ASME
SETTING THE STANDARD

ISLAMIC UNIVERSITY
OF TECHNOLOGY
STUDENT SECTION

# STEM CHRONICLES

VOL.1

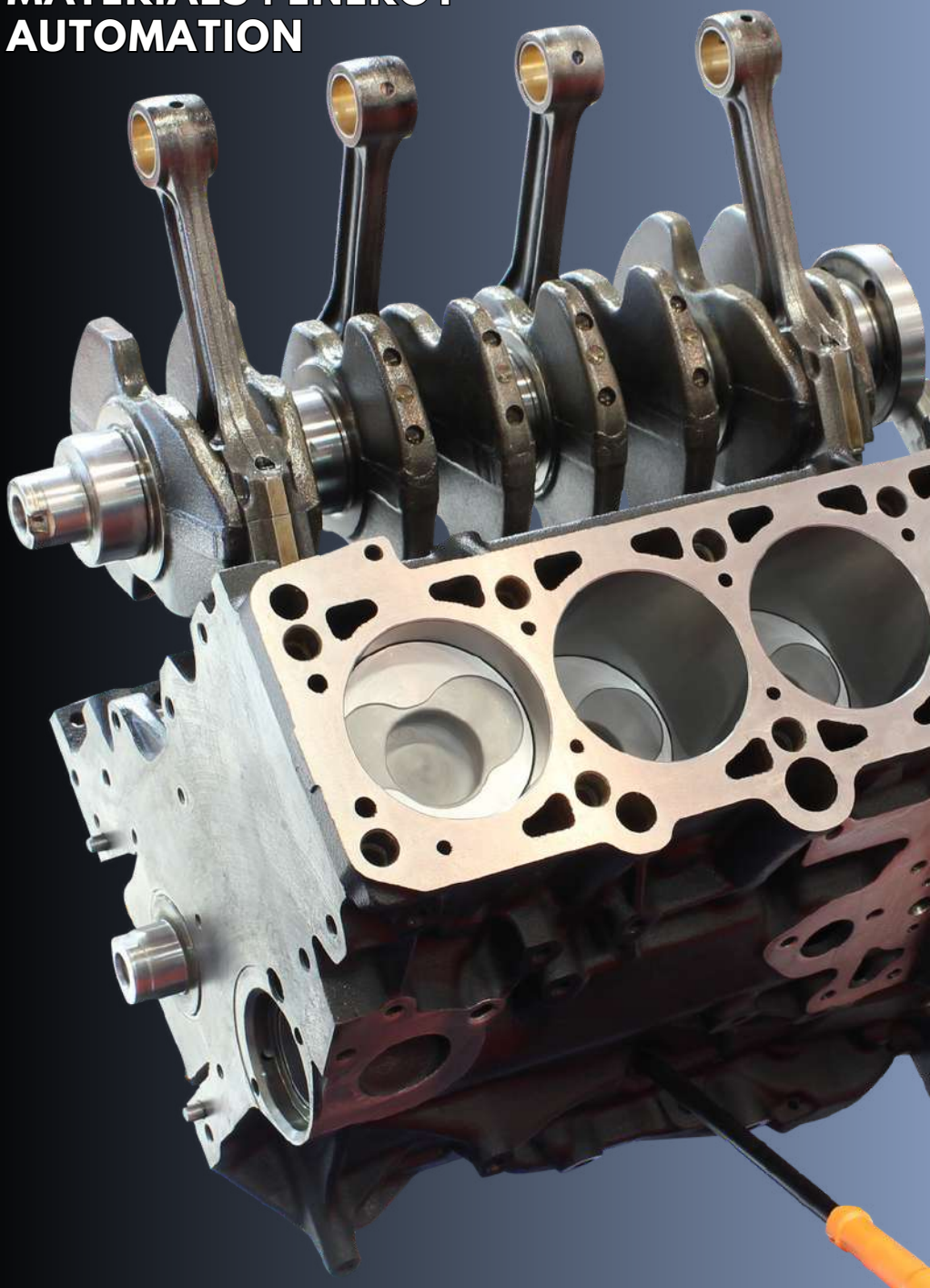
## INTERVIEW

JOURNEY TO HARVARD BUSINESS SCHOOL

BEING A PLASTICS SPECIALIST

## ARTICLES

SPACE I AI
BIOTECHNOLOGY
MATERIALS I ENERGY
AUTOMATION



YEAR 2024

# STEM Chronicles

*STEM Chronicles, an initiative by the ASME IUT Student Section, introduces an E-magazine platform celebrating diverse STEM fields through article contests, interviews, and informative resources. The journeys of established professionals are brought to life to inspire the novices. In a nutshell, it is community where science meets unwavering passion.*

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## *Editor-in-Chief*

Md. Hasibur Rahman Hamim, MPE'19
Chairperson, ASME IUT SS

## *Special Thanks to*

Serniabat Wasit Tawassaf, MPE'19
General Secratary, ASME IUT SS

Syoda Anamika Jahan, MPE'19
Joint Secratary, ASME IUT SS

## *Contributors*

Rawas Saad
Shadman Arif Rohan
Afif Ajjan
Fariha Khan
Safrat Samia
Ahmed Intekhab Rohan
Arfa Wasima Nahin

## *Designers*

Maysha Anan
Maliha Rahman
Tasmiah Zaman
Ramisa Alam
Tasfia Chowdhury
Hasan Abdullah Talha
Mahreen Zaman

*Publisher*
ASME Islamic University of Technology Student Section
Gazipur, Bangladesh
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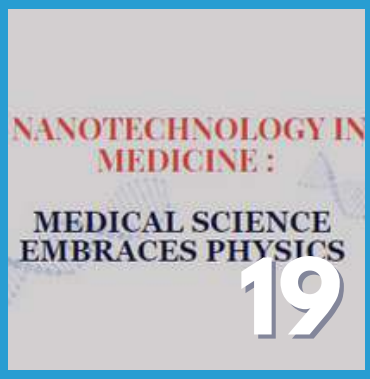
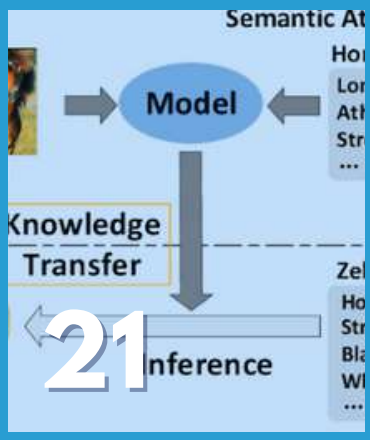
# TABLE OF CONTENTS





## Messages



## Team

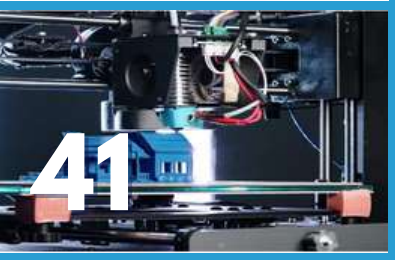


## Interview



## Articles






# TABLE OF CONTENTS



## ASME IUT SS

# FROM THE CLUB MODERATOR


## Dr. Md. Hamidur Rahman

Head of Department, Department of MPE
Islamic University of Technology
Moderator, ASME IUT Student section


**“This initiative marks a significant milestone in our journey as a community of budding engineers.**

Assalamu Alaikum, everyone.

I am Dr. Md. Hamidur Rahman, moderator of ASME IUT STUDENT SECTION. Today, I am brimming with pride and excitement on this momentous occasion – the launch of our, very own e-magazine: STEM Chronicles. This initiative has been truly remarkable and marks a significant milestone in our journey as a dynamic and innovative community of budding engineers.

ASME IUT Student Section was launched in 2021. During its journey of about 3 years, ASME IUT has fostered a vibrant community where aspiring engineers can learn, grow and push the boundaries of their potential. For the very first time, this student section has managed to create a platform that brought together the innovative spirit and intellect of students from various universities.

STEM Chronicles stands as a vibrant tapestry of ideas, perspectives, and solutions. I am genuinely humbled by the diversity of ideas, the depth of research and the passion displayed by the contributors. Within its pages, one will find abundant insightful articles, all meticulously penned by the upcoming generation of engineering leaders.

Every article showcases the potential to drive innovation and shape the future. As you dive into the articles, I encourage everyone to appreciate not only the technical expertise showcased, but also the dedication, curiosity, and the innovative spirit that fuel these young minds. The launch of this e-magazine is just the beginning. We aspire to make it a regular platform for students to express themselves, engage in intellectual discourse, and contribute to the advancement of engineering knowledge. Hopefully, the readers will be active participants of this journey and I will encourage everyone to share their feedback and contribute their own ideas in future editions.

Lastly, I want to express my deepest gratitude to all the contributors, the editors and everyone who played a role in bringing STEM Chronicles to life. Without the collective effort and collaboration of the participants, the publication of STEM Chronicles would not have been possible. Your passion and commitment have made this endeavor a resounding success. Thank you.

# FROM THE EDITOR

Esteemed Readers,
I am delighted to present the latest edition of "STEM Chronicles," the annual e-magazine crafted by the ASME IUT Student Section at the Islamic University of Technology, Bangladesh. As the Editor-in-Chief, I introduce this compilation of insightful articles, essays, and creative works authored by the minds within our academic community.

While not conventional research articles, these contributions represent
a collective effort to explore diverse topics within science, technology, engineering, and mathematics (STEM).
I extend gratitude to each student for investing time and intellectual energy in shaping "STEM Chronicles". Your commitment to excellence and passion for showcasing STEM's multifaceted dimensions exemplify our student section's calibre.
Dear readers, I invite you to engage with the thought-provoking content in this magazine.

Sincerely,

Md.Hasibur Rahman Hamim
Editor-in-Chief
STEM Chronicles.

From analytical reflections to innovative perspectives, each contribution underscores the intellectual depth and innovative spirit within our academic community.

"As we navigate STEM's evolving landscape, "STEM Chronicles" serves as a testament to academic curiosity, critical thinking, and creativity."

I hope this publication informs, inspires, and fosters a deeper appreciation for STEM disciplines.
I express my deepest gratitude to the editorial team for their meticulous efforts. I encourage
all readers to delve into "STEM Chronicles" and embark on a journey of exploration and enlightenment.

# MEET THE TEAM

EDITORIAL

# EDITORIAL

EDITORIAL

Md. Hasibur Rahman Hamim
**EDITOR**

Nazmus Sakib
**SUB-EDITOR**

Md. Mahmudul Hasan Bhuiyan
**ASSOCIATE EDITOR**

PANEL

# PANEL

PANEL

Nazia Tasnim
**ASSISTANT EDITOR**

# MECHANICAL ENGINEERING TO HARVARD BUSINESS SCHOOL: AN UNORTHODOX APPROACH

Although Mechanical Engineering is a broad field, it is possible to combine another field of studies with it to explore diverse opportunities beyond traditional engineering roles.

**MASRUR HOSSAIN MUGDHO** is an IUT Alumni who has taken that route.

**Interviewed & Transcribed By**
Md. Hasibur Rahman Hamim
Syoda Anamika Jahan
Nazia Tasnim
Maliha Rahman
Tasmiah Zaman

He has a Master's degree in Mechanical Engineering from the University of Washington, specializing in sub-second nanocomposite synthesis in continuous flow supercritical CO2 reactors. He is currently a Packaging R&D Engineer at Intel, leveraging his extensive experience as a Mechanical Engineer with the Bangladesh Water Development Board. Their research contributions at the Novosselov Research Group include developing the fastest method for synthesizing porous materials and analyzing semiconductor properties of Graphene-based composites. With publications on sub-second Metal-Organic Framework synthesis and techno-economic assessments olandfill and sewage treatment plant-based power generation, he showcases a commitment to cutting-edge research. Proficient in CAD, Solidworks, CATIA, COMSOL, EBSILON, and Python, coupled with skills in financial analysis, root cause analysis, and Six Sigma methodologies, Masrur Hossain Mugdho is a versatile professional making impactful strides in engineering, research, and sustainable energy. Currently, he is pursuing a Master's of Management degree at Harvard Business School.

**Managing your Harvard courses while working in Oregon must pose challenges. How do you navigate this?**

It's actually been quite manageable for me because all classes are recorded, making it easier to balance. I typically take just one course each quarter, so it's not overly challenging. However, meeting the passing criteria can be tough; for instance, at UW, the passing grade for international students is around 83%, while for local students, it's lower, around 60%.

Experimental material science is a rapidly expanding field, especially with the substantial investments by the US government in renewable energy, particularly battery materials. This trend is expected to continue for the next three decades. Moreover, significant funding in the semiconductor sector has led to the rapid growth of companies like Intel, AMD, and Nvidia. The next decade is poised to be an opportune time to venture into the semiconductor industry.

**"THE NEXT DECADE IS POISED TO BE AN OPPORTUNE TIME TO VENTURE INTO THE SEMICONDUCTOR INDUSTRY."**

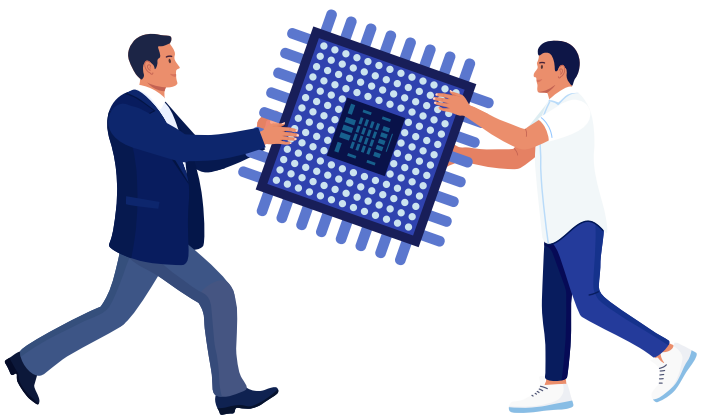
**Why did you opt for business studies after your mechanical engineering degrees?**

I opted for business studies to venture into product management. As a product manager, I gain control over the team dynamics and the strategic direction of the product, including managing its production process and team dynamics. During my master's, I couldn't enroll in numerous business courses as my focus was on experimental material science for my thesis.

**What are the prospects in experimental material science?**

Did you enjoy conducting experiments on materials?

While enjoyable, anticipating experiments failing due to contamination issues is crucial. Analyzing samples, I observed material burning due to temperature instability. Thorough analysis takes about three days per test, and with over 30 samples, a single test mishap could lead to over a month's setback.



**Can you briefly outline your role as a microelectronic packaging research and development engineer at Intel?**

Certainly, our production process starts with bare silicon wafers, progressing to lithographic circuit printing and then packaging individual dice into packages. Our task involves thinning down the silicon wafer using tools like saws, lasers, and pick-and-place sySTEMs. Defects in printed circuits are crucial, often STEMming from materials or tools, necessitating our defect metrology department to ensure tool efficiency. Each engineer oversees a specific operation—I, for instance, handle the saw operation.

**What's the impact of tool defects on production?**

Tool defects pose significant challenges, causing substantial backlogs. Once a tool malfunctioned for three weeks resulted in extensive effort and time to clear the backlog. This emphasizes the necessity to prevent such tool issues.

**How has your role at Intel impacted your personal and professional growth?**

I joined Intel expecting to work within the realm of experimental material science, closely aligning with my studies. However, my actual role diverged significantly, leading to a steep learning curve. As a student, I dealt with a small subsection of a sySTEM, but here, everything is interconnected. If one operation is impacted, it ripples downstream, affecting multiple operations. Control is critical; any disruption initiates a feedback loop, impacting subsequent operations. Continuous monitoring is essential to ensure smooth operations.

**What do you find most rewarding working at Intel?**

Working alongside numerous experts in various specialized fields at Intel is undoubtedly the most enriching aspect. Learning from these experts, whether in lithography or packaging, offers unparalleled knowledge and growth opportunities. However, there's immense pressure to meet quarterly track completion targets, which directly impacts performance evaluations.

**In which production process you're working on right now?**

We engage in a variety of semiconductor manufacturing processes, catering to the production of CPUs and GPUs, including handling wafers from companies like TSMC in our fabrication lab. The intricacies lie in tailoring specific recipes for each product batch based on provided aspects. We meticulously set the tool functioning to ensure optimal production. Downstream, we rely on DEFMAT to assess product performance, acknowledging that achieving 100% efficiency is challenging but aiming to meet the required threshold.

