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PRIYADARSHINI ENGINEERING COLLEGE

VANIYAMBADI

Mechxion

2K17

CONTENT

EDITORIAL BOARD COMMITTEE

A Magzine of

MECHANICAL ENGINEERING

ABOUT THE INSTITUTE

Priyadarshini Engineering College, the flagship of Jai Barath Charitable Trust, was established in 1995 at Vaniyambadi in Vellore district of Tamilnadu. The college has been approved by All India Council for Technical Education, New Delhi and affiliated to Anna University, Chennai. Priyadarshini Engineering College situated in the rural area of Vaniyambadi, Vellore District is committed to the vision of developing itself into a multi campus, Inter - disciplinary Institution of Excellence through symbiotic efforts and innovative practices of management and faculty to provide the student with an ambient academic environment, ideal for the pursuit of knowledge and development carrier.

VISION OF THE INSTITUTE

To inculcate in the young rural minds the aptitude to compete with the world class technocrats.

MISSION OF THE INSTITUTE

1. To instill technical skills to compete in the sustainable world.
2. To impart holistic value based technical education.
3. To intensify research and development (R&D) activities in technological development.
4. To imbibe core values of love for motherland, performance of duty, compassion, tolerance, honesty and integrity.

MOTTO

PERSEVERANCE, ENDURANCE, COMMITMENT

"கற்றலும், கற்றவை கேட்டலும், கேட்டதன்கண் நிற்றலும்"

ADMINISTRATOR'S MESSAGE

I am happy to know that PEC is bringing out its Department magazine every year. I went through the articles and poems published in this magazine. They amply demonstrate the communication skills, poetic prowess, imagination, creativity, humanism, technical competence, andpatriotism of the contributors. I congratulate the faculty and the students of Mechanical Engineering Department of our College to release their Department magazine "MECHXION 2K17". I wish the initiative, and I hope it will contribute to their professional and career development

PRINCIPAL'S MESSAGE

I am very happy that the department of Mechanical Engineering is releasing their Department magazine —MECHXION 2K17 which encompasses the Activities of the department, Technical &General articles of the faculty and students for the academic year 2016-17.

To get better placements in core industries, it is not sufficient to learn fundamentals only. They have to know recent developments in all the fields of Mechanical Engineering. Now a day's Internet is paving the ways for acquiring knowledge in the latest developments in almost all the fields of engineering, technology, arts and sciences. Magazines in general will help the faculty and students to learn the latest developments in the fields Mechanical Engineering I owe my hearty appreciations to the HOD, faculty and students of the department for their sincere efforts to release the magazine to highlight the technical advancements in the branch of Mechanical Engineering. I wish them —The Very Best in all their future endeavors.

VICE PRINCIPAL'S MESSAGE

I am happy to note that Mechanical Engineering department has taken the initiative to prepare a Department magazine "MECHXION 2K17" to highlight the activities of the Department and to bring out the talents of students.It is acquisition of knowledge and skills, building character and improving employability of our young talent, the future leadership.Department magazine enables us to know the hidden talents among the student brought out thought their articles. The magazine also gives a glimpse of the college to the public at large who is one of the stakeholders of the college.

HOD'S MESSAGE

Greeting to the readers of this magazine "MECHXION 2K17". I am happy to inform that our pride rests in the department Magazine "MECHXION 2K17" which highlights the academic and non-academic activities of both staff and students of the department. This year all thestudents of Mechanical shown their magic in every event, every sports, technical event they won prizes. For final year students, I hope we will be a good engineer outside this institution also, loyal to work, pray for hardship to solve every problem of this society also beginners will read this magazine and may get inspired and try to improve departmental activities, form a bond of love with devotion to their education and study place with senior students. In this race for regular students it's a challenge to do better and better than before and achieve new heights.

EDITORIAL BOARD'S MESSAGE

Dear Readers,

Greetings from the editorial board to the readers of this Magazine"MECHXION 2K17".A thought that has been enduring in mind when it becomes real. It is truly an interesting and exciting experience. This Magazine was one such cherished work that had its roots in the persuasion. It would be a snapshot of the various activities and advancements for all associated with mechanical Engineering. It will serve to reinforce and allow increased awareness, improved interaction and integration among all of us. Usually we fail to appreciate the good deeds of many people and activities that happen around us as we are engaged in irrelevant talks and assumptions. We would like to place on record our gratitude and heartfelt thanks to all those who have contributed to make this effort in a successful one. We profusely thank our honorable justice Mr.V.Rengasamy and Principal Dr.P.Natarajan for giving support and encouragement and a free hand in this endeavor This Magazine will be a medium to provide proper acknowledgement and respect all of theseefforts and its results.

ABOUT THE DEPARTMENT

The Department of Mechanical Engineering came into being in the year 1999 and the first batch of Mechanical Engineers graduated in the year 2003.The Department was first started with the intake strength of 40 seats in 1999. After, the intake was increased to 60 seats in 2004.At present the Department offers 120 seats from 2014. The Department has both undergraduate and postgraduate courses in Mechanical Engineering and Design.In the year 2013 Post Graduate Programme in Engineering Design was launched. The Department has laboratory and workshop facilities with modern sophisticated equipment to carry out research in all areas related to Mechanical Engineering. Throughout its history, the department has provided a strong technical foundation to prepare students to meet the changing needs of industry.

VISION OF THE DEPARTMENT

To produce competent Mechanical Engineers specifically from rural based population to confront the latest technological innovations.

MISSION OF THE DEPARTMENT

1. Imparting quality education and training to nurture competitive Mechanical Engineers.
2. Motivating innovations in the various fields of Mechanical Engineering with better infrastructure facilities to meet the industrial and societal requirements.
3. Inculcating ethical values in their careers for their successful life.

PROGRAMME EDUCATIONAL OBJECTIVES(PEOs):

PEO1. Core Competence:

Graduates will Excel in their Professional Career with Strong Fundamental Technical Background.

PEO2. Breadth:

Graduates will be able to demonstrate their Technical Skills in Designing, Fabrication and Installation of New Mechanical Components.

PEO3. Professionalism:

Graduates will be Competent to Exhibit their Multidisciplinary Skills in Related Fields of Mechanical Engineering.

PEO4. Teaching & Research:

Graduates will Pursue Higher Studies in Mechanical Related Disciplines to work in the field of Teaching and Research.

PROGRAMME OUTCOMES(POs):

PO1: Engineering Knowledge:

Apply the knowledge of mathematics, science, engineering fundamentals and core engineering for complex engineering problems.

PO2: Problem Analysis:

Identify, formulate and analyze complex engineering problems.

PO3: Design & Development of Solutions:

Design and develop solutions for complex engineering problems.

PO4: Investigations of complex problems:

Use research based knowledge to conduct investigations of complex problems.

PO5: Modern Tool Usage:

Apply appropriate modern tools and techniques to tackle Mechanical Engineering problems.

PO6: Engineer and Society:

Provide solutions to Mechanical Engineering problems relevant to societal needs.

PO7: Environment and Sustainability:

Acquire contemporary knowledge to sustain in the ever changing environment.

PO8: Ethics:

Apply professional ethics.

PO9: Individual and Team work:

Exhibit individual and leadership qualities in multidisciplinary group.

PO10: Communication:

Comprehend and communicate effectively in a team.

PO11: Lifelong Learning:

Engage independently in lifelong learning.

PO12: Project Management and Finance:

Plan and manage a project in a cost effective manner.

