can be jailed.

In Kentucky, it is illegal to carry a concealed weapon more than six-feet long.

In Boulder, Colorado, it is illegal to kill a bird within the city limits and also to “own” a pet – the town’s citizens, legally speaking, are merely “pet minders”.

Under the UK’s Tax Avoidance Schemes Regulations 2006, it is illegal not to tell the taxman anything you don’t want him to know, though you don’t have to tell him anything you don’t mind him knowing.

It is an act of treason to place a postage stamp bearing the British monarch upside down.

In the UK, a man who feels compelled to urinate in public can do so only if he aims for his rear wheel and keeps his right hand on his vehicle.

Did you know it’s illegal in France to name a pig Napoleon?

Or that in Ohio you’re not allowed to get a fish drunk?
WE ENGINEER TOMORROW

INTELLIGENT SYSTEMS ENGINEERING
Our bachelor’s, master’s, and Ph.D. programs are redefining engineering.
sice.indiana.edu

SCHOOL OF INFORMATICS, COMPUTING, AND ENGINEERING
In the past several years, the term STEM has skyrocketed to the top of our everyday vernacular, thanks in large part to social media. But, what is STEM, exactly?

The term STEM refers to the cornerstones of our world and how it works – via Science, Technology, Engineering & Math. The term was coined by Dr. Judith Ramaley back when she was Assistant Director of the Education and Human Resources Directorate at the National Science Foundation between 2001 and 2004. (Fun fact: formerly, the term was referred to as SMET, an acronym with much less curb appeal.) In her words, “...science and math serve as bookends for technology and engineering. Science and math are critical to a basic understanding of the universe, while engineering and technology are means for people to interact with the universe.”

STEAM, on the other hand, incorporates the “A” for Art into the STEM equation. Dr. Ramaley gave a perfect example of how STEM and art are co-dependent and already highly intertwined in today’s world, citing how Apple and its visionary founder, Steve Jobs, “created devices that are compelling because they are both useful and beautiful,” garnering the arts as a necessary component to STEM.

However, as with any new change in ideas or concepts, there are some that feel that the arts don’t have a place in STEM and others who are strong proponents to the inclusion of the arts. Let’s take a look at both sides:

**STEM**

With the world rapidly advancing and technology being at the core of changing industry, STEM will become an integral part of jobs in the near future. However, current graduates are lacking these skills. There is no question that students will need more in-depth knowledge of math and science along with the benefits that STEM affords to take on these changing industry jobs. Skills like critical thinking, creativity and innovation, problem solving and collaboration will not only be more in demand, but required.

According to edweek.org, “STEM is a specific program designed for a specific purpose – to integrate and apply knowledge of math and science in order to create technologies and solutions for real world problems, using an engineering design approach. It’s no surprise that STEM pro-
grams need to maintain an intense focus.” Based on this logic, that math and science skills are rigorously learned through engineering, STEM advocates feel that adding art to the mix will distract from the main purpose of a STEM curriculum. How can one focus on other subjects, especially something so right-brained as the arts, without losing the mission of STEM or “watering down its primary purpose”?

It’s no secret that when it comes to STEM, the U.S. is not on par with the rest of the highly developed world. According to pewresearch.org, PISA (Programme for International Student Assessment) test scores for 2015 (the latest available as of this publish date), show that the U.S. ranks 24th in the world in science and a whopping 39th in mathematics. Many STEM advocates view this as unacceptable and have a strict take on staying the course, solely in these disciplines, and keeping the arts separate.

STEM proponents also believe that there is really no need to specifically call out arts as part of the acronym because art is organically imbedded into STEM and used as called upon for meeting engineering challenges. For example, language arts are needed for communication, history and social studies are the foundation for setting the context for engineering challenges and art is an inherent part of design. These, advocates say, are already inherently part of the STEAM DNA.

STEAM Proponents of STEAM, on the other hand, believe it is necessary to call out the important role arts play in STEM, not only to perhaps entice those more right-brained, creatively skewed students, but also, to tone down the intimidation that
STEM currently impresses upon those students. Also, some believe not giving the arts their due in the role they play in STEM’s foundation, is also devaluing it in the overall scheme of things.