**Could you update us on the improvement progress of your current project, which focuses on "Fabrication and quality assessment of battery packs"?**

In our field, processors feature distinct architectures, known as designs, which see infrequent updates—Intel, for instance, recently upgraded its architecture, with the next expected update in 4-5 years. Our primary goal is to optimize and enhance performance while retaining the core architecture. Although the annual product release showcases improved performance, our main challenge lies in updating the manufacturing sySTEM, a more complex task compared to design updates. The tools used in this process are expensive, posing challenges for easy replacement.

**You have also worked in Metal-Organic Frameworks. So, could you please share your outlook on how the future of MOF looks like?**

The main challenge with this material is its high cost, exceeding $200 per gram. Despite implementing a batch synthesis process producing 5 grams in 24 hours, the hurdle lies in industrializing the material with a continuous flow process, posing a significant issue. While various applications exist, not all are practical or cost-effective, such as hydrogen synthesis, where spending $200 for just 1 gram raises financial concerns. Seeking genuinely feasible applications, alternative sources like nuclear waste for Xenon gas and MOFs for selective absorption have been explored. MOFs also hold promise in drug delivery due to their water solubility. Refining the synthesis process could significantly enhance MOFs' feasibility in various applications in the near future.

**If the world can find such incentives that these materials are really indispensable then is commercialization possible?**

Absolutely, we're witnessing that shift already. Take, for instance, battery materials where Lithium, a relatively scarce resource, is crucial. Governments are actively incentivizing initiatives in this area. With substantial implementation, government support becomes a driving force in the commercialization process.

"IN OUR FIELD, PROCESSORS FEATURE DISTINCT ARCHITECTURES, KNOWN AS DESIGNS, WHICH SEE INFREQUENT UPDATES.."

**What specific areas within material science are you eager to see more research in, and which ones would you personally like to engage with?**

In Material Science, I'm keen on seeing more research in Molecular Dynamics, the computational counterpart to experimental material science. This approach, enabling data gathering without heavy reliance on experiments, not only saves time and money but significantly enhances work efficiency. Despite being a relatively new field, the lack of sufficiently user-friendly software presents an opportunity for growth and improvement in this area.

**Considering your research on landfill and sewage treatment plant-based combined power generation sySTEMs in Dhaka, do you find this idea feasible for implementation in Bangladesh?**

I believe the concept is feasible, pending government commitment. Reports of a similar initiative in Gazipur, Bangladesh, and China, influenced my research, though they faced delays. Challenges, including health concerns and air pollution, could be mitigated but might incur additional costs. The crucial question is whether navigating these challenges is worthwhile given the current socio-economic conditions in Bangladesh.

**Can you tell us about your overall research journey? How did you start and what opportunities did you get and the difficulties you faced?**

My research journey began during the COVID pandemic's extended break, guided by Dr. Ahsan Habib. Despite initially not planning to apply abroad, the opportune time, Dr. Ahsan Habib's guidance, and team support led me into research. The inspiration for my research topic, the Kalina Cycle, came from Dr. Ehsan, offering a unique exploration compared to established topics. This approach aligns with my master's research on the MOF HKUST, where I combined it with another material, creating a novel composite and venturing into uncharted territory in the field.

**While studying in University of Washington, you have gathered various kinds of works. Who were the people who influenced you or played the role of a mentor? How was the journey so far?**

I am very thankful to all the supervisors and advisors I have had throughout my career. The topic I have worked on is material science I had literally zero knowledge about. So when I approached the other professor, they questioned my experience, but only Professor Dr Igor gave me this chance to work on this. Intel is obsessed about two things. One of them is Phd students. Just a few years back, intel wouldn't have recruited anyone without a PhD degree and it is obsessed with top tier universities. One of the requirements to join the

mechanical sector was you have to work on experimental material science. It is a rare case to see people joining intel in computational material science. Big companies in the US have the tendency of hiring people from the nearest state as per that staying in Utah I targeted Boeing and intel. Boeing doesn't hire international students due to security issues so the next best option was intel. Many seniors from IUT suggested to me that I have to take experimental material science in order to get into Intel without considering anything. On this basis I approached many professors. Later, I only applied to two companies; intel and Tesla. At that time, the economical state of other companies was not that good. Hiring chances were available in only these two so I didn't apply anywhere else.

**How was the application process and interview? Did it all go smoothly or you had to face some obstacles?**

I won't say it was that most. In the USA, the more you know people, the more it increases your chances. So I've applied through a referral. I applied in April and got an interview call within a few days which I didn't expect at all. It was a very impromptu interview, but it didn't go that well; I didn't get that position.

Later I got a few calls for different positions. As fresh graduates didn't expect you to have experience. They mostly ask relevant questions related to academies in problem-solving and stuff, technical questions are not that tough. Behavioral questions are the hardest part to convince the manager of why you are suitable for this job. In Intel for the masters, the interview consists of four rounds in which the last round requires presentation. In Tesla, there were two rounds. Compatibility with the Tesla interview was more hectic.

**What was the turning point of your life?**

There is no significant turning point, I just advise all to keep trying. Obviously you should have an ultimate target. But don't be at peace after attaining that goal. Keep trying for more.

**"THERE IS NO SIGNIFICANT TURNING POINT, I JUST ADVISE ALL TO KEEP TRYING."**

**What helped you to come this far, kept you going?**

My ultimate target was to become a university lecturer after completing my PhD. Based on that, I needed a good result in IUT and a good paper as well. So I work for the opportunities I had, and in this journey, the teachers of IUT were very helpful. But again joining a University after completing PhD is a

bit tough, they require some industrial experience. The good thing here is I can do my PhD research and job at the same time, but the bad side is normally it takes 4 years to complete a PhD, in my case it might take six years. Though it's completely worth it.

**Any advice for the young generation who are starting their research journey, opting for prestigious universities for post graduation, in dilemma about shifting their career from to another?**

I will suggest working on the research skills because it is a must. Besides, presentation skills, communication skills, and negotiation skills are also very important. Good connections will take you to great places. While choosing my subject for future studies, I checked where the job market is bigger and material, material science seemed a field filled

with opportunities and one of the safest options. You can connect many other sectors with material signs such as data signs, CS, AI etc. in the current situation, all the departments are interdisciplinary. So you can't get used to working on a topic forever. It is required to have flexibility and adaptation to change to grow. It was also one of the reasons for joining the industry because I wanted to discover where it is going out of my bookish studies. Here the good news for mechanical engineers is, there is a rapid change in the computer science field but the hardware side doesn't go through such massive change so it's easier to cope up. Whatever you do, you have to be an expert in a particular field so that you become an irreplaceable resource.

**As astonishing and enjoyable as this conversation was, we have approached the end of this interview. The ASME IUT Student Section expresses their wholehearted gratitude for your valuable time.**

It has been an amazing experience from my end as well. Thank you, IUT ASME Student Section for letting me contribute to this great initiative. I hope, I will have this privilege again in the future. I wish every member of the student section all the best.

"Mechanical Engineering"- often considered a bold choice of major as The field is vast, making it challenging for many to navigate their career paths. To make it easier, let's learn from the bests in the field.

# Secrets from the lab and beyond: The journey of a plastics engineer

**Md. Akiful Haque** , holder of a PhD from the top-ranked Plastics Engineering Department in the United States, he navigated his academic journey under the guidance of the UMass Lowell James B. Francis College of Engineering. Currently serving as a Senior Validation Engineer at Amphastar Pharmaceuticals, Inc. His academic pursuit in Plastics Engineering spanned from 2019 to 2023.

**1.What motivated you to pursue a Ph.D. in Plastics Engineering, and what specific research interests or questions drove your academic journey from IUT to University of Massachusetts Lowell?**

In October 2016, upon conclusion of my undergraduate degree, I started my professional career in the energy industry in Bangladesh, specifically in HFO power plants. Throughout that period, I had the privilege of engaging in close collaboration with many multinational EPC firms and vendors, such as Wartsila, ABB, Magnus etc.

Nevertheless, due to my academic achievements during my undergraduate studies, I frequently found myself grappling with the existential query of how I might reconcile my notable successes with the mundane reality of engaging in typical employment like the majority of individuals. Despite my initial intent to pursue a career in this power-plant profession, occasionally, people's comments made me question my career choice. I then posed queries to myself and followed my heart.

In the midst of 2018, I made the decision to pursue a fully funded position, prompting me to do the GRE and IELTS examinations in order to evaluate my aptitude to the fullest extent. The phenomena of environmental influence is frequently regarded as unfavorable; nonetheless, it frequently bestows individuals with a significant advantage. After obtaining my GRE and IELTS scores, I exclusively filed a comprehensive application to the Plastics Engineering program at the University of Massachusetts Lowell. Gaining further knowledge about this department has heightened my curiosity, as it was formerly ranked as the top school in the field of Plastics Engineering in the United States. Prior to that, I was highly driven by the work of Professor Wan-Ting (Grace) Chen, given her specialization in the field of renewable energy. The individual has a high level of expertise in the field of hydrothermal liquefaction (HTL), a commonly utilized procedure for the conversion of various feedstocks into useful fuels. Unfortunately, due to insufficient funding for HTL projects, I was unable to continue my PhD research in this discipline. However, upon realizing the situation, I got captivated by the field of plastic degradation, which presented a compelling real-time issue raised by the U.S. army. This new field of study offered abundant opportunities for growth and exploration.

**“The phenomena of environmental influence is frequently regarded as unfavorable; nonetheless, it frequently bestows individuals with a significant advantage”**

**2. Could you share some of the most influential mentors or experiences from your time at the University of Massachusetts Lowell, where the wisdom you gained still resonates with you today?**

I attribute utmost thanks to my PhD supervisor, Wan-Ting (Grace) Chen, since her guidance and support have been crucial in enabling me to attain my current position. This individual exhibited an approach towards me that suggested an awareness of my status as a novice, and was quite adept at providing evident straightforward explanations in all aspects. Given the importance of a supervisor's guidance and support to a PhD program, I consider myself privileged to have her as my supervisor. As I had limited knowledge of research prior to 2019, she provided me with direction from the beginning. In 2019, our research group consisted of a small cohort, and I had the great privilege of being one of the first doctoral students. However, the group has grown substantially over the past four years.. From engaging with a scholarly article to articulate one's ideas

in a scientific manner, to conducting independent research, and ultimately producing a scientific piece, I would give her the highest level of recognition. In addition, the rigorous curriculum of the Plastics Engineering program at the University of Massachusetts Lowell, which included 47 course credits, 18 research credits, a demanding PhD qualifier, a proposal examination, and ultimately a PhD dissertation, has contributed significantly to my personal development and instilled a strong sense of confidence in my ability to succeed. The inclusion of this component in your Plastics Engineering doctoral program provides a valuable opportunity to effectively leverage and develop your abilities. One may observe that people with greater innate abilities are confronting difficulties in various aspects of life, thereby instilling apprehension. Nonetheless, maintaining a strong faith in Allah (SWT) is beneficial in navigating these difficult circumstances.

**3. Your journey to completing a Ph.D. can be compared to a marathon runner nearing the finish line. Can you elaborate on some of the most challenging aspects you encountered during your academic pursuit and how you overcame them?**

I compare the pursuit of a doctorate to a marathon. The fluctuating nature of performance over time necessitates a steadfast focus on the desired objective. Inconsistent . progress at work frequently leads to frustration and doubts about one's abilities. In this endeavor, however, maintaining a consistent level of performance is crucial. Maintaining an up-to-date understanding of one's job, cultivating a profound understanding of the research being conducted, and fostering self-confidence have proved to be essential to my long-term success. All phases of the PhD procedure are of equal importance. Each obstacle presents an opportunity to evaluate one's skills, abilities, and self-assurance. The occurrence of failure at any level can result in frustration. To effectively resolve the issue, I believe it is necessary to increase the bandwidth and enhance adaptability.

Transitioning from a distinct background in mechanical engineering to a comprehensive program such as Plastics Engineering has always presented a formidable challenge. This degree requires a comprehensive understanding of mechanical principles and a firm grasp of polymer science. Plastics Engineering incorporates processing, design, materials, and characterizations as essential subfields. Notably, individuals without a background in polymer engineering may have challenges comprehending these concepts, as they may not align with their prior knowledge and experience. Initially, I also felt compelled to acclimate myself with all of these disciplines as soon as possible, as doing so would help me overcome the initial obstacle of the PhD qualifying examination.

Given that the pass rate on the qualifying exam for UML Plastics is approximately 60%, it would be imprudent to minimize its importance. In addition to finishing their PhD dissertations, researchers must also disseminate their work in a reputable journal. As a new researcher, balancing multiple roles as a teaching assistant, research assistant, conducting experiments, effectively managing course responsibilities, publishing scholarly manuscripts, directing PhD projects, and navigating cultural differences in the United States present a collection of challenges. To be successful as a researcher, it's necessary to recognize and embrace these challenges, taking a proactive posture in all aspects of one's academic pursuits.

cite a statement by my supervisor, who asserts that a Doctor of Philosophy (PhD) represents a comprehensive process of training and development, as opposed to merely a credential awarded by an academic institution. This statement encourages self-direction in individuals during the training process. The training program under consideration demonstrates unrivaled rigor, fostering the growth of exceptional skills and self-assurance that surpasses all other training programs currently available worldwide.

**"Each obstacle presents an opportunity to evaluate one's skills, abilities, and self-assurance"**

**4. How has your academic background in Plastics Engineering prepared you for your current role as a Senior Validation Engineer at Armstrong Pharmaceuticals, Inc.? Are there specific skills or knowledge gained during your Ph.D. that have been particularly valuable in your professional career?**

In response to this, I would like to

Throughout my time in Bangladesh, my educators, superiors, and colleagues provided me with a wealth of understanding regarding the prestige of an American PhD. After beginning my voyage here, it became clearer to me why this region is distinct from all others. According to the assumption, I acquired numerous skills and competencies during my doctoral studies. These include the ability to engage in critical analysis, provide constructive criticism, draft manuscripts, present scientific findings to large audiences, communicate effectively with

journal editors and expert reviewers, and manage various aspects of laboratory operations, such as conducting experiments, managing data, and ensuring data validity. I also have experience instructing students and serving as a leader on a research team. The aforementioned accomplishments would imbue you with sufficient confidence to face future obstacles.

In my current position as Senior Validation Engineer at Armstrong Pharmaceuticals, Inc., I am confronted with significant challenges that I confidently approach due to the rigorous training I received during my doctoral program. As a member of the pharmaceutical industry, I routinely engage in critical trend analysis of pharmaceutical drug products, work closely with FDA regulations and cGMP, and interpret characterization reports. Moreover, I actively identify and evaluate the most significant limitations of established processes, while validating production processes and equipment. These responsibilities have been an integral part of my professional career, which has been strengthened by my doctoral studies.

**5. In the realm of your research paper on "Degradation behavior of multilayer packaging films in presence of highly acidic sauce", what emerging trends or technologies do you find particularly exciting or promising for the future?**

Within the scope of my research pertaining to the comprehension of the deterioration patterns exhibited by multilayer packaging materials, with a particular focus on their application in the preservation of highly acidic food products, significant discoveries have been made. The interaction of liquid hot sauce and aluminum foil initiates a chemical reaction, resulting in the oxidative destruction of polyethylene (PE). The presence of acidic substances in hot sauce induces the process of oxidative degradation of PE layers inside multilayer films. The phenomenon of oxidation in multilayer films containing PE has been seen to exhibit greater intensity

when exposed to hot sauce as opposed to acetic acid solutions. The erosion of the surface of multilayer films occurs when exposed to hot sauce and acetic acid. The extent of PE oxidation in multilayer pouches is shown to be more significant when subjected to liquid hot sauce compared to powder hot sauce. The diminished efficacy of the oxygen barrier leads to the incapacity to effectively carry out sensory evaluation. A feasible substitute for Barex® in the hot sauce component of MRE rations has been discovered in the shape of a singular pouch. My work presents a comparative examination of the impact of liquid and powder hot sauce on multilayer pouches, thereby contributing novel insights into the manner in which hot sauce causes degradation in the pouches. These findings have the potential to inspire the future advancement of MRE ration packaging innovations.