A FAMOUS INSPIRATIONAL SPEAKER SAID

HARIHARAN.K-THIRD YEAR

"Best years of my life were spent in the arms of a woman, who wasn't my wife. "Audience was in shock and silence. He added: "She was my mother." (A biground of applause and laughter).

A very daring husband tried to crack this at home. After dinner, he said loudly to his wife in the kitchen: "Best years of my life were spent in the arms of a woman, who wasn't my wife".

Standing for a moment, trying to recall the second line of that speake.By the time he gained his senses, he was on a hospital bed, recovering from burnsof boiling water.

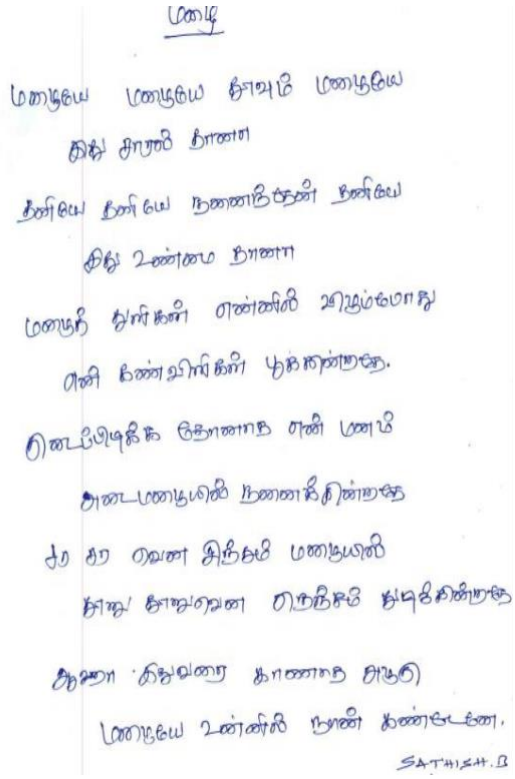
Moral: Don't Copy, if you can't Paste

LAW OF SUCCESS

ASHOK.Y-THIRD YEAR

Thereis no moredangerous person Dangerous to himself and to others than Theperson who passes judgment Pretendingto knowfacts. To lovepraise, but not worship it, and fearCondemnation butnot go down under it is evidenceofawellbalanced personality. Theperson who sowsasinglebeautiful thought in the mind of another,renders theworld a greater service than thatrendered byallthe faultfinderscombined. Thereisnolazyman.Whatmayappearto bealazyman is onlyan unfortunateperson who has not found the work forwhichheis best suited.

Congratulateyourself whenyoureach that degreeof wisdomwhichpromptsyoutoseelessofthew eaknessofothers andmoreofyour own,foryou willthen be walkinginto the futureofreallygreat.



A SHORT COURSE IN HUMAN RELATIONS

RAMKUMAR.D.S-THIRD

The six most important words: I admit that

I was wrong.

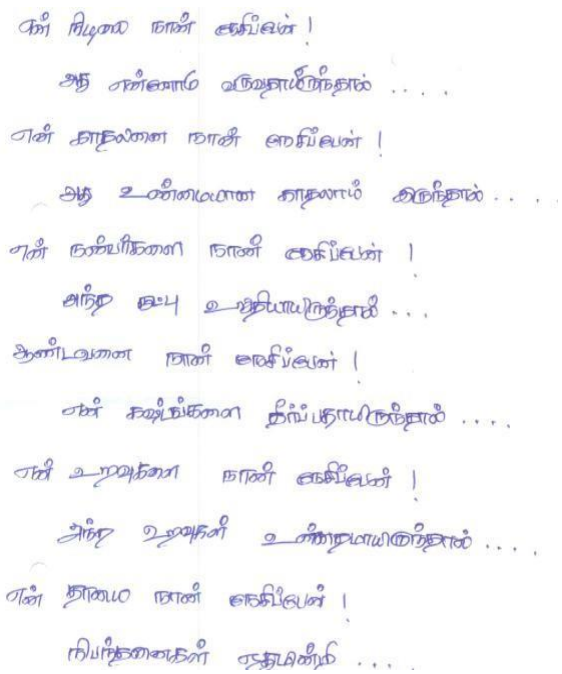
The five most important words: You did a great job.

The four most important words: What do you think?

The three most important words: Could you please. . .

The two most important words: Thank you.

The most important word:
We. The least important
word: I.



PRABHAKARAN .S-THIRD YEAR

HOW TO DEVELOP LIFELONG FRIENDSHIPS WHILE IN COLLEGE

PRABHAKARAN .M -THIRD YEAR

Developing lifelongfriendships may be one of the mostrewarding aspectsof college life.This article hasafew suggestions howto develop these types of friendships.

FriendshipStatistics

Between theages of 15 and 25 iswhenmostpeople establishlifelong friendships.Singlestendtorely onfriends for companionship. Bestfriendsusually becomeanextended family. Since many students who are in college may not have family or friendsfrom high school nearby,they'relookingforother peopleto study with and hang out. College friends are somewhat different than friends from high school because you bondindifferentways.Youmay bond during late night study sessions, making dinnertogether,orduringlong drives home. In a way, they're somewhatlikeyourfamily awayfrom home. Some friends may make sure that you wake up in time for your midterm or make you soup when you're sick. Duringcollege thereare a variety ofwaystodevelopthese friendships,whichhavethe potentialof becominglifelong friendships

Living with Roommates

Sometimesmany studentsmake lifelong friendships with their roommates. If you have a good experience with your roommate during your first year of college, you may want to continue living with that roommate. You mayalso decide to live withother peopleaswell. Sharinga house or anapartmentallowsyoutospendtime withpeopleandreallyget toknowwho theyare.Youmay learnthingsthatonly their familiesknowabout them like how long they take in the shower or whatkinds of odd things theyliketo eat. Living togetheralsoprovidesopportunities foralot of inside jokes, which can create evenstronger bonds. You mayalso becomecloserwhen oneofyou becomes sick,and theparental instinct kicks in.

Joining a Club

By joiningaclub,youmaybeable tofindpeoplewhoshare similarinterests. Usuallycollegecampuses offer avariety of

clubs like those that are associated withacademic majors,public interests, politics, music, or careers. Thereare also fraternities and sororities at different colleges. Clubsprovide an opportunity tomeetpeopleoutsideofthe classroom,and theopportunity for you to get involved with something that you're passionate about. Being involved inextracurricularactivitiesmay also alleviatesomeofyour stress.

Making Friends for Life

Developing lifelong friendships does takesome time. Don't be discouragedifthefirstcoupleofpeople youmeetdon'tturn outtobe the type of friends you were hoping for. You may need to keep on trying to meet new people. You may make friends with people whoyou wouldn't

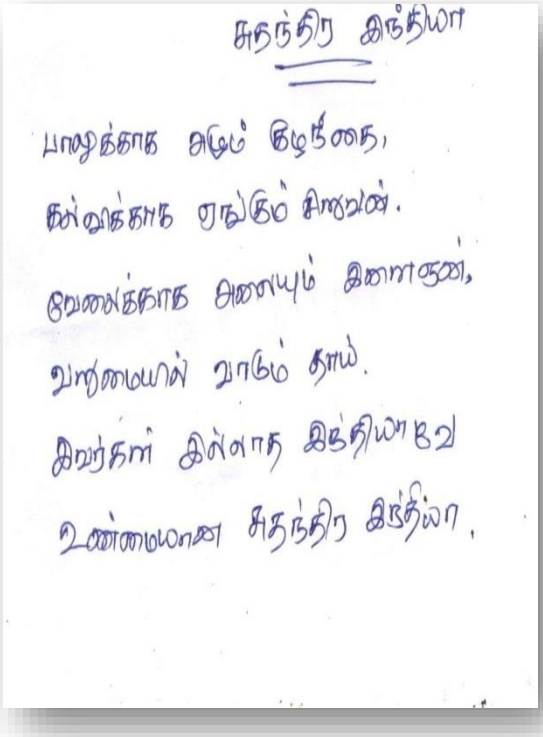
have consideredbeing friends with before. If you feel uneasy about the friendsyou havemade,try toremember whatyoulikedaboutyourfriends from high school. Keep yourself surrounded by good people who share similar goals to helpyou stayon track.