Let’s not forget the reason there are massive STEM initiatives put in place by education organizations and companies in the U.S.; the reality is that as a superpower country, the United States ranks very low in STEM-based studies and graduation rates. In fact, a 2017 article in Forbes ranks the U.S. third after China and India as the countries with the most STEM graduates. You may say, “Third place is pretty good, right?” Let’s take a look at the numbers: compared to China (4.7 million graduates) and India (2.6 million), the U.S. clocks an underwhelming 568,000 graduates. Clearly, more needs to be done to entice kids into STEM and put the U.S. at the forefront of these industries. And one of the ways to do this, some believe, is by including the arts in a way to boost interest in kids.

As mentioned earlier, it is important to reiterate that currently, the basis for STEM, inherently already incorporates the arts. Therefore, STEAM isn’t an attempt to teach the arts to STEM students per se but rather, how to utilize the arts and apply the knowledge to processes, that in turn, leads to deeper, more critical thinking.

Here are some ways that the arts can impact STEM:

**Performing Arts** – Components like drama and speech play a quiet yet large role in the communications aspect of engineering. You may have a great idea but how do you communicate it persuasively if you don’t have the skills to translate it, write it and present it effectively?

**Creative Thinking** – When faced with finding a solution to an engineering problem, it’s important to think “outside the box”. This is where innovation thrives. Approaching a challenge more creatively allows for a more inventive, artistic result.

**Design** – Whether design is applied graphically or digitally via computers or traditionally via pen and paper, students can use this technique to create stylized function and appearance and improve product usability.

**Physical Art** – No, we aren’t talking paintings and sketches but rather, creating something from nothing, for example, using 3D printers. They can be used to create models of ingenious industrial prototypes to life-saving components. A mainstream example of the latter was when a 3D printer was used on an episode of “Grey’s Anatomy” whereby the staff printed a portal vein and a replica of a patient’s heart, liver and attached tumor in an effort to pre-visualize the surgical strategy and determine post-treatment.

More so, what you may not be aware of yet is that STEAM has indeed picked up “steam” and pushing evolvement into STREAM. In fact, the National Science Foundation (NSF) and the National Endowment for the Arts (NEA) are pushing to add “R” to the acronym for Reading and “wRiting” as they believe these thinking skills are also important. For example, the proponents of STREAM note that the average science course will require a student to learn the same number of new vocabulary words that would be learned by taking a foreign language class! The “R” component aids in mastering STEM as a well-rounded entity.

Let’s look at how all of these components as a whole (STREAM) can be interconnected by noting an example conceptualized by Amy Pietrowski in an article for edtechmagazine.com. She calls this, “demonstrating how to start the process of uniting different subject matter into on STREAM-powered unit”. Pietrowski, a K-8 educator with a Masters in Educational Technology from Michigan State University, uses the hypothetical guidelines for 3D shapes, angles and the Earth’s weather systems to visualize “castles and cities” as follows:

Science can be used to represent landforms as 3D shapes, demonstrating the effects of weathering; Technology, as one option, can be used to program and explore the
angles and shapes: Reading comes into play in by looking into non-fiction resources on weathering and weather systems for perspective; Engineering can help determine the shape and location of large buildings by looking at how different land features can affect location and how they can present the results before and after weathering; Art can help students envision and produce the castle aesthetic and design a city around it; and finally, Mathematics is key for measuring out the 3D shapes and angles.

No matter if you’re an art proponent or not, the need for STEM study among young kids and college students is undeniable and the push is getting stronger by the day, even being reflected to the masses via mainstream advertising, as it was done recently by Verizon. A new spot shows young kids responding to “What do you want to be when you grow up?” with answers like “pro basketball players” and “an actor or a model”. Then it features prominent athletes like basketball star LeBron James and supermodel Adriana Lima saying, “The world doesn’t need more LeBrons” and “The world doesn’t need more Adrianas” as stats appear on screen about the thousands of pro athletes and models already out there.

Then a tagline reads: “But there are over 4 million available science and tech jobs in the United States.” The powerful ad is part of the wireless giant’s new #weneedmore campaign, promoting an initiative on their part to donate $160 million in free tech, free access and hands-on immersive learning in STEM for students in need through their Verizon Innovative Learning Initiative that impacts 300,000 students, 7,400 teachers and 1,900 schools and clubs.

I am venturing to guess that campaigns and initiatives like this are only the beginning – that other companies and educational institutes will follow suit and promote and subsidize interest in STEM/STEAM/STREAM related fields for kids. So, the question shouldn’t be, “Do the arts have any business in STEM?” but rather, “Why wouldn’t STEM benefit from the inclusion of arts to make for more equipped, 21st century job candidates?” A well-rounded education, like STEAM offers, is what’s most important at the end of the day. Because kids are the future...and our future depends on them.

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