**6. Can you share any advice or insights for individuals who aspire to pursue a Ph.D. or a career in the pharmaceutical or plastics engineering industries, based on your own experiences and achievements?**

I would like to provide a suggestion to individuals who aspire to pursue a Doctor of Philosophy (PhD) degree in the future. It is advisable to maintaina strong sense of focus on your academic objective and to gradually develop your skills and knowledge over time. I was fortunate to successfully complete my doctoral degree in a duration of three years and ten months. However, it is important to note that this timeframe may not be applicable to all. The key to success in the long term is patience The PhD journey can often deviate from anticipated outcomes, leading to repeated disappointment. It is vital to maintain a steadfast sense of hope and unwavering determination, as the manifestation of success becomes increasingly discernible, akin to a luminous beacon emerging from the depths of a tunnel. It is imperative to maintain emotional composure and cultivate resilience to effectively confront adversity. Lastly, it is crucial to prioritize one's work ethics, since they have significant importance in the United States, particularly within academic settings. It is essential to bear in mind that establishing a reputable standing requires a considerable amount of time and effort, while tarnishing it can occur swiftly and effortlessly.

**7. How do you balance your professional commitments with personal interests and well-being, as you believe the importance of maintaining a healthy lifestyle in your journey?**

While I prioritized my academic pursuits throughout my doctoral route, I consistently encountered difficulties in balancing personal interests and keeping a healthylifestyle. Nevertheless, I would suggest striving for a harmonious equilibrium between one's personal and professional obligations, acknowledging that achieving this balance may not always be possible. It is important that I strive to maintain a high level of professionalism within the academic sphere. This entails adhering to principles such as consistency, integrity, and a strong work ethic. Once an individual has made significant progress in their career, their capacity for personal growth and well-being will also expand, as per my perspective.

**8. What future goals or ambitions do you have, both in your current role and beyond, as you continue to make contributions to the field of Plastics Engineering and the pharmaceutical industry?**

My primary objective is to pursue a profession that offers me the opportunity to leverage the knowledge and expertise acquired throughout my doctoral studies, while also providing me with the flexibility to further expand upon this knowledge. My primary area of focus involves the packaging of high barrier films in challenging environments. A majority of pharmaceutical drugs require advanced packaging that adheres to particular standards. I am interested in utilizing this chance inside the pharmaceutical industry and aspire to develop my expertise in this subject over time.

I greatly appreciate your questions once again. It is anticipated that this exchange will provide prospective graduate students from IUT with valuable insights and potentially inspire them to pursue a PhD, thereby experiencing the fulfillment and prestige associated with this academic achievement.

**“My primary area of focus involves the packaging of high barrier films in challenging environments”**

**Interviewed By**
Md. Hasibur Rahman Hamim
Syoda Anamika Jahan
Nazia Tasnim
Maliha Rahman
Tasmiah Zaman

# NANOTECHNOLOGY IN MEDICINE : MEDICAL SCIENCE EMBRACES PHYSICS

Ramisa Alam

"NANOTECHNOLOGY IN THE MEDICAL SPHERE HAS GIVEN RISE TO THIS CROSS-DISCIPLINARY STUDY FIELD"

Nanotechnology, a field that has remained fascinating in its application since the very beginning, has already tamed industries like agricultural, semiconductor, robotics, electronics, materials science, energy, and others. Now it is time for this field to conquer the world of health-care.

The study of materials and devices at the nanoscale, which typically ranges from 1 to 100 nanometers, is the focus of this multidisciplinary area. Working at the nanoscale has enabled the creation of new materials and technologies with special qualities and capabilities that were previously unachievable.

The application of nanotechnology in the medical sphere has given rise to this cross-disciplinary study field known as nanomedicine, which holds the potential to significantly improve on currently used medical therapies. The use of nanoscale materials and devices for medical purposes is the focus of the specialized discipline of nanomedicine.

For the prevention, diagnosis, and treatment of many illnesses and medical disorders, it entails the design, development, and use of nanoscale tools and procedures.

A large reduction in side effects, if not zero side effects- is possible with the careful engineering of nanomedicines to demonstrate extraordinary selectivity for particular cells or organs. This served as the birthplace of nanomedicine. When compared to traditional pharmaceuticals, the first generation of nanomedicines did not always provide better disease treatment; nonetheless, they significantly reduced side effects.

The multifunctionality of nanomedicines is the most intriguing aspect of this field. When combined with mechanical, immunological, electrical, and even mechanical properties, a single nanomaterial can include one or more medicinal molecules. This quality is very desirable, especially in cardiovascular tissues

where mechanical, electrical, and immunological aspects are all crucial for efficiency.(Wang et al, 2021)

With some notable success, nanotechnology has been applied to the production of restorative materials in dentistry. Better dental materials and enhanced oral health-related diagnostic techniques are being made possible by nanotechnologies. It is safe to say that recent developments in nanotechnology may hold the key to a paradigm change in the field of dentistry.(Verma et al, 2018)

Moving on to a less common application of nanomedicine - wound healing. The microenvironment around a wound may become more active as a result of nanomedicine on several cellular and molecular levels. The antimicrobial, anti-inflammatory, and angiogenic qualities it possesses allow it to accomplish this. It might therefore have the ability to change the non-healing wound milieu into a healing-promoting one.(Kushwaha et al., 2022)

Now, let us explore the emerging fields of nanomedicine that are yet to flourish. By enabling precise targeting of drugs to certain cells and tissues through nanoparticles, nanomedicine transforms drug delivery. This strategy reduces side effects and improves medicine effectiveness; it is especially helpful in the treatment of cancer.(Fornaguera & García-Celma, 2017).

In the near future, it is anticipated that personalized medicine, which tailors medicines to patient groups, would have a substantial impact. Nanoparticles are essential in modern medical interventions because of their small size and versatility in delivering therapeutic chemicals to their targeted locations of action.

*"nanotechnology may hold the key to a paradigm change in the field of dentistry"*

Nanotechnology, in all its glory, has started a revolution in the field of medicine. It is just a matter of time before we see nano-robots performing surgeries by themselves and customizing medical drugs for us.

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# Zero-Shot Learning: Bridging the Gap in Artificial Intelligence

Rifat Bin Kawsar

Think about the situation when you recognize a category of an object in an image without having ever seen a picture of that particular thing. If you've read a thorough description of a cat, you might be able to identify it in a picture the first time you see it.

This idea is applied by contemporary computer vision algorithms using a method known as "zero-shot learning.

"By leveraging auxiliary information, like as text descriptions, to guess what could be in an image, zero-shot learning enables a model to accomplish a job without having access to any training data. In the ever-evolving landscape of artificial intelligence and machine learning, one of the most intriguing and challenging frontiers is "zero-shot learning."

Zero-shot learning fundamentally departs from conventional supervised learning, where a model is trained on labeled data to recognize specific predefined categories or classes. In contrast, zero-shot learning equips machines with the ability to recognize objects, concepts, or classes they have never encountered during training.

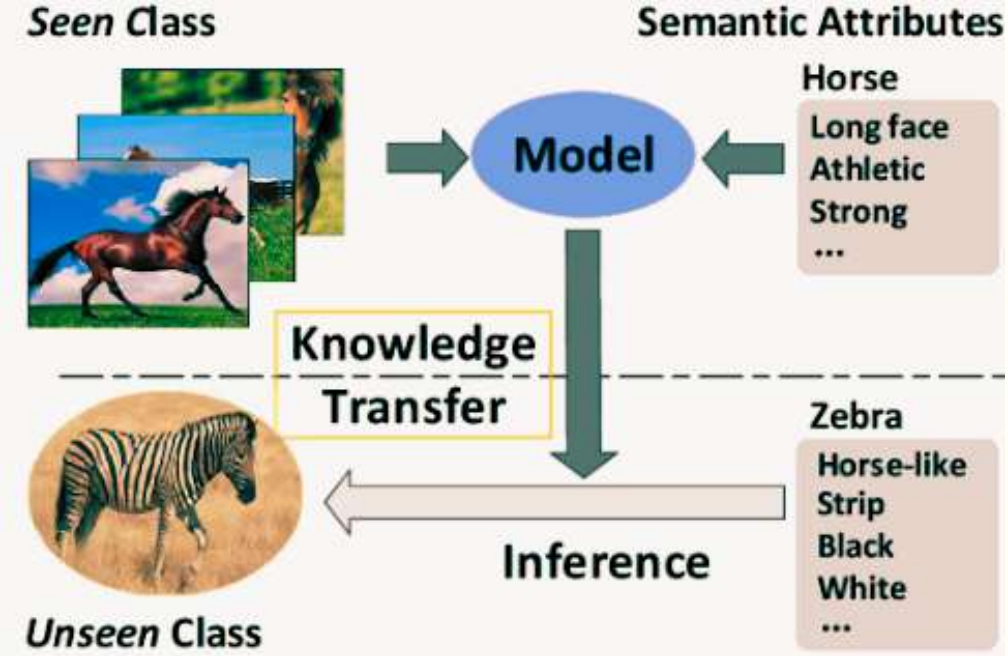


Fig: zero-shot learning process

This capability is achieved through the power of abstraction, inference, and transfer learning.

The central idea behind zero-shot learning is knowledge transfer. In traditional machine learning, models are like students meticulously studying a fixed syllabus. They become proficient at answering questions related to the material they've learned but are utterly clueless when posed with questions from outside that syllabus. Zero-shot learning, however, turns machines into adaptable learners, capable of answering questions they've never explicitly been taught.

How is this achieved? One of the key techniques in zero-shot learning is the use of semantic embeddings. This involves mapping data and class labels into a shared semantic space where relationships between classes are preserved. For example, if we have embeddings for animals and vehicles, the model can calculate the similarity between an unseen class like "giraffe" and known classes like "elephant" and "car." This similarity score aids in classifying the unseen object without the need for direct training data.

Another approach within zero-shot learning is attribute-based recognition. In this method, each class is described by a set of attributes or characteristics. For instance, a zebra can be defined by attributes like "black and white stripes," "four-legged," and "long neck." By combining these attribute vectors, models can infer the class of an unseen object based on the presence or absence of these attributes.

Zero-shot learning is not confined to the realm of computer vision alone. It extends its reach to natural language processing, where models are trained to understand and generate text in multiple languages or on diverse topics. This enables translation between language pairs that the model has never explicitly seen during training, showcasing the potential of zero-shot learning in multilingual applications.

While zero-shot learning holds immense promise, it also presents challenges. Designing effective semantic embeddings, handling a vast number of unseen classes, and dealing with noisy data are ongoing research endeavors. Nonetheless, as artificial intelligence continues to advance, zero-shot learning offers a glimpse into the future of intelligent sySTEMs that can adapt and recognize new concepts without extensive training, making it a pivotal area of study in machine learning and a testament to the limitless potential of AI.

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# Composite Materials in SPACE & BEYOND

Sazidur Rahman Chowdhury

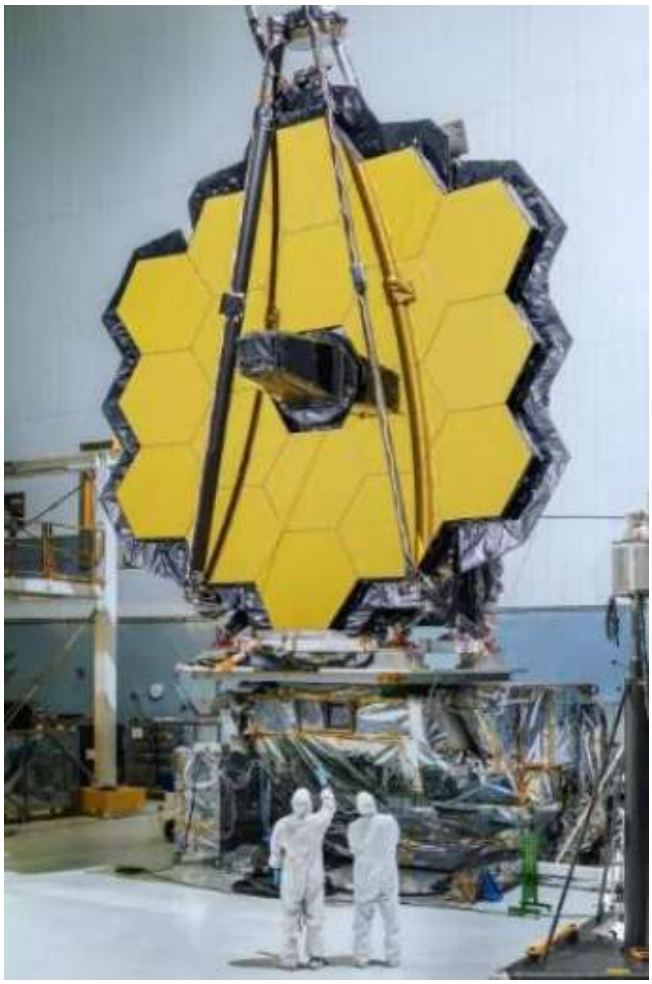
Composite materials refer to substances formed by combining two or more distinct components, each possessing unique properties. The amalgamation results in a novel material with improved characteristics that are not present in the individual components. To illustrate, envision a chocolate chip cookie: the dough serves as the "matrix," soft and cohesive, while the chocolate chips act as the "reinforcement," adding extra goodness.

One prevalent example of a composite material is Carbon Fiber Composites. Crafted from ultra-thin carbon fibers, known for their exceptional durability and lightweight nature, these fibers are dispersed within a matrix, functioning as a binding agent for the carbon fiber threads. The matrix not only holds the structure together but also imparts strength, distributes loads, and provides insulation. When these fibers are integrated into a composite, as seen in a carbon fiber bicycle frame, the resultant material exhibits strength comparable to that of a nail but with the weight of a feather.

Carbon Fiber Composites are widely employed in support structures, frequently constructed using honeycomb sandwiched panels. Their high stiffness modulus and dimensional stability make them a preferred choice for aerospace applications. A notable example is the James Webb Space Telescope, utilizing a carbon fiber structure to support instruments and mirrors, despite weighing over 2000 kilograms.

Figure 1(a): Orion's Carbon Fiber heatshield [Composites world, https://www.compositesworld.com/articles/composites-in-space(2) ]

# JAMES WEBB TELESCOPE, NASA



Materials used in space are susceptible to mechanical, chemical, thermal, and UV damage. Even carbon fiber composites are prone to failure due to cyclic or repeated loads. To address this, Carbon Nano Tubes are utilized in nano/micro-sized healing agents to enhance the strength of repaired regions. After a 24-hour healing period, carbon fiber composites with micro-healing agents may regain up to 56% of their fracture toughness.

Fire poses a constant threat to astronauts and aeronautical components in space. Carbon-carbon composites, with covalently linked atoms, offer great strength and can withstand temperatures up to 1500 °C. They are employed in cryogenic fuel tanks, replacing conventional metal tanks. Rocket nozzle exit cones, such as those used in the Orion heat shield manufactured by Lockheed Martin, utilize carbon-carbon composites for their high-temperature handling and fire resistance.

In space, electromagnetic interference (EMI) can disrupt satellite communications, leading to signal problems. EMI shielding is employed in spacecraft and satellites to protect sensitive electronic components from interference, ensuring reliable communications. Aerogel-impregnated composites exhibit powerful EMI shielding capabilities, with high absorption-shielding abilities. Magnetic nanoparticles like Iron, Manganese, Nickel, and Ferrites are embedded through various techniques to enhance microwave absorption. Si-C foams, used in this context, benefit from the addition of Carbon Nano Tubes, increasing electron density and, consequently, shielding capabilities.

As the race to space intensifies, composites play a crucial role in overcoming challenges. The fusion of composites and aerospace holds immense potential for the future, promising exciting advancements in space exploration.

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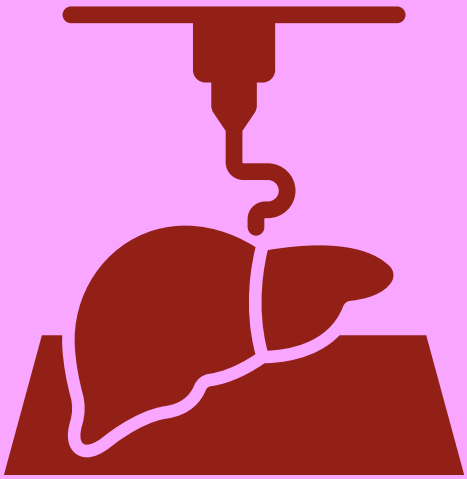

# ORGAN 3D Printing : The Future

Tasmiah Zaman

Organ 3D printing, a term originating in the 1980s, involves rapid prototyping of organs in laboratories using 3D printers and biomaterials via additive manufacturing technology and computer-aided design (CAD) models. These lab-created mimic organs find applications in research, pharmaceutical development, medical education, and, crucially, organ transplants.

As of March 2023, 104,234 people were on the national transplant waitlist, with 17 individuals dying each day while awaiting a transplant. Organ rejection, acute or chronic, remains a risk even post-transplant. Printed organs, derived from the patient's own cells, significantly minimize the risk of rejection.