RAHUL.A-SECOND YEAR

JOKE:

VIOTH.A-SECOND YEAR

Teacher:u call ur MOTHER as MUM then what will u call ur mother's elder sister and younger sister?
BOY:Simple Iwill call elder as "MAXIMUM" and younger as"MINIMUM".



JOTHILINGAM.R-FINAL YEAR

HARD WORK

Hard work is like thesteps, Luck is like thelift

Lift mayfailat times

But steps will never fail, Getyou to thetop

RAJESH.K-THIRD YEAR

OPPORTUNITY

Thereis theactive Vigilancewhich seeks an Opportunityto progress, Seeks to utilize

Everycircumstanceto advancemorequickly.

PRADEESH.M-FINAL YEAR

OUR COLLEGE

It is our Priyadarshini engineeringcollege ,Whereweget precious knowledge ,It has become in ourlifeapart.

That wecan neverforget it through we depart ,ThePEC students arethebest.

Theycan overcome anytypeof tests. Though theyplaysomeplans

Theyalwaysget ranks.Thelecturers areso fine Theyalways makeus shine.

People like them areveryrare Henceanicerelationshipweshare. Lecturers with their explaining Students alert with understanding. Wewillleavethis collegetomorrow

With ourhearts heavyand full of sorrow. The collegelifeto meisatreasure .Fornever wewillfind such apleasure

FACTS ABOUT INDIA

SUDHAGAR.S–FINAL YEAR

1.First Mining of Diamond was DoneinIndia

2. Ben Kingsley was bornin Indian descent

3. Adolph HitlerWas BigFanofMajorDhyanchand

4.Shakuntla Devi The HumanCalculator

5. Sugar was FirstConsumed inIndia

6. Largest ProducerofMilk in World

7. Most Vegetarian Friendly Country in World

8.Second Largest English Speaking country in the world

9. First Indian Rocket was Transported on Cycle

10.Switzerland's Science Day is Dedicated to APJ Abd...

11.Water On Moon was Discovered by Chandrayaan

12.Concept of Shampoo was Invented in India

13.Earth Circumference=Wires Used in BandraWorli Sea Link

14.IndiaHave aFloatingPostOffice

15.Snakes and Ladders is an Indian Invention

16.Bangladesh National Anthem is Written by Rabindranath Tagore.

AYAZ AHMED-THIRD YEAR

EXAMINATION

SAKTHI.C-SECOND YEAR

Nearing is our examination Must study
with concentration English with its
pronunciation Signals with its
classification Maths with its
transformation
Electronic circuits with its derivation
Electrical engineering with its operation
Digital electronics with its simplification
OOP with its virtual function
Thereby increases our stress and tension
And there is no time for relaxation
Don't abuse it!

AFTER GRADUATION IN ENGINEERING:

LOGANATHA.V–AP/MECH

HIGHER STUDIES

Aftergraduations the nextstep is getting amaster's degree like M.tech, MBAorM.S. andafterthatifone isstill enthusiastic,thenthey cangoforaPh.D. Let's discuss each option onebyone.

1. Masters in Technology (M.Tech)

There are two ways possible. Either go for an Indian university like IITs, IIScor go to foreign university. In USA the equivalent degree is M.S, which will be discussed in a separate tab.For M.Tech one needs to appear for GATE.

Graduate Aptitude Test in Engineering (GATE)

It is jointly conducted by IISC and seven IIT and is considered to be a benchmark test for engineering graduates. Each year one IIT take the responsibility of conducting the exam on rotation basis. The scores are only for application to graduate programs in engineering disciplines in India. Any candidate who has cleared her bachelors or masters or is in the final year of her respective course is eligible for GATE. Some PSUs like BARC, NPIL and HAL give preference to GATE scores, so apart from being a ticket to higher education, it is also helpful in landing up at that dream job.

Basic Features of GATE :

Examinations forall the 22 papers will be conducted by an ONLINE Computer Based Test (CBT). The online examination paper willcontain some questions for whichnumerical answers must be keyed in by the candidate using the virtual keypad. Rest of the questions shall be of Multiple Choice Question (MCQ) type.

2. Master of Science (MS)

USA has been a preferred destination for Indian engineers for the past several years and Indians continuously form the largest chunk of foreign students in USA. To get admission in a foreign university for MS, one needs to appear for Graduate Record

Graduate Record Examination (GRE)

It is an admission requirement for many graduate schools in USA and in other English-speaking countries. It is a computer-based test measuring verbal reasoning, quantitative reasoning, critical thinking, and analytical writing skills that have been acquired over a long period of time and that are not related to any specific field of study. Unlike GATE, there is no cut-off line for GRE and the admission score varies from one university to other. After appearing for GRE, one needs to apply to the universities of his choice. As applying to each university is very costly affair, hence selection of universities is an equally important activity. The selection should be based on realistic assessment of One's abilities and GRE score. For scholarships many universities also consider the research work that a candidate has undertaken previously. Combining this with the GRE core, they give an admission offer to a candidate.

3. Master of Business Administration (MBA)

Again like M.Tech one has many options. In fact the options are much more here, owing to the presence of a large number of good private colleges. First we will discuss about the options available in India. For admission to Indian institutes there are many exams like CAT, MAT, XAT, apart from separate exams conducted by some universities like FMS.

Common Admission Test (CAT)

It is conducted by IIMs on an all-India basis and is basically used for admission to IIMs. There are other colleges as well, which use CAT score for granting admissions. Post 2009, the pattern has moved from offline to online mode and has seen a change in pattern as well. With the increase in number of IIM and increase in number of seats in each IIM, it has become an attractive option. What works against it is the exorbitant fees being charged by the IIMs.

Management aptitude test (MAT)

It is the smaller, less popular and less efficient brother of CAT. Its score is applicable to basically every other college that is not covered under CAT.

XAT, FMS

Some other colleges like XLRI Jamshedpur, XLRI Bhubaneswar and FMS New Delhi conduct their own admission test and a student need to appear in these exams to be eligible for these institutes.

Graduate Management Admission Test (GMAT)

It is a computer-adaptive standardized test in mathematics and the English language for measuring aptitude to succeed academically in graduate business studies. Business schools commonly use the test as one of many selection criteria for admission into graduate business administration programs (e.g. MBA, Master of Accountancy, etc.) Principally in the United States, but also in other English-speaking countries. Similar to GRE, based upon preference, score and capability, one needs to apply to institutes.

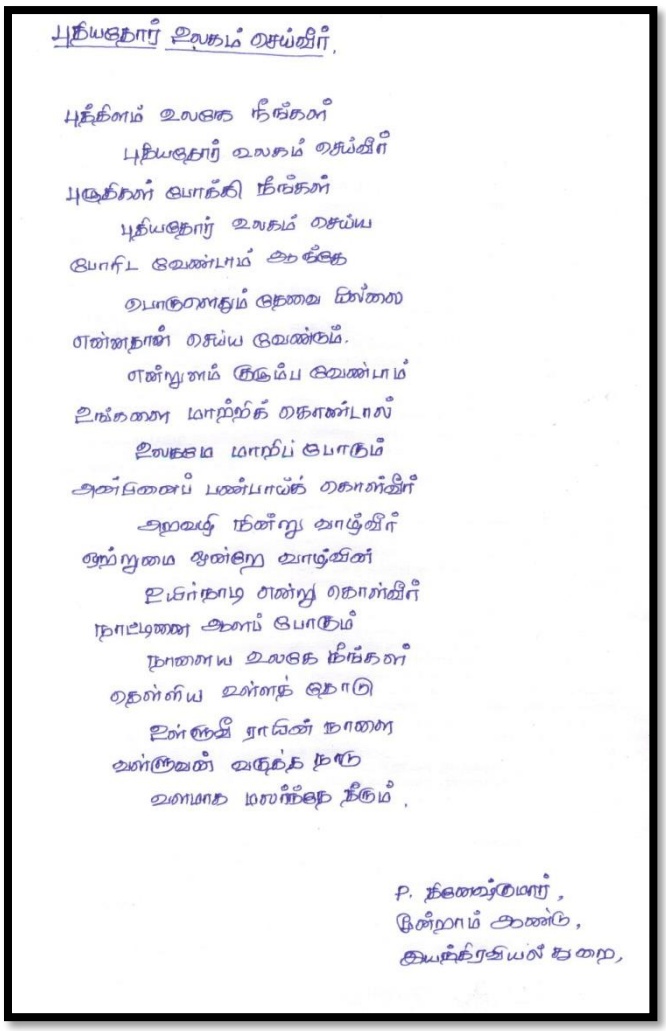
Most good universities give a lot of weight to work experience (unlike Indian institutes). Thus a similar score can land you in different university based upon your work experience. A GMAT score is valid for five years, so you can take the exam during your student days (when your mind is really sharp) and then apply for schools after three years (with proper work experience). To select a B-school one can have a look at the last year average and median score, which is published by most of the schools.

Test of English as a Foreign Language (TOEFL)

It evaluates the ability of an individual to use and understand English in an academic setting. It sometimes is an admission requirement for non-native English speakers at many English-speaking colleges and universities. So it is an advantage if you have taken TOEFL along with GRE/GMAT. Sometimes some universities demand this score if you are a foreign student (as in the case of Indian student). The test consists of reading, listening, speaking and writing section. The minimum score may vary from one school to other, with Harvard and MIT demanding a score of 100. Unlike other exams it can be taken any number of times, to improve upon the previous score and the score is valid for two years. Colleges consider the most recent TOEFL score as a parameter.

International English Language Testing System (IELTS)

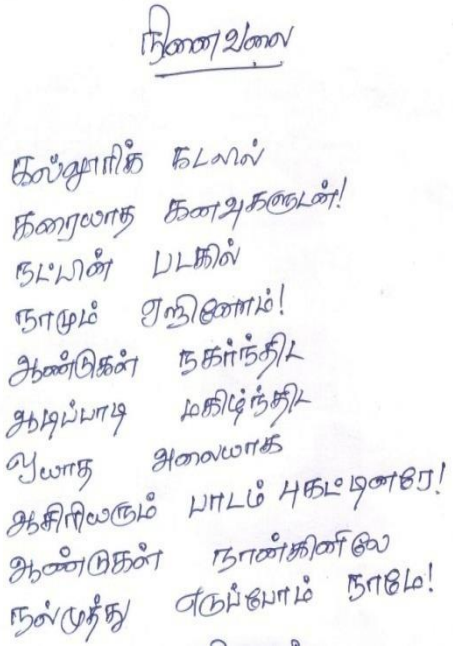
It is an international standardized test of English language proficiency. It is jointly managed by University of Cambridge ESOL Examinations, the British Council and IDP Education PtyLtd, and was established in 1989. For applying to any British university IELTS score is generally a precondition. The structure is similar to TOEFL and both the scores can be used interchangeably. Again similar to TOEFL the requirements for each university vary with Oxford demanding a score of 7.0 and Essex University demanding a score of 5.5. The score is valid for two years. For information into IELTS and application procedure, one can directly walk into any British Council.



புதியதோர் உலகம் செய்வீர்,

புதிகளம் உலகை நீங்கள்
புதியதோர் உலகம் செய்வீர்
புதுதிசைகள் யாக்கி நீங்கள்
புதியதோர் உலகம் செய்ய
போரிட வேண்டாம் ஆங்கே
பொதுமைதும் தேவை இன்னை
என்னதான் செய்ய வேண்டும்.
என்றுனம் சோம்ப வேண்டாம்
உங்களை மாற்றிக் கொண்டால்
உலகமே மாறிப் போகும்
அன்பினைப் பண்பாய்க் கொள்வீர்
அறவழி நின்று வாழ்வீர்
ஒற்றுமை ஒன்றே வாழ்வின்
உயர்நாடி என்று கொள்வீர்
நாட்டினை ஆளும் போதும்
நானைய உலகை நீங்கள்
தென்னிய உள்ளத் தோடு
உள்ளுவீ ராயின் நாளை
வள்ளுவன் வகுக்க நாடு
வளமாக மலர்ந்தே நீளும்.

P. தினேஷ்குமார்,
மூன்றாம் ஆண்டு,
இயந்திரவியல் துறை,



நினைவலை

கல்லூரிக் கடலில்
கரையாத கனவுகளுடன்!
நட்பின் படகில்
நாமும் ஏறினோம்!
ஆண்டுகள் நகர்ந்திட
அடிப்பாடி மகிழ்ந்திட
ஓயாத அலையாக
அகிரியரும் பாடம் புகட்டினரே!
ஆண்டுகள் நான்கினிலே
நல்முத்து எடுப்போம் நாமே!

SHALMAN.S -THIRD YEAR

TECHNICAL ARTICLES

TOP 6 ROBOTIC APPLICATIONS IN MEDICINE

According to a recent report by Credence Research, the global medical robotics market was valued at $7.24 billion in 2015 and is expected to grow to $20 billion by 2023. A key driver for this growth is demand for using robots in minimally invasive surgeries, especially for neurologic, orthopedic, and laparoscopic procedures.As a result, a wide range of robots is being developed to serve in a variety of roles within the medical environment. Robots specializing in human treatment include surgical robots and rehabilitation robots. The field of assistive and therapeutic robotic devices is also expanding rapidly. These include robots that help patients rehabilitate from serious conditions like strokes, empathic robots that assist in the care of older or physically/mentally challenged individuals, and industrial robots that take on a variety of routine tasks, such as sterilizing roomsand delivering medical supplies and equipment, including medications.

1.Telepresence :Physicians use robots to help them examine and treat patients in rural or remote locations, giving them a "telepresence" in the room. "Specialists can be on call, via the robot, to answer questions and guide therapy from remote locations," writes Dr**.** Bernadette Keefe, a Chapel Hill, NC-basedhealthcare and medicine consultant. **"**The key features of these robotic devices include navigation capability within the ER, and sophisticated cameras for the physical examination."