Traditional tissue engineering entails seeding cells onto a permeable, mechanically stable scaffold. While it provides structural support and a suitable microenvironment for cells, it faces challenges in achieving uniform cell distribution, high cell density, control over size and placement, and issues related to cell viability and reproducibility, particularly for complex organs.

In 3D bioprinting, organs or tissues are constructed layer by layer through three key steps: pre-processing, processing, and post-processing. Pre-processing begins with CT and MRI image acquisition, which is then transformed into 3D models using CAD software. These models are converted into Standard Triangle Language (STL) format for input into the 3D printer. In the processing step, bio-ink, prepared from harvested cells and ex vivo-cultured hydrogel, initiates the printing process. The printed structure matures in a bioreactor, becoming suitable for transplantation or experiments.

Bio-inks consist of cells and hydrogels, supporting cell viability, proliferation, and differentiation while maintaining mechanical properties. Cell selection is critical, as these cells need to endure the entire process and successfully reproduce.

Various methods exist for organ 3D printing:

1. Vat photopolymerization: Photosensitive polymer liquids are employed to build objects layer by layer, with photopolymers solidifying under specific light. This method offers high manufacturing accuracy, as seen in stereolithography.

2. Material Jetting: Also known as

inkjet printing, a print nozzle ejects material droplets, cured by an auxiliary curing device.

3. Material Extrusion: Filamentous material is extruded through a nozzle, heated, and then cooled and solidified on a platform, a cost-effective option.

4. Powder Bed Fusion: High-power lasers or electron beams melt and bond powders at specific locations, as in selective laser sintering.

5. Binder Jetting: Similar to powder bed fusion and material jetting, this method uses binder substances.

Organ 3D printing can be accomplished through direct and indirect methods. The direct method prints the organ directly from the 3D printer or in multiple parts later assembled, while the indirect method involves creating a mold first, followed by a single process of printing the organ. Combining both methods often yields more effective results.

Post-processing steps are essential, encompassing surface smoothing, coloring, gluing, suturing for multiple parts, and sterilization for surgeries or preservation.

The primary challenge in mimicking organs involves vascularization and neural structure replication. Overcoming these hurdles will be a significant step towards commercializing organ printing. Recent advances have been made in vitro models and in vivo scaffolds, but enhancing tissue viability and nutrient transport in specific vascular networks remains a priority.

This revolutionary process stands on the verge of transformative breakthroughs, holding great promise for the future of medicine.

## Organ printing represents the future, poised to save millions of lives worldwide.

This revolutionary process stands on the verge of transformative breakthroughs, holding great promise for the future of medicine.

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# EMISSIONS TO ELIXIRS

MALIHA RAHMAN

## Challenges faced in converting emitted $CO_2$ to alcohol, using catalysts

**Continued $CO_2$ emissions could cause a 3–4°C temperature rise by the century's end, intensifying climate-related disasters and impacting billions.**
**While we are not able to reduce the emission, why not reproduce something out of it? [1] [2]**

From this thought, the researchers developed a new copper and iron-based catalyst that uses light to convert carbon dioxide ($CO_2$) to methane, the primary component of natural gas. Although heterogeneous catalysis has been widely explored for $CO_2$ reduction, there are still substantial problems in producing active, selective, and stable catalysts appropriate for large-scale commercialization. [3] [4] [5]

### Challenge 1: Catalyst Selection [6]

Three different product types can result from the catalytic conversion of $CO_2$ to $H_2$: [6]

- CO via the reverse water-gas shift (RWGS) process
- Methanol via selective hydrogenation
- Hydrocarbons via a combination of $CO_2$ reduction and Fischer-Tropsch (FT) reactions.

Studies on these processes have shown how vital it is to stabilize key reaction intermediates to efficiently control catalytic selectivity. Moreover, a large scale of $CO_2$ free $H_2$ source is needed to do the conversion. [6] [7]

Significant $CO_2$ emission reduction requires large-scale processes and affordable catalysts with the reducible properties commonly found in $CO_2$ reduction catalysts with $H_2$.

The process begins by breaking down $CO_2$ into oxygen and CO, and researchers have discovered catalysts that facilitate this step when $CO_2$ is passed through water with an electric current. Copper oxide, a widely available and cost-effective combination of copper and oxygen, is among the extensively studied catalysts. However, it tends to split more water than $CO_2$, leading to the production of less energy-rich molecular hydrogen ($H_2$). The addition of a tin oxide layer later improved the conversion of 90% of $CO_2$ molecules into CO.

## Challenge 2: Advancements in $H_2$ Sources Free of $CO_2$

Currently, 95% of hydrogen ($H_2$) comes from hydrocarbons, like methane reforming, coal gasification, and oil waste, producing $CO_2$ as a by-product. Affordable, renewable, and $CO_2$-free $H_2$ sources are crucial for large-scale $CO_2$ reduction. Reducing renewable $H_2$ high costs would make $CO_2$ fuel competitive with gasoline, enabling economically viable light olefin production. Biomass conversion and water electrolysis offer potential $CO_2$-free $H_2$ sources, with water electrolysis as the preferred large-scale choice due to no by-products besides $O_2$. Recent research has yielded cost-effective electrocatalysts for hydrogen production in acidic and basic conditions. [6]

## Challenge 3: Kinematics of reaction

Identifying and stabilizing important intermediates is essential in each part focusing on $CO_2$ reduction with $H_2$. CO is important among these, as catalysts with higher CO binding energies favor MeOH and hydrocarbon synthesis, whereas those with lower CO binding energies promote RWGS. Ongoing research in the field of MeOH synthesis strives to identify the correct intermediate(s) and structure-property descriptors, with an emphasis on stabilizing CO to obtain high MeOH yields. DFT simulations can be used to uncover additional descriptors, which can help to speed up catalyst screening and development. [6]

## Ongoing initiatives: Solution to Challenges

Recent research has made progress in turning $CO_2$ into useful products using light-capturing compounds inspired by photosynthesis. Especially the combination of enzymes with photocatalysis and photo electrocatalysis.

The thermo-catalytic conversion of $CO_2$ to CH3OH through heterogeneous catalysis has emerged as a highly promising method. Significant advancements have been achieved in the creation of diverse catalysts, encompassing metals, metal oxides, and intermetallic compounds. [8] [9]

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# Genetic Alchemy: Dawn for Mankind... Or Dusk?

**Khaja Arjani Ahamed**

From its groundbreaking debut in the realm of genetic engineering, the CRISPR-Cas9 sySTEM represents the fastest and cheapest method of genome editing technology that has revolutionized molecular biology. While it was originally discovered as a cornerstone in prokaryotic adaptive immune sySTEMs, its key components can be reproduced such that it can be applicable to all organisms.

Like every hotshot science-fiction breakthrough in the movies, 'the possibilities are endless'.

In layman terms, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) is an efficient tool for easily editing the in-built instruction manual inside you and me in order to fix parts that otherwise end up causing major problems in our livelihood, like the Big C.

The CRISPR-Cas9 sySTEM comprises of two principal components; a nuclease enzyme called Cas9 capable of behaving like a pair of scissors to the paper that is DNA, and a guide RNA (i.e. sgRNA) that would help Cas9 locate where to create the double-stranded breaks. Cas9 was originally sourced from the Streptococcus pyogenes bacterium while sgRNA can be artificially designed and produced, precision in which is absolutely critical to ensure success in CRISPR-based gene editing experiments.

Genetic engineers design this sgRNA according to the gene they want to edit then create an 'effector complex' with Cas9 which proceeds to read the genome and make the cut at the site of the targeted gene. Next, the site of the cut is repaired in one of two ways, depending largely on gene function and if a template DNA is available. Preferably through homology directed repair, the originally defective gene can be partly changed or completely replaced with a desirable counterpart.

The applications of this technology is not even just limited to human beings. What does this mean for us?

Crops can be engineered to be more resilient to diseases and yield more food. Cancer immunotherapy can be transformed, arming host killer T cells to be able to identify and combat cancerous tissue. Genetic and autoimmune diseases like cystic fibrosis or sickle-cell anemia can be treated like never before to almost 'snap' them out of existence. And it does not even cost one everything!

The applications of this technology is not even just limited to human beings. What does this mean for us? Crops can be engineered to be more resilient to diseases and yield more food. Cancer immunotherapy can be transformed, arming host killer T cells to be able to be able to identify and combat cancerous tissue. Genetic and autoimmune diseases like cystic fibrosis or sickle-cell anemia can be treated like never before to almost 'snap' them out of existence. And it does not even cost one everything!

That being said, CRISPR also raises a truckload of ethical concerns. Will it be used on STEM cells, even if unintended consequences down the road can create genetic anomalies lasting for generations? Are people going to use it for frivolous reasons like changing facial bone structure, even though we still don't know about all the genes that control it?

**Will a crazy scientist use it on animals to engineer them for military use just to end up with a species capable of wiping out the human race as we know it?**

Who knows?

Beyond how I explained it can be used now, CRISPR could also be used in the future to track cell development. What we know about the human body can reach heights never imagined before. The future for CRISPR is vast and just as scary as it is exciting.

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# NANOTECHNOLOGY

# THE FUTURE OF ADVANCED ENGINEERING

Shah Umme Hani

Nanomaterial is defined as any material with dimensions ranging from 1 to 100 nm. In 1965, Richard Feynman introduced the term nanotechnology, describing the technological development at atomic, molecular, and macromolecular levels and the manipulation of materials at the nano level.

This development at the nano-level technology opened a wide range of research interest in the early 21st century. Some of the main innovations of nanotechnology are nanocomposites used as structural health detection, deicing, actuators, switches, color-changing devices, robotics parts, and artificial muscle; Triboelectric Nanogenerators (TENG) used as power source, supercapacitors, plasma generator, and electric gun; Nano-sensors are highly applicable as human health monitoring, small signal generation, robotics, Internet of things; Medical sector is also developing with the technological development of nanotechnology such as drug screening, gene delivery, diagnosis, therapy, detection of problematic cells.

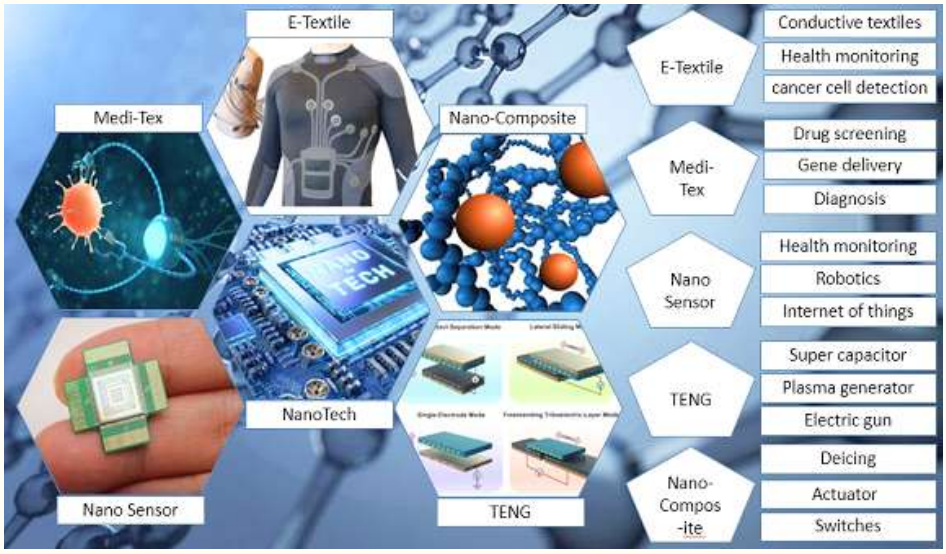


Figure 1: Recent innovation in nanotechnology and applications.

E-textiles are getting much popularity in very recent times with the development of TENGs such as conductive textiles, health monitoring via heart signal, cancer cell detection, artificial nerve sySTEMs, and many more shown in Figure 1.

Except for those heavyweight uses nanotechnology can be used in day-to-day life for simple yet highly effective purposes. Some of the ideas shared in this article are self-warm textiles, emergency signals, and animal protection.

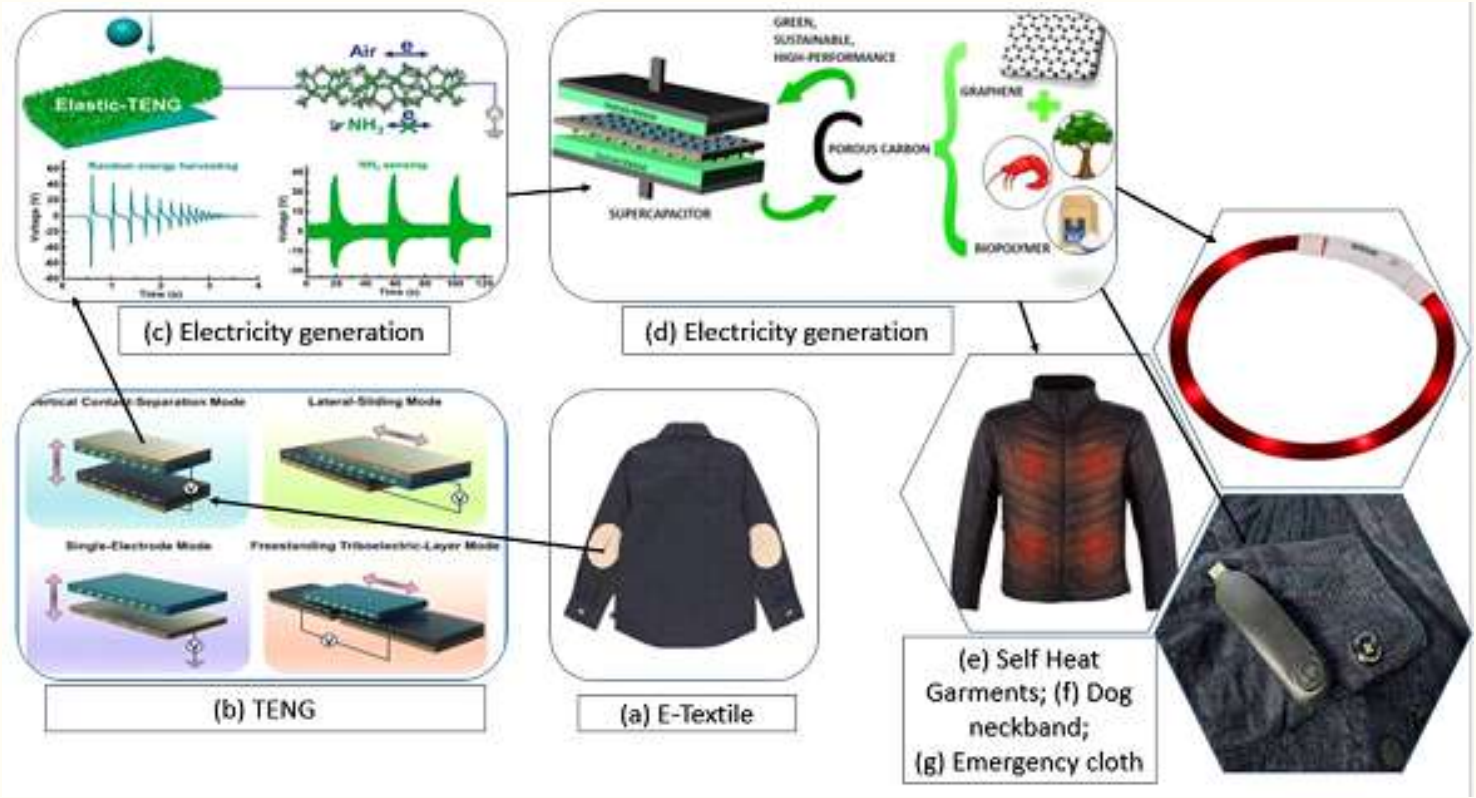


Figure 2 illustrates the basic principle of this article. A TENG* is attached to textiles at high-stress places such as the elbow, underarm, thigh, and knee joints. Due to bending and friction in those areas, mechanical force is applied to TENG and converted to electric energy which can be directly transferred to different parts of the body via the conductivity of the textile or can be stored in a supercapacitor for further use. Electricity from this supercapacitor can be converted to heat to make self-warm garments. This type of garment equipped with TENG and special IoT can provide emergency signals to selected audiences. Here special signal refers to unwanted or abnormal signals provided by TENG and can include car or bike accidents, and manual press in any sense of danger where reaching a phone seems impossible.