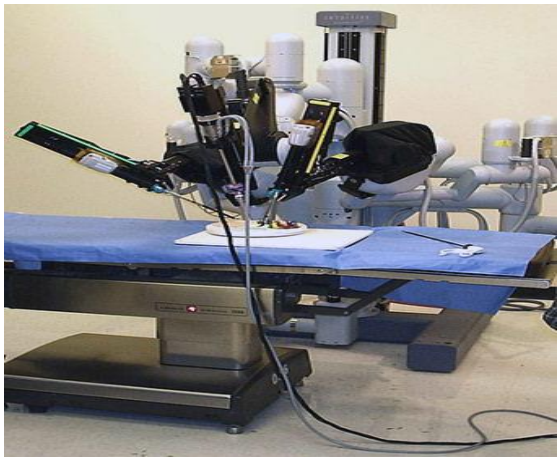


Fig 1:Telepresence

2.Surgical Assistants:These remote-controlled robots assist surgeons with performing operations, typically minimally invasive procedures. "The ability to manipulate a highly sophisticated robotic arm by operating controls, seated at a workstation out of the operating room, is the hallmark of surgical robots," says Keefe. Additional applications for these surgical-assistant robots are continually being developed, as more advanced 3DHD technology gives surgeons the spatial references needed for highly complex surgery, including more enhanced natural

stereo visualization, combined with augmented reality.

3. Rehabilitation Robots:These play a crucial role in the recovery of people with disabilities, including improved mobility, strength, coordination, and quality of life. These robots can be programmed to adapt to the condition of each patient as they recover from strokes, traumatic brain or spinal cord injuries, or neurobehavioral or neuromuscular diseases such as multiple sclerosis. Virtual reality integrated with rehabilitation robots can also improve balance, walking, and other motor functions.

4.Medical Transportation Robots: Supplies, medications, and meals are delivered to patients and staff by these robots, thereby optimizing communication between doctors, hospital staff members, and patients. "Most of these machines have highly dedicated capabilities for self-navigation throughout the facility," states ManojSahi, a research analyst with Tractica, a market intelligence firm that specializes in technology. "There is, however, a need for highly advanced and cost-effective indoor navigation systems based on sensor fusion location technology in order to make the navigational capabilities of transportation robots more robust."

Fig 2 :Medical Transportation Robots

Upper limb rehabilitation. Image: Center for Applied Biomechanics and Rehabilitation Research, National Rehabilitation Hospital, Washington DC

5.Sanitation and Disinfection Robots:With the increase in antibiotic-resistant bacteria and outbreaks of deadly infections like Ebola, more healthcare facilities are using robots to clean and disinfect surfaces. "Currently, the primary methods used for disinfection are UV light and hydrogen peroxide vapors," says Sahi. "These robots can disinfect a room of any bacteria and viruses within minutes."

6.Robotic Prescription Dispensing Systems: The biggest advantages of robots are speed and accuracy, two features that are very important to pharmacies. "Automated dispensing systems have

advanced to the point where robots can now handle powder, liquids, and highly viscous materials, with much higher speed and accuracy than before," says Sahi.

Future Models

Advanced robots continue to be designed for an ever-expanding range of applications in the healthcare space. For example, a research team led by Gregory Fischer, an associate professor of mechanical engineering and robotics engineering at Worcester Polytechnic Institute, is developing a compact, high-precision surgical robot that will operate within the bore of an MRI scanner, as well as the electronic control systems and software that go with it, to improve prostate biopsy accuracy.

To develop robots that can work inside an MRI scanner, Fischer and his team have had to overcome several significant technical challenges. Since the MRI scanner uses a powerful magnet, the robot, including all of its sensors and actuators, must be made from nonferrous materials. "On top of all this, we had to develop the communications protocols and software interfaces for controlling the robot, and interface those with higher-level imaging and planning systems," says Fischer. "The robot must be easy for a non-technical surgical team to sterilize, set up, and place in the scanner. This all added up to a massive systems integration project which required many iterations of the hardware and software to get to that point."

In other research, virtual reality is being integrated with rehabilitation robots to expand the range of therapy exercise, increasing motivation and physical treatment effects. Exciting discoveries are being made with nanoparticles and nanomaterials. For example, nanoparticles can traverse the "blood-brain barrier." In the future, nanodevices can be loaded with "treatment payloads" of medicine that can be injected into the body and automatically guided to the precise target sites within the body. Soon, ingestible, broadband-enabled digital tools will be available that use wireless technology to help monitor internal reactions to medications."Existing technologies are being combined in new ways to streamline the efficiency of healthcare operations," says Keefe. "While at the same time, emerging robotic technologies are being harnessed to enable intriguing breakthroughs in medical care."

ENERGY GRID WITH A MIND OF ITS OWN

The United States' energy grid needs immediate attention and the federal government's Quadrennial Energy Review can help if carried out correctly, says Alan Snook, president of Grid20/20, which makes sensors and software to monitor the grid.In 2015, the Obama Administration released the first part of its Quadrennial Energy Review (QER) and also allocated $72 million in U.S. Department of Agriculture loans for smart grid and solar projects in rural areas.

Fig 3 :Wind Energy Production

"The grid has obvious problems that need support on the federal level," says Snook. "We'll deal with it now or later. The cost is higher and risks are greater if done later. Kicking the can is a bad idea."TheQER focuses on modernizing the grid, expanding energy storage, and promoting interoperability with grid technology. The report looks at transmission, storage, and distribution infrastructure that the administration defines as: "The networks of pipelines, wires, storage, waterways, railroads, and other facilities that form the backbone of our energy system."

The report also addresses concerns over how to integrate renewable energy onto the grid, the administration said.When fully realized, the smart grid will perform as an automated energy-delivery network that monitors all the players in the network, from power plants to customers to individual appliances. By monitoring all aspects of the network, the grid will deliver real-time information and enable the near-instantaneous balance of supply and demand down to the device level, according to the according to the U.S. Department of Energy.

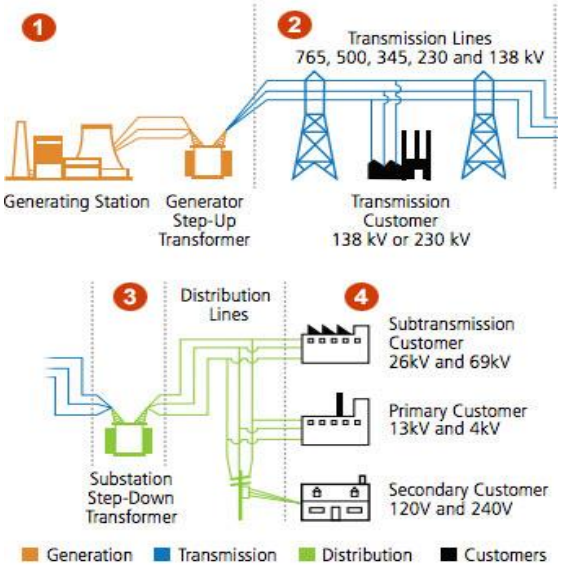


Fig 4:Quadrennial Energy Review

The grid will include smart meters placed on homes that track energy usage and immediately return that information to utilities, and will also include many other component technologies including phasor measurement systems. These systems sample voltage and current many times a second at a particular location to provide a deep-dive look at the power system in real time.

Once completed, the grid will let utilities base energy prices on their delivery costs and offer a range of options, including for peak use. Data collected can also be used to program machine learning algorithms that will incorporate energy users' desires (based on past use) into the grid.Households may save money by having use automatically scaled back when peak demand is high, for example, according to the DOE. For that household, control mechanisms that run dishwashers and laundry systems and that raise air conditioner settings would go into effect during times of peak demand, for example.