TENG can be a modern and complete technological solution to animal protection from road accidents. Street dogs, foxes, and other free animals are common victims of it. The most probable cause of these is the invisibility of animals at night when crossing the road or in sharp turns i.e. blind zones. A neckband equipped with TENG, supercyapacitor, and LED lights can make them easily visible at night. The TENG converts the mechanical force (Vibration, stress) into electric energy and stores it in the supercapacitor for further use by LED. This technology makes a lifetime neckband that will be non-rechargeable, biodegradable, and eco-friendly thus leading to a sustainable solution.

While this source of electricity is suitable for small loads, the increasing prevalence of the Internet of Things (IoT), projected to reach up to 200 billion devices by 2025, suggests that TENGs could serve as a sustainable alternative to conventional batteries, reducing environmental pollution.

# AUTOMATED GUIDED VEHICHLES

MD.IBRAHIM HOSSAIN KHAN

AGV is an abbreviation for "**Automated Guided Vehicle**." An AGV is a particular kind of mobile robot that is intended to move materials and items autonomously throughout a controlled setting, like a warehouse, factory, or distribution center. These robotic vehicles have proven to be indispensable in streamlining operations, enhancing efficiency, and reducing costs in a wide range of industries. Apart from the industrial sector, a **delivery robot** is an **autonomous or automated robot** that provides "last mile" delivery services.

The Importance of AGVs in Modern Industry

1.Increased Productivity: By automating routine jobs like moving materials, they free up human workers to concentrate on more difficult and valuable duties. Faster manufacturing cycles and higher productivity are the results of this.

2.Safety and Risk Reduction: AGVs may operate in settings that might be dangerous for human employees, such as those with extreme temperatures or chemical exposure, because they are developed with safety in mind.

3.Enhanced Accuracy: AGVs operate with astounding accuracy, lowering the possibility of mistakes and guaranteeing that items are delivered to the proper location at the appropriate time.

Apart from the industrial usages, Automated or Autonomous guided vehicles now contributing in the transportation sector by delivering foods, medicines and other necessary stuffs. The autonomous robot can transport goods safely and contact-free while moving along paved roadways or within buildings.

*Figure 2:* *Delivery robot*

**Food Delivery:**

**Hygiene and Food Safety:** Food safety is considered during the design of AGVs. They can have refrigerator sections to keep perishable things at the proper temperature while in travel, lowering the chance of food contamination and deterioration.

**Lower Labor Costs:** By automating delivery activities, AGVs can assist in lowering these expenses and freeing up human personnel for more customer-facing positions.

**Contactless Delivery:** They reduce the risk of virus transmission by delivering food without direct human contact. AGVs offer contactless delivery, which became crucial during the COVID-19 pandemic.

Medicine Delivery and Science:

Reduced Medication Errors: Drug errors are less likely when AGVs are combined with barcoding and scanning sySTEMs to verify drug orders. They can safely transport and store pharmaceuticals.

**Timely Medication Delivery:** AGVs can make sure that patients receive their prescriptions on time and accurately at healthcare institutions like hospitals and pharmacies. This is essential for patients with rigid drug schedules and in emergency situations.

**Pharmacy Automation:** AGVs are utilized in drug store situations to type in medicine orders, recover pharmaceuticals from stock, and move drugs all through the office. The precision and effectiveness of sedate apportioning are made strides by this computerization.

**Research and Development:** AGVs can move materials, chemicals, and lab equipment, expediting research and improvement processes. This is particularly important in pharmaceutical research, where accuracy and speed are essential.

**Safety in Hazardous Environments:** Transport-related jobs can be safely handled by AGVs, lowering the chance of exposure for human workers.

In conclusion, by assuring contactless, prompt, and accurate deliveries, delivery robots improve the quality of patient care, the safety of the food, and the effectiveness of operations in the medical and food industries. They expedite material transfer in industrial settings, lowering labor costs and raising production. Automated guided vehicles are now becoming a part for the betterment of human life.

# PRINTED POSSIBILITIES: THE 3D PRINTING REVOLUTION IN MANUFACTURING INDUSTRIES

MUEEN SHABIB

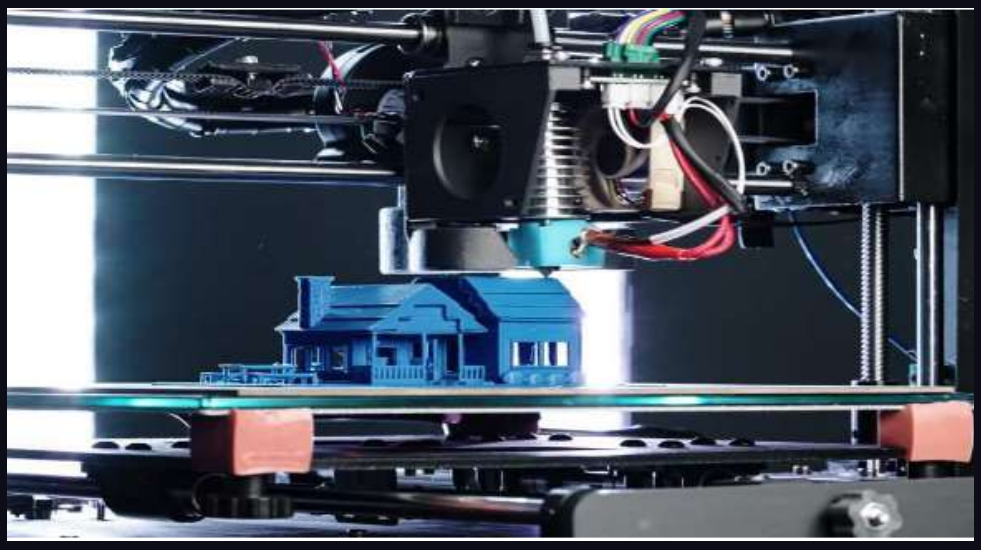

Figure: Functional 3D Printer. [5]

In the realm of modern manufacturing, 3D printing, referred as additive manufacturing, is redefining standards of production in the modern manufacturing. This groundbreaking technology enabling manufacturers to create intricate designs, customize products and reduce waste. [1] [2]

Fundamentally, 3D printing is a grand technique that builds three-dimensional structures by incorporating layered materials from CAD, usually in the forms of plastics (ABS, PLA, PETG), resins, powders or filaments. The additive nature of 3D printing gives it versatility because it enables manufacturers to create intricate geometries layer by layer, in contrast to traditional subtractive manufacturing techniques like drilling, turning and lathe work that remove material from a solidified mild steel ingot. [1] [2]

Beyond its additive methodology, 3D printing offers significantly more capabilities. It also depends on the varieties of materials that are available, which includes biological materials in addition to metals, ceramics and polymers. The final product's qualities are greatly influenced by the material selection, which allows for a wide range of applications. [3]

3D printing has a significant and widespread effect on the manufacturing sector. Prominent domain of influence include:

1. Rapid Prototyping: 3D printing has revolutionized the synthesis process, enabling manufacturers to create prototypes quickly and cost-effectively. This agile approach allows for iterative design improvements and drastically reduces development time and costs.
2. Supply Chain Optimization: The ability to create products on demand through 3D printing has reduced the need for extensive inventories and complex supply networks, as parts can be manufactured at convenient location, minimizing lead times and wastes.
3. Complex Geometries: 3D printing unlocks the potential to create intricate and lightweight structures that were previously elusive with regular manufacturing methods. The aerospace industry, for example, leverages 3D printing to craft components that enhance aircraft efficiency and performance. This is especially significant in industries such as healthcare, where personalized prosthetics, dental implants, and

patient-specific surgical instruments are now a reality.

4. **Minimize Material Waste**: Large amounts of material are frequently wasted during conventional manufacturing procedures. In contrary, being an additive process, 3D printing only uses the precise amount of material required for each layers. This reduces waste and helps create a manufacturing process that is more sustainable.

The real-world applications of 3D printing are astounding, with notable examples demonstrating its far-reaching potential:

1. Aerospace: Industry giants like Boeing and Airbus utilize 3D printing to create lightweight, high- strength components. For instance, Relativity Space created an aerospace fuel tank just in 7 days that would take at least 12 months by traditional approach. [6] [7]

2. Biotechnology: In the healthcare sector, 3D printing is revolutionizing patient care. Customized prosthetics, dental implants, and patient-specific surgical instruments are becoming standard practice. One remarkable instance involved the creation of a functional ribcage replacement, highlighting the life-saving potential of this technology. [6] [7]

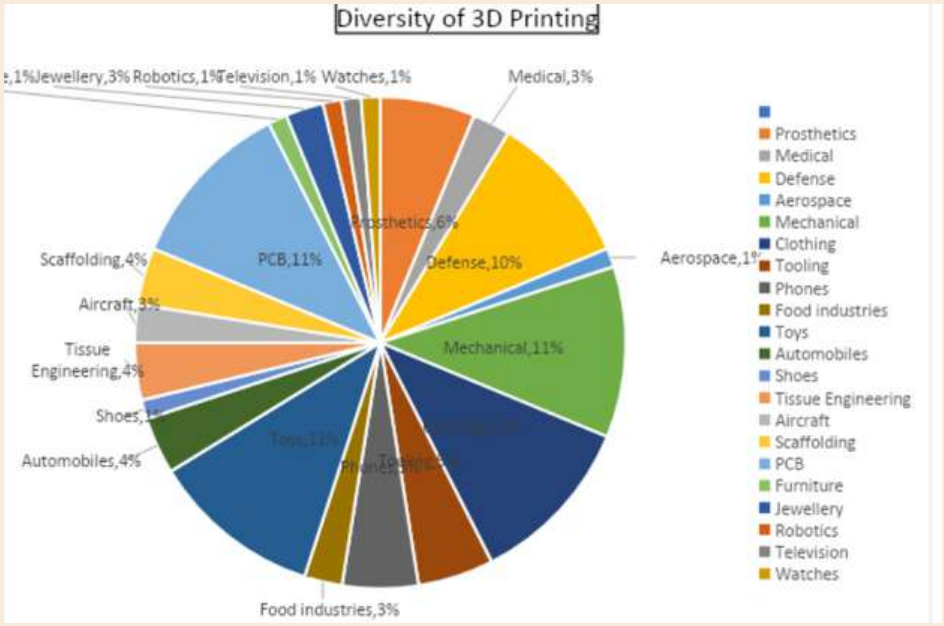


Figure: Modern 3D Printing Technologies: Future Trends and Developments [8]

3. Automotive: Leading automakers like BMW and Ford employ 3D printing for rapid prototyping and the production of complex parts. In a groundbreaking move, Local Motors designed and manufactured the Strati, the world's first 3D-printed car, showcasing the technology's potential in automotive manufacturing. [3]

3D printing has unleashed a wave of innovation in the manufacturing industry, reshaping the production landscape. In the coming years, we may witness the large-scale 3D printing of buildings, advanced bio-printing for tissue and organ regeneration, and a more integrated approach to aerospace and automotive manufacturing as customization, sustainability, and efficiency become the driving forces of modern production, 3D printing is set to be at the forefront of this transformative journey.

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10. 3D PRINTING TECHNOLOGIES IN VARIOUS APPLICATIONS A. Ramya Mechanical, BVRIT Hyderabad College of Engineering for Women, Bachupally, Hyderabad -500 090, India Sai leela Vanapalli Mechanical, BVRIT Hyderabad College of Engineering for Women, Bachupally , Hyderabad - 500 090, India

International Journal of Mechanical Engineering and Technology (IJMET) Volume 7, Issue 3, May-June 2016, pp.396-409, Article ID: IJMET_07_03_036 Available online at http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=7&IType=3 Journal Impact Factor (2016): 9.2286 (Calculated by GISI) www.jifactor.com ISSN Print: 0976-6340 and ISSN Online: 0976-6359 © IAEME Publication

# EVOLVING HORIZONS

## Unveiling Cutting-Edge Innovations in STEM and Their Transformative Impact

ARFA WASIMA NAHIN

In the realm of Science, Technology, Engineering, and Mathematics (STEM), recent years have witnessed groundbreaking innovations that transcend the boundaries of what was once thought possible. These innovations have already begun to transform our world in remarkable ways. In this article, we delve into the most remarkable of these advancements, supported by quotes, dates, and data, and explore the diverse applications that are poised to reshape our lives.

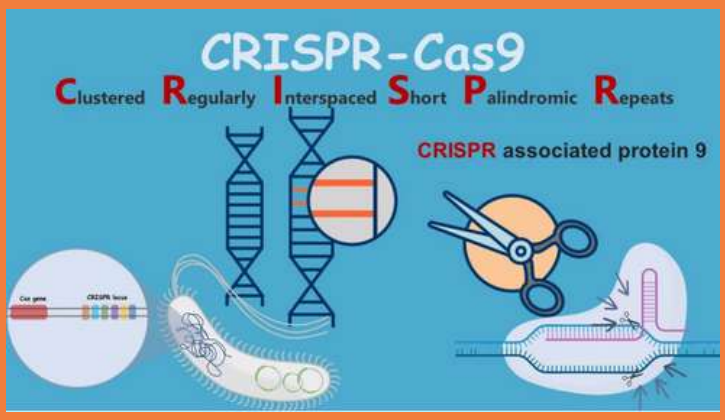
**Quantum Supremacy: A Quantum Leap in Computing (2019)**

Quantum computing, a paradigm-shifting advancement, has the potential to revolutionize various sectors, including cryptography, drug discovery, and materials science. In October 2019, Google's quantum computer, Sycamore, achieved what was ermed "quantum supremacy" by solving a problem in 200 seconds that would take the world's most powerful supercomputers over 10,000 years to compute. Sundar Pichai, CEO of Google, aptly noted, "Quantum computing will help us solve problems in seconds that would take the classical computer longer than the age of the universe." This development marks a significant milestone in computational capabilities.

**CRISPR-Cas9: Genome Editing Revolution (2012)**

The CRISPR-Cas9 gene-editing technology, developed by Jennifer Doudna and Emmanuelle Charpentier, received the Nobel Prize in Chemistry in 2020, affirming its profound impact on the scientific community. This technology allows precise modification of DNA sequences, offering potential treatments for genetic diseases, and creating genetically modified organisms to address environmental and agricultural challenges.

As Jennifer Doudna expressed, "The ability to edit DNA is one of the greatest scientific advances of all time."




**SpaceX's Reusable Rockets: Cost-Efficient Space Exploration (2015)**

Space exploration took a giant leap forward with the introduction of reusable rockets by Elon Musk's SpaceX in 2015. Musk's vision of making life multiplanetary became closer to reality as these reusable rockets significantly reduced the cost of space travel. As he wisely stated, "Reusability is the key. It is the only way to make life multi-planetary." This innovation has ushered in more frequent satellite launches, manned missions, and even the prospect of space tourism, making space more accessible than ever before.

**5G Technology: A Quantum Leap in Connectivity (2020)**

The advent of 5G technology in 2020 marked a pivotal moment in connectivity. With speeds upto 100 times faster than 4G, 5G enables innovations like augmented reality, remote surgery, and smart cities. Cristiano Amon, President of Qualcomm, emphasized its transformative potential, saying, "5G will enable a future where connectivity is seamless, latency is negligible, and the Internet of things

truly comes to life." This technology promises to reshape the way we live, work, and communicate.

**Renewable Energy and Energy Storage (Ongoing)**

Advancements in renewable energy have gained momentum, with solar panels becoming more efficient and affordable, wind turbines becoming more powerful, and energy storage technologies, such as Tesla's Powerwall, improving. As Dr. Fatih Birol, Executive Director of the International Energy Agency, rightly noted, "The shift to renewable energy is no longer a choice but a necessity." These innovations are vital in reducing our reliance on fossil fuels and mitigating climate change.

**AI in Healthcare: Personalized Medicine and Early Diagnoses (Ongoing)**

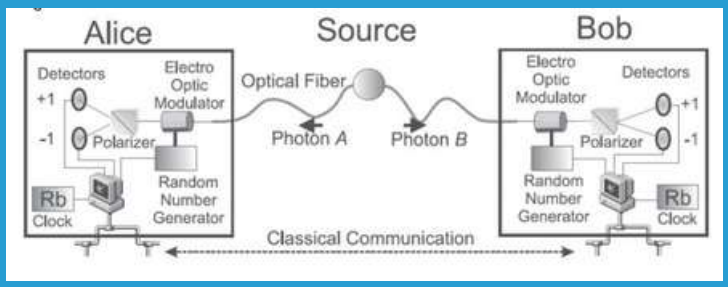
Artificial Intelligence (AI) is revolutionizing healthcare by enabling personalized treatment plans based on an individual's unique genetic makeup and health history. Eric Topol, a prominent cardiologist, and author, articulated the promise of AI in healthcare: "The promise of AI in healthcare is to move from one-size-fits-all medicine to personalized treatment plans." Machine learning algorithms can analyze extensive datasets to detect diseases like cancer at earlier stages, offering more effective and less invasive medical care.

**Data-Driven Conservation: Protecting Biodiversity (Ongoing)**

Advancements in STEM have equipped conservationists with powerful tools to protect biodiversity. Remote sensing technologies and data analytics allow for real-time monitoring of ecosySTEMs, tracking of endangered species, and the implementation of more effective conservation strategies. As Jane Goodall, a renowned primatologist and conservationist, pointed out, "We are on the cusp of a new era in conservation, where data-driven strategies empower us to protect our planet's precious biodiversity more effectively."

**Quantum Teleportation and Cryptography (Ongoing)**

Quantum teleportation, although still in its infancy, holds the promise of enabling truly secure, instantaneous communication, revolutionizing cryptography. Dr. John Preskill, a leading theoretical physicist, emphasized the potential of this technology to reshape how we secure our digital world. In this rapidly evolving landscape of STEM, these innovations are not just scientific breakthroughs; they are solutions to global challenges. As we move forward, it is crucial to harness these advancements responsibly, ensuring that they benefit all of humanity and contribute to the well-being of our planet. With our collective imagination and determination, the possibilities for the next groundbreaking innovation are endless, promising to astonish us with its transformative applications and usher in a new era of scientific exploration and progress.

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# METAL RECYCLING

Shahnila Anan

**Nowadays, there lies a connection between the words "wastes" and "recyclables." Recyclables can be termed as waste material products that can be remanufactured into new usable products, increasing the utility of the material. Mostly recycled materials include plastics, metals, papers, glass, woods, and clothing. Among these, typically recycled materials are metals.**

Metals like iron, steel, and aluminum are mostly found in forms of scrap metal wastes and cans. According to the statistics from Statista, waste generated until today on our planet Earth is more than 2.01 billion tons. It is estimated that by 2050, municipal solid waste generation will increase by 70%. In Bangladesh, the solid waste generated is about 25,000 tons daily.

Solid metal waste is hazardous to health, causing contamination. Moreover, iron and steel take time to degrade and can cause soil pollution and water pollution. So, it will be a wise decision to recycle metal wastes.

The magnetic separation technique is the preliminary step to separate metals with higher magnetic attraction from waste. It is the process of separating ferromagnetic components from the wastes by the influence of a magnetic field. In the magnetic separator, when wastes containing different magnetic properties are passed through the magnetic field, the metals get absorbed by the equipment that generates a magnetic field, and the others go for further recycling. Later on, iron and steel get separated in this technique. Via magnetic separation, about 65% of iron and steel is recycled.

After separation, the scrap metals are crushed in a ball crusher and jaw crusher depending on the size of the scrap. The melted metals are converted to powdered metals by the process of atomization. By blending and applying high pressure to the powdered metal into basic shapes of manufacturing like slabs, blooms, and ingots, the next step is executed. Heating the powder below the melting point allows solid-state diffusion and bonding the particles together; sintering is done. The heat treatment cycle of sintering involves three phases: preheat, sinter, and cool down. Thus, the desired metal parts can be used in manufacturing and converted into usable goods.

The USA recycles more than 40% of the metal wastes by the process of magnetic separation, contributing to earning an annual revenue of 63.4 billion dollars. Not only by benefiting the environment but also by converting the wastes into usable products, the recycling industry is evolving, creating new job opportunities, reducing unemployment, and contributing to economic development. In Bangladesh, due to a lack of proper machinery and infrastructure, we are unable to recycle metals fully. But recycling can play an effective role in developing the economy of the country. Metals can be reprocessed and converted into usable products by this process.

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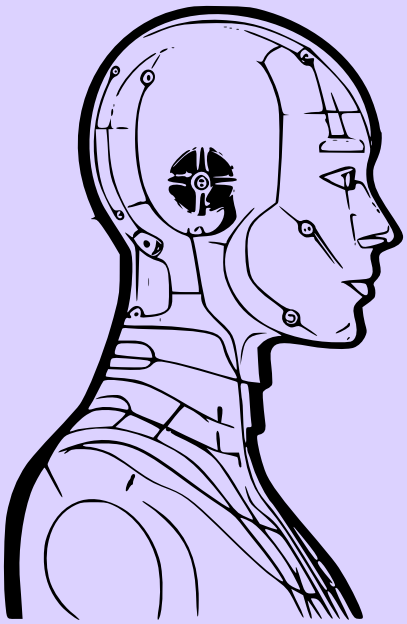
“WASTE DOES NOT EXIST IN NATURE BECAUSE ECOSYSTEMS REUSE EVERYTHING THAT GROWS IN A NEVER-ENDING CYCLE OF EFFICIENCY AND PURPOSE.

- FRANS VAN HOUTEN.



# HOW AI PREVAILED OVER PARALYSIS

AYAANA CHOWDHURY

One of the recent wonders of Science is the technology that helped Gert-Jan Oskam - a 40-year-old man from the Netherlands,suffering from paralysis,walk again. Sensational, isn't it? What would have been considered impossible a few years ago, has been made possible by a group of researchers from Lausanne University Hospital situated in Switzerland.

A brain-spine interface (BSI) had been used by the researchers to re-establish the communication between brain and spinal cord which was disrupted by the injury from a terrible motorcycle accident a few years ago. The BSI stimulated the muscles in the leg which helped the Dutch man move again."I feel like a toddler, learning to walk again," said Mr.Oskam. The BSI consists of two electronic implants which collectively decipher the brain signals and send signals to the spinal cord in order to generate natural physical movements. For this remarkable breakthrough, two surgical procedures were done by the medical professionals: one at the cerebral level which involved the placement of two electrodes in order to capture the brain signals and another one in the spinal cord level where electrodes were placed on top of the spinal cord (this place is responsible for controlling leg movement). This enabled the establishment of a digital bridge which helped to transform Oskam's thoughts into actions.

Although more improvements have to be made in order to make it generally available, it is still a huge leap in neurotechnology which will tremendously benefit the patients in the future.

The surprising thing about this invention is that, after a certain period of time, Mr.Oskam was able to move and walk with crutches even when the implant was switched off! Along with that,he also showed signs of neurological recovery and had improvements in walking and standing functions. The researchers are working to make this technology more accessible and easier to use so that the patients can use it at home without any kind of supervision.

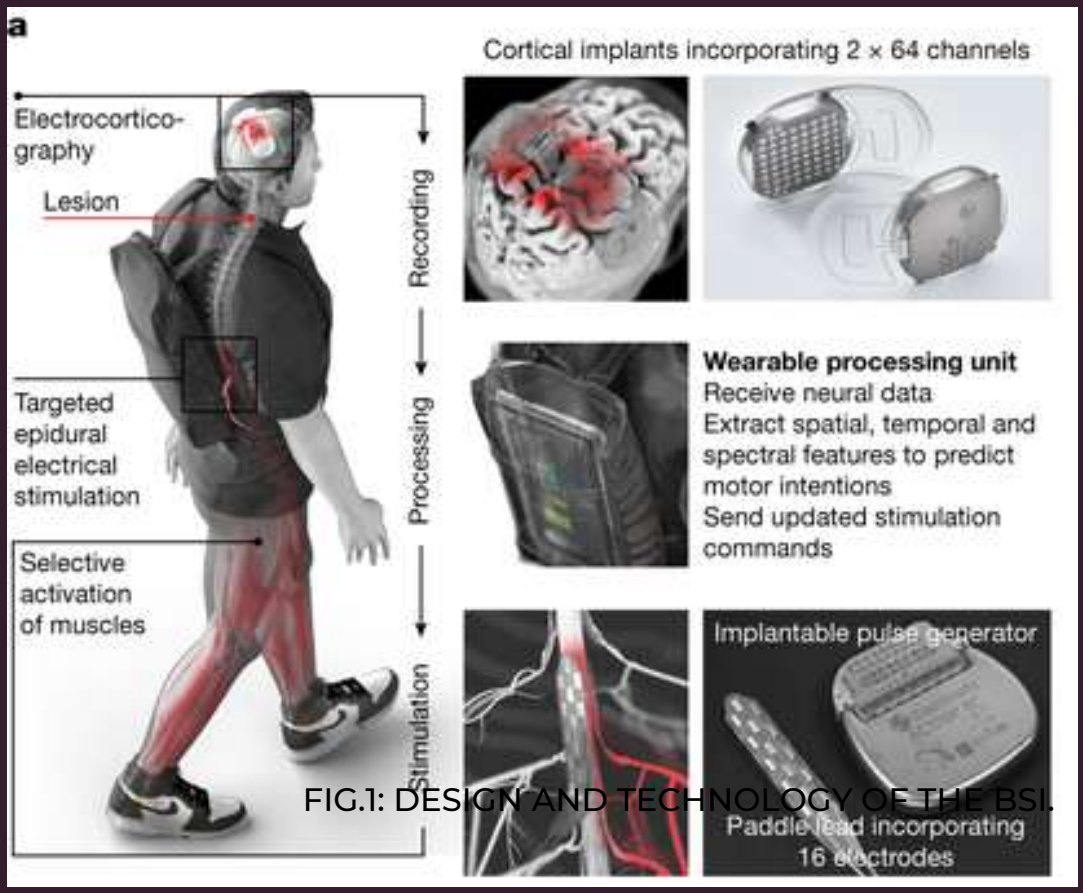



FIG.1: DESIGN AND TECHNOLOGY OF THE BSI.

FIG.1: DESIGN AND TECHNOLOGY OF THE BSI.HTTPS://WWW.NATURE.COM/ARTICLES/S41586-023-06094-5#FIG1 (WITH PERMISSION FROM SPRINGER NATURE)

**Furthermore, this technology can be used to improve control of prosthetic limbs; help in the treatment of Epilepsy, Alzheimer's disease and Parkinson's disease;relieve chronic pain; etc.**

This breakthrough will certainly change the lives of people suffering from paralysis and other neurological disorders.It's truly impressive how much progress has been made in the field of science.

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# CONNECTING YOUR BRAIN TO MACHINES:

## From science fiction to reality

NABILA ISLAM KHAN

For science fiction enthusiasts, we've all seen those iconic movies where the hero effortlessly connects their brain to a machine. Take "Neo" in the movie "Matrix," for example. His brain was plugged into a complex sySTEM, allowing him to navigate his hovercraft with just his thoughts. While these scenes captivated many, the reality often seemed far away.

However, truth is, that this technology exists and is a growing field of research ; all thanks to the huge advancements in neuroscience, signal processing, computational neuroscience. It is known as “Brain Computer Interface”

This is a technology that establishes a communication path between the central nervous sySTEM, and external machines. It has the potential to establish interaction between humans and machines by just thinking about them! Primarily it was designed to provide communications capabilities to severely disabled people who are totally paralyzed or ‘locked in’ by neurological neuromuscular disorders, such as amyotrophic lateral sclerosis, brain STEM stroke, or spinal cord injury [1]. However, with


Fig: Willett, F., et al. (2021).[ brain-computer-interface-turns-mental-handwriting-into-text-on-screen] Photograph. Nature.URL:[A]

time, the technology has evolved, developing beyond their initial use in medical applications, and has made it available to various domains where human-machine interaction is required. The development of BCIs has led to the exploration of different types, including – the electroencephalography (EEG) based, invasive, and non-invasive approaches.EEG-based BCIs: EEG measures brain activity and translates it into commands for external devices. An example is the Emotiv EPOC 16-channel EEG headset, which can be used for various applications such as mental state monitoring and entertainment. It has been used in health improvement, where continuous EEG monitoring devices have been proposed for brain wave recording within the ear canal and controlling hearing devices using BCI [2].

Invasive BCIs: Invasive BCIs involve implanting electrodes directly into the brain. One application is in stroke rehabilitation, where brain signals are used to control assistive devices like robots or muscle stimulators . Studies have shown that EEG signals from both the ipsilateral and contralesionally hemispheres can be used to control cursor movements and assist in motor planning and execution [2].

Non-invasive BCIs: Non-invasive BCIs use techniques like EEG and fNIRS, and TMS. An example is the use of fNIRS to measure brasin activity and control external devices. It has applications in mental state monitoring and artificial prosthesis control [2]. TMS is another non-invasive technique used to stimulate specific brain regions and modulate brain activity for therapeutic purposes [2].

With every advancement, there are challenges as well. BCIs encounter technical hurdles like poor signal quality, user training difficulties, and, a lack of standardization in hardware and software Beyond technological issues, ethical considerations include privacy, misuse, and data protection. The ability to access and analyze cerebral activity raises concerns about privacy and security of ideas and intentions.

**Finally, using BCIs for study or medicine requires informed consent and control over neural data. [2]**

Despite these challenges, the revolutionary potential of BCIs in enhancing quality of life and increasing human capabilities is substantial, and ongoing research and development in the field hold promise for a future in which BCIs are integrated into a variety of societal elements.

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MAHTAB MAHDI NIHAL

# Does Facebook listen in on our microphone?

FIG 1: A MIMICRY BASED ON FACEBOOK LISTENING TO ITS USERS VOICE. WSJ

**Have you ever been thinking about a certain product, or talking to someone about it, but you didn't search the internet, but then you saw a related ad on Instagram or Facebook. Then you start to get scared and think, Facebook is recording your mobile audio for better ad shows. Is this true?**

In short, no. Facebook knows so much about you or me that it doesn't need to spend extra money on tapping our microphone. And Facebook doesn't do that.

First, the number of Facebook users is in the billions. **Is it really possible for a company like Facebook alone to collect the voice data of so many people and traffic based on it?**

The answer is yes. Highly probable. Large-scale audio data analysis requires a high level of computing capacity. The Facebook firm is well-equipped to follow the voice data of its customers thanks to its 18 data centres worth $20 billion and ownership of the largest and most productive supercomputer in the world. Facebook alone to collect the voice data of so many people and most productive supercomputer in the world.

However, they don't. Facebook already has more data than your voice, for this reason. Facebook is done forecasting, even if you haven't considered your next move yet, it might even match.

Once more, Facebook could get voice data, but it wouldn't be particularly helpful. Imagine you are in a restaurant with 50 other individuals, all of whom are using mobile phones. It would be difficult to determine who is speaking and providing specific advertisements in this situation. However, Facebook's parent corporation meta probably doesn't mind too much because they advertise you fairly well both online and offline. Facebook does not tap our microphone . Because by examining the traffic from our phones and computers, the Electronic Frontier Foundation, or EFF, found no proof that anyone was actually gathering voice data from them during advanced testing.[1]

## Why do you believe Facebook tapped your Microphone, then?

Facebook has information on you, your body type, age, place of residence, place of travel, family members, friends, the grocery store you usually shop at, the information associated with your credit card, the items you use, and the types of content about which users maintain their data. Facebook also has access to your location, purchase history, bank account information, etc. They used to purchase this information from third parties who collected data, but Facebook now employs its own data collectors and has no affiliation with any other third parties.[2]

Facebook also gathers information about your search history by using Facebook Pixel. Facebook maintains a comprehensive list of all your activity, preferences, and likes. With their enormous processing capacity and this list, they can target adverts so effectively that we don't need to process our voice separately.[3]

Without a doubt, Advertisement and this advertisement company are responsible for maintaining free internet. However, aside from Facebook, other applications can also gather your data by following you around in other ways. And the interesting and scary fact is, without ever listening to you or seeing you, they know more about you than you do.