Utilities save by better understanding demands to balance resources and avoid running power plants specifically built to handle peak capacity.All this calls upon the Internet of Things (IoT) model, which uses sensors and software to monitor a system in real time and continually report back about findings. In essence, the smart grid could be said to be part of the IoT.While the DOE says the smart grid is still several years away from realization, many utilities are installing smart meters for their customers and otherwise taking steps to bring real-rime systems monitoring to their energy networks.

The USDA loans are intended to help rural utilities participate in smart-grid readiness projects, according to the report, and Snook says those utilities could use the federal funds. Their customers are also hard hit by storm-related power outages, headds.Weather-related power outages between 2003 and 2012 cost the U.S. economy $18 billion to $33 billion, Snook says, quoting the 2013 presidential report titled "Economic Benefits of Increasing Electric Grid Resilience to Weather Outages."

"The grid is subject to windstorms, snow damage, pole damage, and trees hitting lines. That's stuff happening every day in the distribution space," he says. "That's the most dynamic and volatile space on the grid. That's where the problems are that need to be addressed first."The QER comes right down the center of all this important stuff–the reality of the infrastructure problems and

struggles and challenges, whether storm related or otherwise, and it's driven by federal funding, whether low-cost loans or grants or both," he adds.

QER implementation is a stepping-stone process, Snook adds. It should start with technologies that aid the distribution system already in place.Since full-scale energy grid replacement is fiscally and logistically impractical, utilities should leverage emerging technologies to overlay the existing platform, he says."People can say, 'You're obviously very biased,' because I work in that area, but it's that area of the power grid that has the most problems and the biggest area of opportunity and gain," he says. Grid20/20 makes sensors and software to monitor and analyze grid activity such as voltage, current, and temperature changes.

PETAL POWER BOOSTS SOLAR CELL CAPACITY

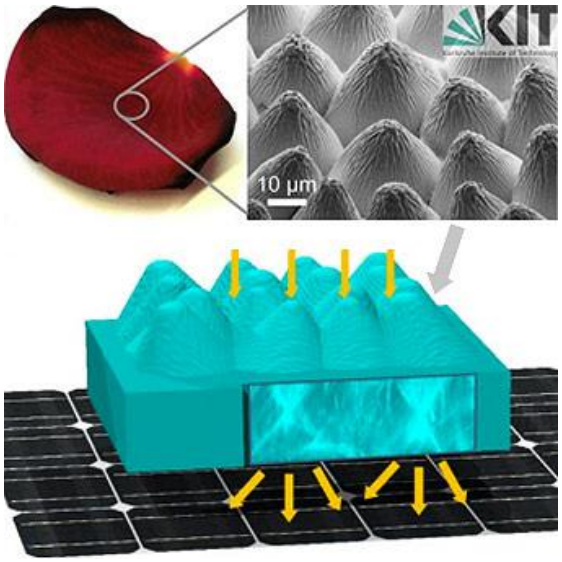
Both photovoltaic and plant photosynthesis absorb light and convert it into a different form of energy. Power conversion efficiency is greatly affected by incomplete absorption of the sunlight. To maximize conversion, it is important to capture as much of the sun's light spectrum as possible, including light from all incidence angles as the angle changes with the sun's position. Plants—which have developed this remarkable capability through a long evolutionary process—can provide clues for how to broaden the absorption spectrum and incidence angle tolerance of future solar cells.

"Nature has evolved complex micro-structured and nano-structured surfaces on the leaves and petals of plants that are very efficient in harvesting incoming photons," says Guillaume Gomard, a photonics researcher at Karlsruhe Institute of Technology's Light Technology Institute in Germany. "As both solar cells and plants should be efficient sunlight collectors operating under various illuminations conditions, that is, under different angles of incidence, we thought solar cells might benefit from the naturally designed structures found on plants."

Fig 5 :Solar cell Grid

To investigate this idea, a research team led by Gomard, including scientists

from the Center for Solar Energy and Hydrogen Research, decided to study the optical and anti-reflection properties of the epidermal cells in different plant species. Their work showed that the epidermal cells of rose petals have especially good anti-reflection properties. When this cell structure was incorporated into an organic solar cell, it increased the cell's power conversion efficiency by 12 percent for vertically incident light.



The epidermis of a rose petal is replicated in a transparent layer which is then integrated into the front of a solar cell. Image: Guillaume Gomard / KIT

Why Rose Petals?

When Gomard and his fellow scientist investigated the optical and antireflection properties of different plant species, they focused especially on the antireflection effect of the epidermal cells. These properties are particularly pronounced in rose petals, where they provide stronger color contrasts and thus increase the chance of pollination. Using the electron microscope, "We discovered the epidermis of rose petals consists of a disorganized arrangement of densely packed microstructures, with additional ribs formed by randomly positioned nanostructures," says Gomard.

To produce a synthetic replica of the structure, the team created a negative mold of the epidermis in a silicon-based polymer called polydimethylsiloxane, and then pressed this negative mold into transparent optical glue that was left to cure under UV light."This easy and cost-effective method creates microstructures of a depth and density that are hardly achievable with artificial techniques," adds Gomard.

The transparent replica of the rose petal epidermis was then integrated into an organic solar cell. This resulted in a power conversion efficiency gain of 12 percent for vertically incident light. At very shallow incidence angles, the efficiency gain was even higher. "This is primarily due to the excellent omnidirectional antireflection properties of the replicated epidermis that is able to reduce surface reflection to a value below five percent,

even for a light incidence angle of nearly 80 degrees," says Gomard. He also notes that each replicated epidermal cell works as a microlens that extends the optical path within the solar cell, enhancing the light-matter-interaction and increasing the probability that the photons will be absorbed.

Flower Power

Gomard's research reveals that light-harvesting micro- and nano-hierarchical structures replicated from the epidermal cells of plants can be exploited for photovoltaicapplications when integrated into state-of-the-art organic solar cells. Their broadband and omnidirectional antireflection properties, combined with their light-trapping capability, result in significant conversion efficiency gains.

Particularly surprising to Gomard was the angular tolerance of the replicated structures. "If we take the example of reflection [integrated over the spectral range of interest, namely between 300–1,300 nm], it is just above five percent for an angle of incidence as high as 80 degrees," he says. "In the same conditions, the reflection of a bare planar glass surface reaches more than 40 percent. Therefore, plant structures have very efficient omnidirectional optical properties and consequently are particularly well-suited to photovoltaic applications."

This research leads to another basic question: What is the role of disorganization in complex photonic structures?"Plant structures are disordered at many levels," Gomard continues. "We are currently using optical simulations to analyze those structures and figure out if disorder has a significant impact on the overall optical properties. We believe this research area has great potential, not only for photovoltaic applications, but also designing anti-glaring films for buildings or self-cleaning surfaces with additional light-collecting properties."

BETTER FUSION REACTORS ON THE HORIZON

The Stanford CHENG Gun, a pulsed electrode plasma source that produces a high-energy, high-density plasma jet in vacuum. Image: Stanford.MarkCappelli, professor of mechanical engineering at Stanford University, is a part of work that will hopefully propel the future of fusion reactors."We are able to create this plasma jet and impinge it on surfaces to study interaction to see how it degrades a surface; creates stresses in surfaces," he says. "All of that is relevant to fusion

machines because when we eventually have to try and engineer these machines you hope the maintenance part of the machine won't be high or it won't pay itself back."

Getting Testy

According to Cappelli, they realized six to seven years ago that the plasma that accelerated (high energy, high velocity) is similar to the plasma jets that form in the peripheral part of a fusion machine."The curious thing about these machines is when you think of them as large spheres and about being close to the wall of the spheres. There's a strong magnetic field and the field prevents the plasma from [being in] the proximity of the other wall, like a barrier," he says.

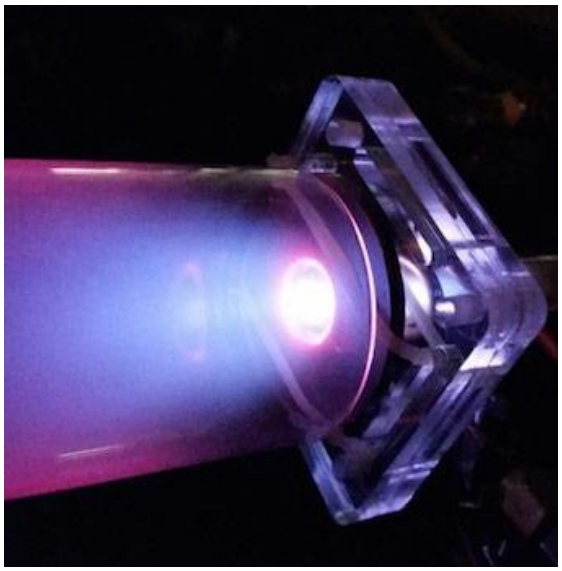


Fig 6 :A 50W helicon discharge for use in microsat propulsion.

"One problem is that the curtain that is the strong magnetic field becomes leaky. Plasmas become unstable and squirt through the magnetic field," says Cappelli. "This plasma rocket we were developing presents the same kind of conditions you see in a fusion machine. We took an interest in how these plasmas accelerate and what happens when these plasmas strike a wall that is designed to protect a plasma vessel," he adds.

Their work started off with something involving space propulsion and ended up moving towards fusion. "With regard to the device that creates the jets, we start out with the means of storing tremendous amounts of electrical energy then take that energy and release it into what some would call a can," he says. "Think of it as an inductor. It creates a magnetic field. This plasma jet squirts it out of this balloon inflated with magnetic energy and into inductance into this balloon storing this magnetic energy. It pops and produces this high velocity and the relatively high temperature jet of plasma. We don't understand the popping part well and that's something we're working on."

The capacitor used is several cubic meters but the device itself is about half of a meter in size and about one-fifth of a

meter in diameter. He compares it to a cannon. The device is essentially a cylinder with a center electrode in the cylinder," he says. "When that magnetic bubble breaks, there are conditions that are comparable to the core of a fusion reactor. We think this can be intriguing but, again, our interest is on the jet that's accelerated, the plasma compressed to very high temperatures."

Cappelli has learned important lessons from the testing thus far. "For my work, what I'm realizing is that just one disruption event, meaning just one firing on our machine, can have a huge effect," he says. "What we find when we look at the surface it strikes and damages are cracks and ablation. You have to ask, 'If I fire this thing a bunch of times what will the surfaces be like?'"Another problem is where the surface ends up. "It has to go somewhere and can go into the reactor. The core of the reactor is bringing in hydrogen and this material which is largely tungsten is very disruptive to the fusion process," he explains. "It's an impurity which is very difficult to mitigate against and wreaks havoc on fusion reaction. I believe the investment has to be made in understanding what causes these events that will eventually degrade the walls to where maintenance on the machine might not be sustainable. Think of us as crash test engineers continuing to try to help improve the first wall, that part of that wall that faces the plasma."

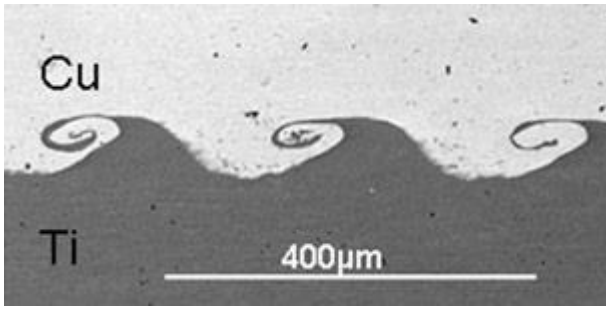
NEW WELDING PROCESS JOINS HIGH-STRENGTH METALS

Connecting the pieces, whether it be for a bridge, boiler or small-scale medical device, is perhaps the most basic part of the manufacturing and construction process, and welding is one of the primary methods to do so. But the advent of lighter, high-strength metals used, for example, in automotive manufacturing has made the welder's job more difficult because high heat and re-solidification can weaken the material along the bond. Now, Ohio State University materials science professor Glenn Daehn and his team believe they've devised a solution that joins the new materials without melting.

Fig 7 :A new VFA welding method.

Their system is called vaporized foil actuator welding (VFA), and works using a high-voltage capacitor bank to produce a very short electrical pulse within a thin piece of aluminum foil. The foil vaporizes within microseconds and the resulting hot gas pushes pieces of metal together at very high speed, joining them without melting. The bond is produced by impact so there is not a seam of weakened metal that is the result of melting.Daehn says his lab works on "mostly developing new processes based on 'what does the world need?' Now there is a problem with joining new materials," and he says VFA can help solve the problem, especially in automotive manufacturing.

"One of the biggest potential applications is in auto body construction," he says. "Manufacturers use hot stamped steels with remarkable high strength. There are aluminum alloys is door panels. Joining aluminum to steel and aluminum to aluminum are outstanding problems."



Microscope view of copper (top) welded to titanium (bottom) using VFA technique. Image: Glenn Daehn / The Ohio State University Daehn developed the process in his Impulse Manufacturing Laboratory within Ohio State's Department of Material Sciences and Engineering. VFA tests there have successfully welded aluminum with steel and other metals using collision velocities ranging from 200 meters per second to one kilometer per second."This is not the way commercial welding looks," he says. "But we join at full strength and join a very wide variety of materials. And we use much less energy, ten percent to twenty percent of the energy used in fusion spot welding process."

Daehn believes VFA will offer a better alternative to resistance spot welding, where a high electrical current passes through pieces of metal. The metal's natural electrical resistance creates heat, melts and forms a weld. But the weld loses strength and the process is very energy intensive.Daehn has been working with impulse metal forming for about 20 years. "There's a few different ways of doing things but they all have issues," he says. He began working with VFA seriously about four years ago. "It's kind of been known that if you run a pulse current through wire it will vaporize. But it hasn't been used in manufacturing."

An aluminum foil actuator, polyimide tape is used to electrically insulate the conductor from the VFA assembly. Image: Glenn Daehn / The Ohio State University The process utilizes a thin metal conductor. When electrical current stored in the capacitor bank is released, the conductor is heated above its energy of sublimation before it has time to melt, according to the lab. The metal conductor vaporizes directly into a gas and quickly expands. The pressure pulse from the expanding gas drives the weld, joining the two pieces of metal at the atomic level. Seen under a microscope, the bond is illustrated by curls where the veins of the materials loop and wrap around each other.

Daehn has patents on the technique, but acknowledges even though it holds promise for commercialization, it is not yet mature enough to draw much interest from industry. "It's always difficult to find funding for this kind of work," he says. "The culture within manufacturing companies is very conservative."So far, the work has been largely funded through grants from the Alcoa Foundation, the U.S. Dept. of Energy and the National Science Foundation. It is one of the first projects to receive support from I-Corps@Ohio, a state program based on NSF's I-Corps commercialization program.