Therefore, there is a well-known phrase,

> **"IF SOMETHING IS FREE ON THE INTERNET , THEN YOU ARE THE PRODUCT."**

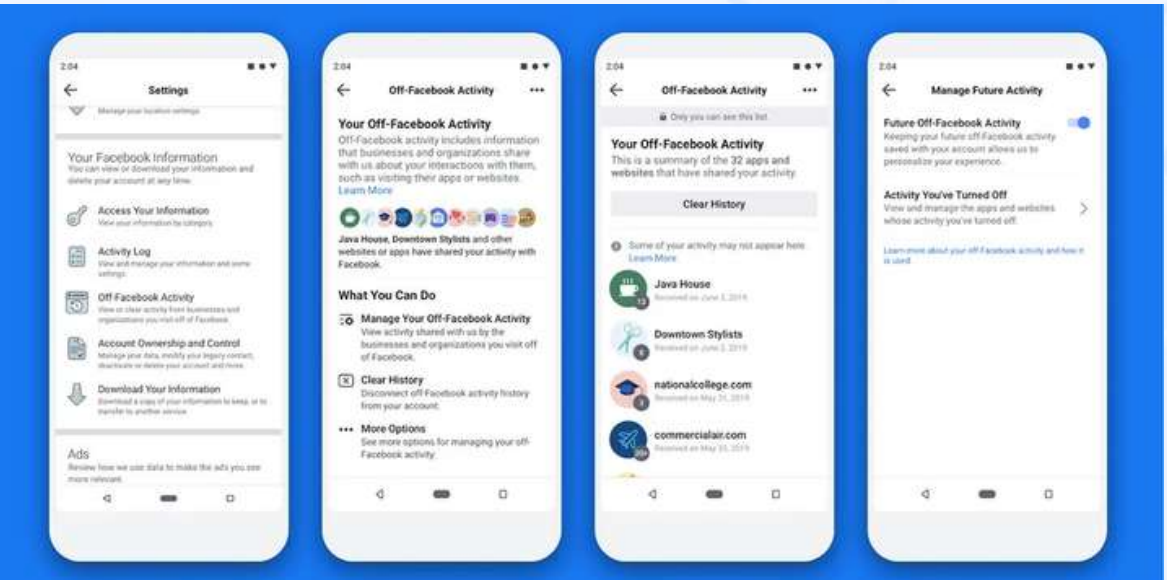


FIG 2 :FACEBOOK DO SPY ON YOU VIA DIFFERENT METHOD , JUST NOT BY TAPPING YOUR MICROPHONE. (WIRED.IO)

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# ARTIFICIAL INTELLIGENCE
## ADVANCING ARCHITECTURE

SAMIRA TABASSUM ZARIN

AI has been causing a stir across a number of sectors, and architecture is no exception. The creation of sySTEMs that can do activities that traditionally need human intelligence is the focus of this technology, which is becoming more and more integrated into architectural practices and resulting in substantial changes to the design process.

## AI IN ARCHITECTURAL DESIGN:

The design process is one of the most noteworthy instances of AI being used in architecture. For instance, Stanislas Chaillou's research on the use of AI to space planning and architectural design has attracted considerable attention. Chaillou created a sySTEM that creates and furnishes floor layouts while taking into consideration utility and style using deep learning and Generative Adversarial Neural Networks (GANs). This tool enables several project revisions and generates realistic floor plans that the designer may use as the foundation for more research and inspiration.[1]

In a similar vein, academics at the University of Michigan have been looking at AI's application in architecture. Their research examines how artificial intelligence may be used to develop fresh architectural concepts. On 2-D-to-2-D neural style transfer challenges, which entail altering one picture to conform to a particular style, neural networks have been employed. [2]

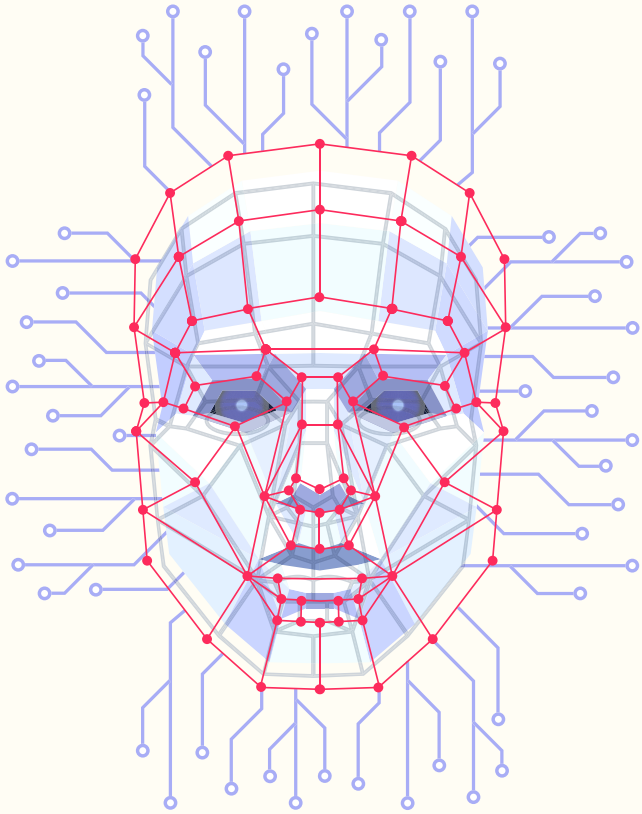
## INFLUENCE ON ARCHITECTURAL TECHNIQUES:

Opportunities presented by AI might fundamentally alter the way that the architectural profession now works. By giving users access to vast quantities of data, producing models, deciphering the built environment, and generating cost estimates, it may greatly simplify the planning process. To expedite design and construction, architects may quickly receive all this information.

Additionally, AI makes it easier to gather and analyze massive amounts of data, which may reduce costs and incorporate sustainability into designs. Architects and clients may better predict how the completed construction will appear and how it might be improved by incorporating these smart elements into the blueprints[3].

## FUTURE POSSIBILITIES:

Your paragraIt may not take long until this body of work achieves a critical mass and enters the mainstream design process, even if AI's advancement in architecture is presently only visible at the periphery through research projects, art, and cross-pollination across other study fields. A detailed examination of its design procedures and AI technologies has already been conducted by the research section GXN of famous architectural firm 3XN. The study found three key areas where AI may have a beneficial impact: information organization, iterative process improvement, and creation of an internal experience database[1].



In conclusion, through enhancing design processes and introducing novel solutions, AI is ready to transform architecture. This technology will likely play a more important part in society as it continues to grow at a rapid rate.

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# Scientists Discover New Shapes That Can follow You Anywhere

ABDULLAH OMAR NASSEEF

Imagine you are a small child scribbling random squiggles on a sheet. After you are finally tired of your chore, you pick up the toy you have lying around and voila, it starts to roll over all those squiggles you scribbled, following its path. While this sounds like something out of a fairy tale, it could be made into reality.

If you place a ball or a cylinder on a table, you will see that it rolls down a straight line predictably. You may get slight twists and turns. However, there is no absolute control over the way it will move independently without applying any external force. But what if you could make a shape that will follow any specific path you want, with many unpredictable twists and turns? Scientists have been looking for an answer to this question, and a recent breakthrough provided them with one. A group of physicists and mathematicians from the Institute of Basic Science in South Korea have discovered a mathematical algorithm that could serve this exact purpose. Provide this algorithm a path you want your shape to follow. and it will model a shape for you that will follow that exact path on its own, without any external “push” or guidance. And the name the scientists came up with for these shapes is “trajectoid,” as they can follow any given trajectory.

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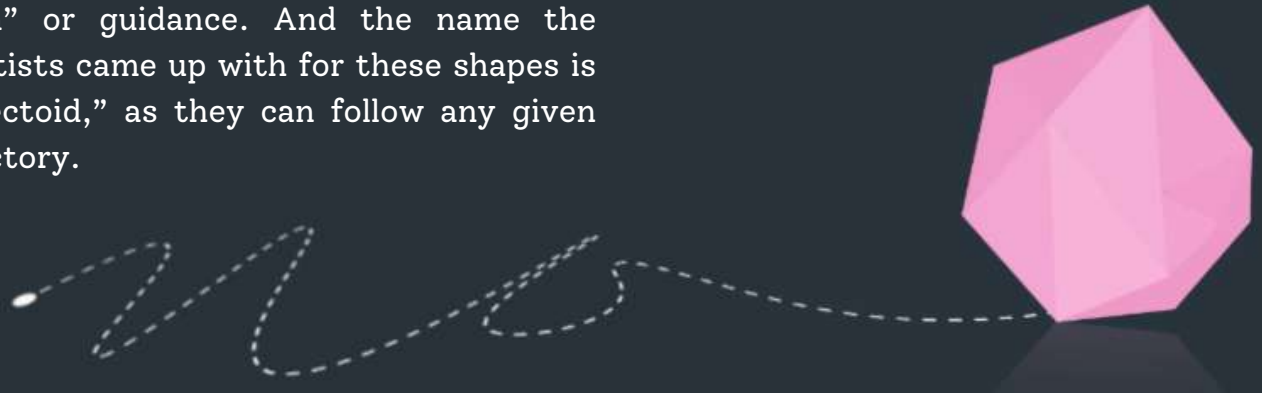
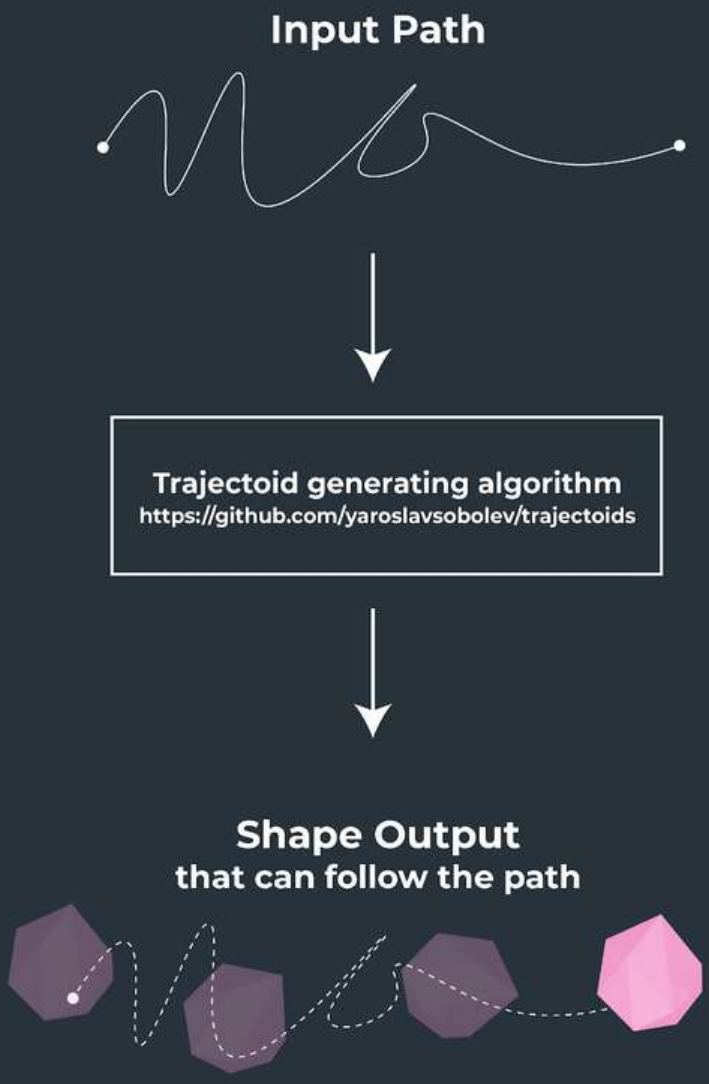
follow that exact path on its own, without any external “push” or guidance. And the name the scientists came up with for these shapes is “trajectoid,” as they can follow any given trajectory.

This is not just a theoretical prospect – the scientists also have 3D printed these trajectoids, and, if the center of mass is kept fixed by placing a heavy ball bearing inside the hollow shape, it could follow the path it was made for. A wonderful video demonstration of this could be found on YouTube titled “These shapes roll in peculiar ways thanks to new mathematics”, uploaded by the channel “nature video”.






Citation:
Sobolev, Y.I., Dong, R., Tlusty, T. et al. Solid-body trajectoids shaped to roll along desired pathways. Nature 620, 310–315 (2023). https://doi.org/10.1038/s41586-023-06306-y

As with any scientific discovery, there is always the question of real-life applications. And the real-life applications for trajectoids are immense and diverse. Imagine you need to send a rover along a pre-defined path such as a valley with lots of twists and turns. Trajectoids could be utilized to navigate these pathways in a cost-efficient way, as you do not need to use any controllers to guide your rover. Other than robotics, it also has applications in synthetic biology. Cells could be designed in shapes so that they can follow pre-defined pathways to target specific organs or tissues in the human body, delivering a required drug more precisely for some treatment. Think of delivering drugs with trajectoids to destroy cancer cells. There is also ongoing research on its applications in various other fields like quantum physics and quantum computing.

Other than real-life applications, the discovery and research on trajectoids provides a profound realization regarding mathematical research as a whole. While mathematics as a major or minor is generally seen as something extremely theoretical and lacking in any real-life applications, the discovery of the algorithm to generate trajectoids proves that mathematics can be an essential tool to guide us toward discovering practical solutions utilizing various other fields of science, technology, engineering, and mathematics, or as we like to call – STEM.

# ELECTRIFYING STRESS

RAIYAN IBNE HOSSAIN

Gen-Z humour features memes where mental stress gets converted into electricity. In reality, converting mechanical stress into electricity is a real thing whose history dates back to 1880. This phenomenon, discovered by Pierre Curie and Jacques Curie, is called the piezoelectric effect. Piezo means 'press' or 'squeeze' in Greek. Just like the name suggests, the effect manifests when materials like quartz and PZT (lead zirconate titanate) are compressed along specific axes. Such application of pressure causes the material to emanate an electric field. When it comes to real life applications, piezoelectricity offers endless opportunities.

With rapid depletion of fossil fuel and exacerbation of environment, the scientific community is making extensive efforts to fully switch to clean, green energy generation which includes both nuclear and renewable energy. Some of the sustainable energy types are solar energy, wind energy, biomass energy, nuclear energy, hydro energy, etc. Recent developments show that piezoelectric energy has immense potential too.

Piezoelectricity has some unique advantages over conventional methods of electricity generation. Unlike other forms of electricity, it requires no external electromagnetic or thermal excitation. There is no significant electromagnetic or thermal loss associated with this technique. It offers high energy and power density. It is implementable at both micro and macro scales. It is easy to integrate piezoelectric transducers in energy harvesting sySTEMs. The cost of required piezoelectric material and relevant equipment to build a piezoelectric energy harvesting sySTEM is low too. All these benefits make piezoelectricity an exciting prospect. However, piezoelectricity has few shortcomings as well. Its power output is very low; a single piezoelectric energy harvester can reach the order of milliwatts at max.

Certain factors influence a harvester's power output. Intrinsic factors include the material's frequency constant, piezoelectric and mechanical properties of the material, and the temperature and stress dependence of the physical properties. Extrinsic factors comprise the input vibration frequency, acceleration of the base/host structure, and the amplitude of the excitation. Output power is maximized when the resonant frequency of the

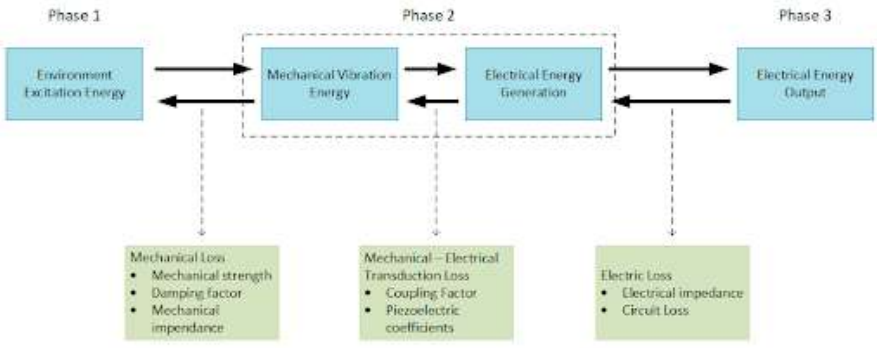



Fig 1: Flowchart of piezoelectric energy generation (Covaci et. al 2020)

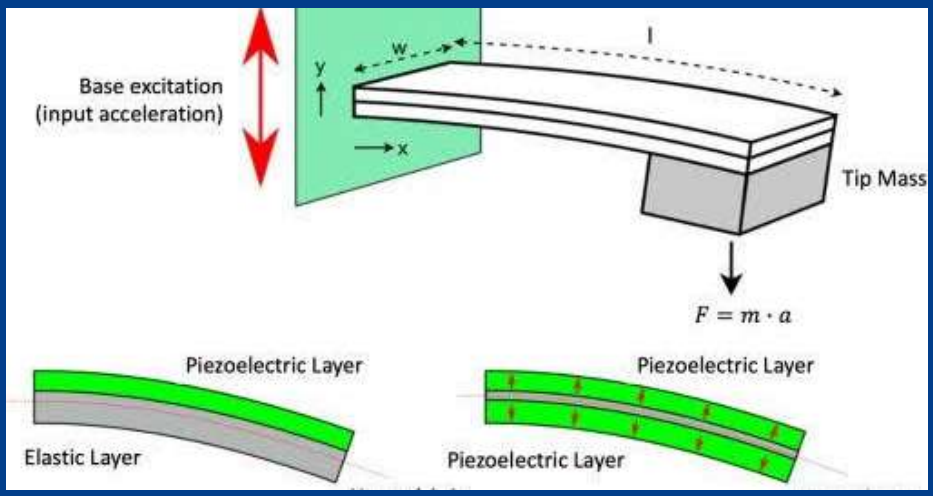



Fig 2: Mechanism of receiving input by a piezoelectric energy harvester (Sezer et. al 2021)

material matches the frequency of the input vibration.