Because the work is so new, he also points to the immediate need of establishing standards and certification for the technique. "We're trying to build up much of that infrastructure," Daehn says. "We see a vision that this technique should join other mainstream techniques."Daehn, who has worked with the auto industry for over 20 years, says the quest to make cars lighter and stronger puts pressure on connections. There are other techniques for joining, including fasteners, which the Ford Motor Co. uses in the manufacture of the all-aluminum F-150 truck. "That's not the way they really would like to join," he says. "It is not efficient. You can also use resistance spot welding, but with aluminum it is difficult."

Daehn says his team has demonstrated that the VFA technique is two to three times stronger with aluminum than resistance spot welding, the technique they use to benchmark against. As they further the process, he looks to escalate its potential by developing equipment that can make multiple welds, scaling the tooling to demonstrate its robustness.VFA also can

be fitted to robots for potential work on manufacturing line. “We can use our technique and put it on the end of a robot,” he says. “We can come up with the equipment to make several thousand welds. This holds a lot of promise.”

GEAR UP FOR DRIVERLESS TAXIS

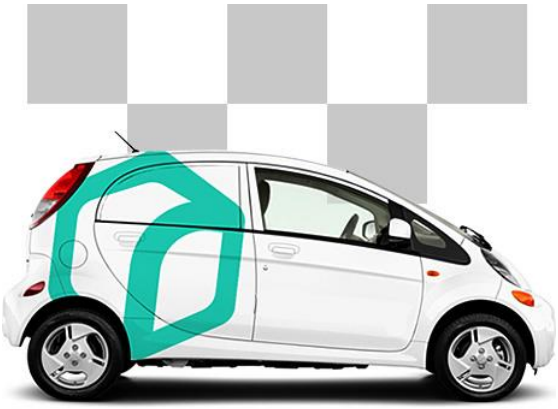


Fig 8 :A self-driving taxi

When the big names most associated with driverless cars (Google, Tesla, Mercedes, and others) discuss timelines for being ready, their projections can stretch out to a decade. Now, a relatively small startup, Cambridge, MA-based nuTonomy, may be offering a commercial taxi service using driverless cars much sooner.A 30-person startup, nuTonomywas founded by two Massachusetts Institute of Technology research scientists/professors, Karl Iagnemma and Emilio Frazzoli. Both had earlier earned their doctorates there, Iagnemma in robotics and Frazzoli in aeronautics and astronautics. The company evolved out of their work over the past decade developing autonomous vehicles for a variety of organizations, such as the Defense Advanced Research Projects Agency, Nissan and others, and lecturing about the benefits of driverless cars.

“Eventually a couple of years ago we looked at each other and realized what we have been developing has far broader application than just MIT research projects,” says Iagnemma, who serves as nuTonomy CEO. “We realized that to make an impact on a global scale we would need to take the technology outside of MIT.” Frazzoli is chief technology officer. They both are on leave from MIT.

Fig 9:The team behind the driverless taxis project.

While most of the major companies are focusing onautomated highway driving, nuTonomy is developing a fleet of

driverless cars for an urban taxi service to be launched first in Singapore and later in other markets. The taxis will be able to be hailed with a smart phone. While Iagnemma declines to cite a specific date, he says, "It will be sooner than people think."The company recently reached several milestones. The car passed its first "driving test" in late March that included navigating a custom obstacle course without incident and was granted official permission in early April to begin driving on public roads. "It was a big day," says Iagnemma. "So we will start doing that probably tomorrow."

Iagnemma believes what sets nuTonomy apart from other driverless car developers is the advanced decision-making techniques they are applying from the aerospace industry. "We take a principled approach to decision making and have a set of methods for encoding both rules of the road and driving preferences. We're not hard-coding our decision-making engine, which can result in systems that are brittle, non-robust and subject to error," he says. "We're also not solely relying on machine learning, which results in a black box system that is difficult to validate. We take a middle ground, where we use a principled algorithmic approach for translating specific rules to the operation of the vehicle. That is unique in automotive to our knowledge."

For example, to meet some of the city-state's objectives, algorithms nuTonomy's engineers designed will indicate the maximum number of cars needed at any given time, taking into consideration a reasonable wait time for the number of individuals seeking a taxi, thus reducing traffic and emissions. Algorithms also allow the cars to break low-priority rules of the road when that can be done safely in order to drive flexibly and efficiently. If there are no oncoming cars, for example, the taxi will know it's not violating an important rule of not hitting another object when it drives around a double-parked car.

According to Frazzoli, "These are situations we encounter every day, and we use our judgment to understand the rules we can violate. We have these same judgments embedded in our algorithms."Even though driving driverless in urban centers is much more complex than cruising on a highway, Iagnemma believes nuTonomy can create the most value by focusing on urban driving and be ready sooner. One reason is that this business model allows better control related to geography. "You can be very choosy about the environment," he

notes. “We can get very good at driving in Singapore without having to worry whether someone might take our car to Kuala Lumpur for the weekend or take it off road in Malaysia somewhere. We don’t have to plan for all the contingencies that are linked to different geographies. We can focus on a single geography and get very good in that area.”

Tonomy expected its second car to arrive in mid-April and will continue to build its fleet in the coming months as well as to continue doing development. “Driving on public roads exposes us to the real complexity of urban driving,”Iagnemma says. “We learn a lot. It helps us improve our software. We continue to test and refine the software, and we continue to seek out more complex driving situations in the city. That process will continue until we feel the software is mature enough to launch.

MANUFACTURING GETS SMART

The industrial hype machine has not worked this hard since the early days of the Internet. The object of its affections is the full-on mashup of manufacturing with modern information technologies. This goes by many names, from Industrie 4.0 and digital manufacturing to cyberphysical systems and smart—no, make that brilliant—factories. What they all have in common is the use of intelligent software and machines to interact with one another (and with people) autonomously, both in the factory and through the cloud. According to boosters, this new combination of brains and muscle will revolutionize manufacturing in ways that rival the introduction of steam, electricity, and automation.

`Beyond the hype, this could lead to some real and startling changes.In the data-driven factory of the future, engineers would receive instantaneous feedback on the cost of design changes and on which parts are most likely to fail in the field, so they can improve designs and change production processes. Factory machines and logistics equipment would communicate with one another autonomously to assign and route jobs through the factory—and reroute them when unexpected problems arise. Cloud-based AI would constantly compare parts and processes to optimize performance.

Perhaps one day, entrepreneurs and engineers may even create entire virtual factories, buying time on underutilized assets the way they buy products from different vendors on Amazon.This vision, like that of the early Internet pioneers, is

compelling—and perhaps even closer than we think.

The Internet blossomed because desktop computers and corporate networks were ready to plug in. Similarly, data-driven manufacturing is emerging now because many critical technologies—from networked machines to the alphabet soup of manufacturing software—PLM, ERP, CAD/CAM, CFD, MES, DMS, PLC and more—are already in place.

Today, these discrete systems collect some of the data, some of the time. Data flows freely within a single software program, and more or less well within software suites from a single vendor. Problems arise when they have to make sense of machines in geographically diverse factories that may use software from multiple vendors. Consider engineering design software. While most computer-aided design programs have proprietary file formats, and readily share information with CAD systems from different vendors. They also export data to simulation software and computer-aided manufacturing systems.

Unfortunately, sharing data is far from seamless. When sharing files between CAD systems from different vendors, engineers must still review drawings to fix missing, misplaced, or disconnected features. Some CAD systems share only some of their data. For example, they might keep the material specifications essential for efficient machining locked away. Nor

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