The prospect of piezoelectric energy generation is two-fold. First, it can be deployed in embedded electronics to make those devices self-operating, eliminating the necessity of a battery. Second, energy harvesters can be installed in hundreds of miles of pavements, urban roads, motorways and railway tracks. The vibrations produced by millions of people's footsteps, thousands of motor vehicles and trains are enough to generate power on the order of megawatts. This allows the power grid to capture power which otherwise would have been lost as vibration.

At present, adoption of piezoelectricity can be found in high-precision applications. Piezoelectric sensors are used in diesel fuel injectors, engine knock sensors, pressure sensors, etc. Piezoelectric actuators are great for ultrasonic cleaning & welding, printers, speakers & buzzers in different devices, high-precision optical adjustment, piezoelectric motors, etc. Innowattech and Pavegen are companies which have successfully generated energy from road traffic and/or footsteps using piezoelectric energy harvesters.

In a world where energy crisis has been looming over for decades, which has been worsened by the diminishing of fossil fuel and its irreversible negative environmental impact, it is of utmost importance to look for scalable clean energy alternatives to replace the incumbent. Piezoelectric energy harvesting gives the world the hope that diversified clean energy is the future.

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# Wind-powered cars:

## The Gale of the Future

**Mohammad Mahriz Mashir Hossain**

Wind. The source of renewable energy that has been harnessed and used widely by human beings, starting more than 7,000 years ago. More than any other sector, wind has had a massive impact on transportation. After all, wind was used to navigate ships from ancient times with the help of sails. Though wind had effectively "fallen out of fashion" as a transportation fuel in the early 1900s, it has recently seen a revival in the form of proposals for and developments in wind-powered cars.

Wind-powered cars are probably one of the longest on-going prototype projects ever since the dawn of motor cars. In the 1930s and 1940s, various independent automobile makers designed and proposed cars that had propellers and fans mounted on the rear; the initial steps taken to lasso the abundant wind energy of the Earth and use them in cars. Unfortunately, gasoline and coal power was the trend and as a result, this new innovation never really took off. In recent times, however, with the rising concerns for global warming and climate change, the impactful potential of wind-powered cars are being considered by automotive companies worldwide. In the early-2010s, the island of Orkney, off the north coast of Scotland, gained a name for using clean energy and wind was one of them.

The islanders of Orkney decided that, rather than waste the abundance of wind

Fig 1: The Toyota Mirai (Adapted from AMPO, https://ampo.org/are-wind-powered-cars-a-reality-or-just-science-fiction/,

and tide available in the region, they could use this energy to break down water into hydrogen. This hydrogen was then used to power their cars and buses instead of natural gas or fossil fuels, reducing the pollution of the community overall. Automotive companies from around the world were quick to note the innovation that was taking place at Orkney and initiate research and development into this particular area.

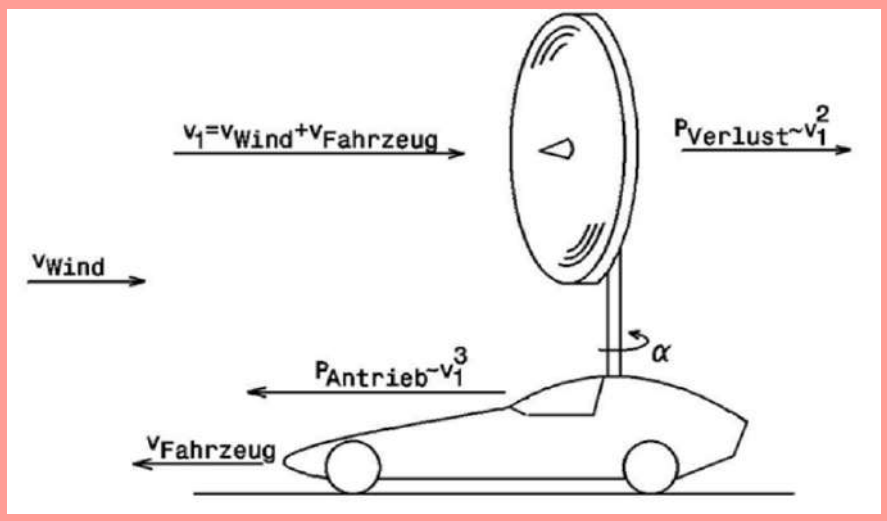
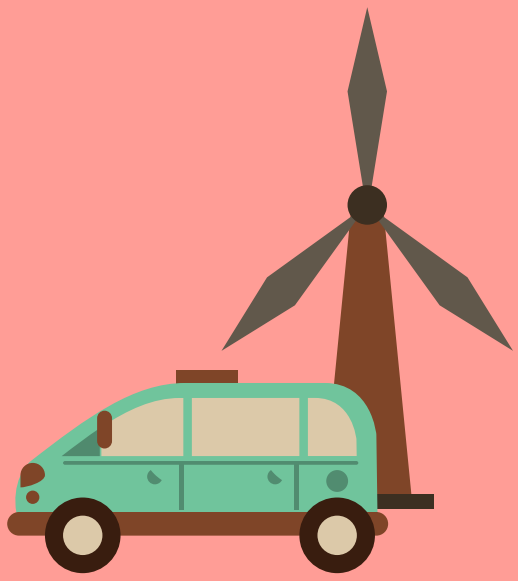



Fig 2: The Ventmobile (Adapted from AMPO, https://ampo.org/are-wind-powered-cars-a-reality-or-just-science-fiction/,

Japanese automobile makers were some of the first to successfully develop wind-powered cars commercially, namely Toyota and Lexus. The Toyota Mirai (Fig 1) is a hydrogen fuel-cell car that has been in production since 2014. Not only does it have the ability to combine hydrogen and wind energy, but it can use the wind to produce the hydrogen required to fuel the

car. Another example is the Lotus Nemesis from the British manufacturer Lotus. The car indirectly uses wind energy to power its electric powertrain. It is notable for being in development for two years as well as being worked on by a team of Formula 1 engineers. Yet another successful and unique wind-powered vehicle was designed by the students of The University of Stuttgart in 2008, called “The Ventmobile” (Fig 2). The car had a large fan attached to its roof that would use wind power to run. Though it was just a concept, its design stated that wind-powered vehicles were not too far off from becoming the future of transportation.

With rising problems in vacancy of space, population and demand for fuel, automotive experts have stated some disadvantages and hindrances in the path of



wind-powered cars. It has been noted that to properly develop an automobile that runs solely on wind, it might take more than a decade from now. As such, companies have started to wonder if investing in other sectors of innovation is wiser. Nevertheless, wind-powered vehicles have made their stand in the myriad of developments and despite the criticisms and rejections, they have settled into the modern canvas of automotive development as the gale of the future.

## References:


Fig 1: Adapted from AMPO, https://ampo.org/are-wind-powered-cars-a-reality-or-just-science-fiction/, originally published by Martin Banks

Fig 2: Adapted from AMPO, https://ampo.org/are-wind-powered-cars-a-reality-or-just-science-fiction/, originally published by Martin Banks

# THE MATHEMATICIAN WHO DOES NOT EXIST

MAHTAB MAHDI NIHAL

> "STRUCTURES ARE THE WEAPONS OF THE MATHEMATICIAN.
> – NICOLAS BOURBAKI

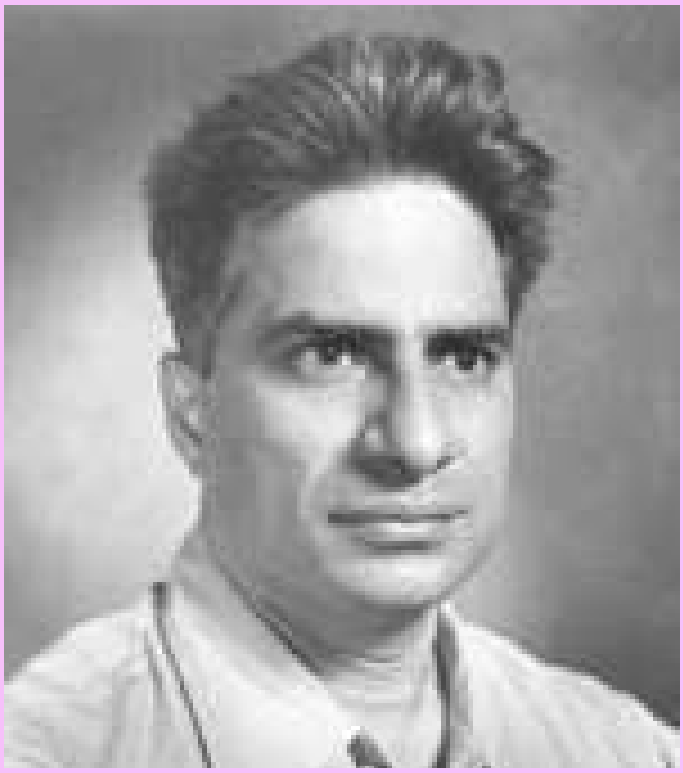
The above quote was said by a French mathematician, Nicolas Bourbaki. One of the top 25 mathematicians in the world. His book, Theory, is still in use in many parts of the world. But People had only one minor issue with him. That is, this individual does not exist. I mean, one of the world's best mathematicians, Nicolas Bourbaki, doesn't really exist.

Let's go back a little , 16 years ago, in 1934. In the Latin Quarter of Paris, France, five students from the École Normale Supérieure gathered in a secret meeting. They all had the same purpose. Developing a global set of universal mathematical norms. At that time , there were no uniform criteria for formulating mathematical formulas or conjectures . Every mathematician was expressing terms in their own individual manner.As a result, it caused numerous difficulties for other people to understand those terms. Also, their textbooks at the time were quite difficult to comprehend. So they started working together to create an excellent, easy-to-read book for everyone and also to establish universal terms to express mathematical conjectures. The Bourbaki Congress had two main goals. The initial action was to develop a standard format for mathematics, and the second was to produce a universal textbook. But no one will publish the paper of an unknown mathematician. Also, if this is done in the name of a single member of Congress, no one else gets credit. Erosion will occur as a result. To address this issue, they developed a character named Nicolas Bourbaki, a fictional mathematician who does not exist. Nicolas Bourbaki described himself as a highly educated mathematician with multiple publications.Many people began to see him as a great mathematician after seeing his writing style. They gradually began publishing books and essays. Nicolas Bourbaki remained the author of this work and Borbaki Congress mathematicians stayed in the background. People used to say that Bourbaki never met anyone. He spoke to very few people. Article or book publication was done through correspondence. These were normal in those days. The world knew one Nicolas

Bourbaki. And the mathematicians of Bourbaki Congress achieved their goal. So far 12 books have been published under the name of Bourbaki. His first published book was Theory of Sets. Then Algebra, starting with General Topology, his last book was on Algebraic Topology.

But it was not easy for Bourbaki to become a member of the Congress. Being a part of this club required a lot of talent and hard work and a lot of selection. From 1934 to 2000, only around 40 people managed to become members of this Congress. But the Bourbaki Congress was not a serious matter at all. To maintain the illusion of Nicolas Bourbaki's existence, they even went to great lengths, such as sending out wedding invitations for Bourbaki's daughter and responding to doubters and critics. After nearly 20 years of fooling the world and mathematicians, finally in 1968 the Bourbaki Congress decided to put an end to this prank.


THE MAIN COUNCIL OF BOURBAKI CONGRESS



THE PHOTO USED FOR NICHOLAS BOURBAKI

The Bourbaki Congress, under the guise of Nicolas Bourbaki, accomplished its objectives, leaving an indelible mark on the history of mathematics. However, many criticised them for deceiving the world for 20 years. In any case, the mathematicians working under the pseudonym Nicolas Bourbaki succeeded in achieving their goals, that much can be said.

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# ACTIVITIES
## of ASME IUT Student Section

ASME is facilitating sessions on career development, conducting workshops on research writing and organizing sessions on developing LinkedIn and Facebook profiles to equip students for their upcoming professional endeavors. Other activities include hosting seminars to provide guidance to students on the processes involved in publishing research, covering topics such as scientific paper composition, journal selection and navigating the peer-review sySTEM. Other works are organizing an orientation program to introduce ASME to new students and showcase its activities, also placing stalls at various events, including OIC Day and IUT - ICMMPE, to promote ASME and its initiatives.


Pictures of ASME Orientation 2023

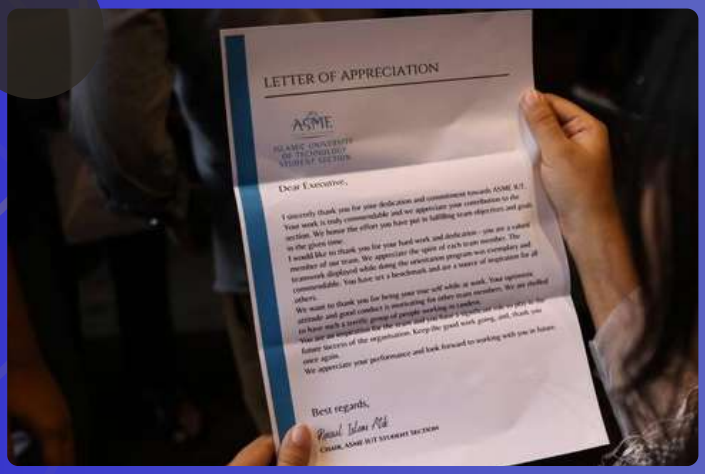


Pictures of ICMMPE conference day

Pictures of OIC day 2023

# ACHIEVEMENTS

“The last two years for the ASME IUT Student Section have been commendable in its history. The course of time has been full of achievements for both the individuals and the teams. Let’s throwback to the milestones our honorable members have reached to feel great and get some inspiration.”




Raisul Islam Atik, a founding member and former chairperson of the ASME IUT Student Section, showcased exemplary leadership both locally and globally. He excelled as Chairperson and contributed significantly to the ASME Student Regional Board – Asia Pacific team. His impactful leadership extended beyond campus borders, leaving a lasting legacy. Notably, he attended The Student Leader Training Conference (SLTC), strengthening ties with ASME members worldwide and representing the ASME IUT Student Section on a global platform.

One notable achievement this year was by Tasnia Islam Rifa, Vice Chair of the executive panel 2022-23 of ASME IUT Student Section, who became the first Bangladeshi to receive the ASME Foundation Variable Scholarship. This recognition was awarded for her exceptional academic performance, leadership, and contributions to the ASME IUT Student Section. Additionally, the mention of her and our society in the national newspaper, "The Daily Observer," added to our pride.

Fawaz, the treasurer of the ASME IUT Student Section's executive panel 2022-23, is highly respected for his talent in Mechanical Design. His active involvement and willingness to share his skills have inspired others and expanded the knowledge domain within the society. Fawaz's remarkable designing fluency has been evident to IUTians.

Md. Hasibur Rahman Hamim, a distinguished Chairperson of ASME IUT Student Section, is renowned for his exceptional management and leadership abilities across our campus. He is also a highly talented individual with outstanding writing skills. Since his 3rd year, he has been actively involved in research and has published a paper in a Q1 journal under the guidance of our professor.

Our own vice chairperson, Nazmus Sakib, achieved the 2nd runner-up position in Assemblaze presented by ACI Motors and received a 70% scholarship for the CSCA course offered by ISCEA through PTAK.


Serniabat Wasit Tawassaf, the general secretary of ASME, excels in CAD design, contributing significantly to our institution's reputation. His achievements include runner-up positions at TechnoCAD (MindSparks 2023) and CAD Contest (Ignition 2023), as well as winning titles such as Champion at CAD Crosshairs 2.0 (IPE Fiesta 2024) and CAD Contest (Calibration 2024). Additionally, he won the PTAK prize of a 70% scholarship for the CSCA course organized by ISCEA along with our assistant general secretary Md. Mahmudul Hasan Bhuiyan and organizing secretary Nazia Tasnim and became the champion of the ASME E-Fest 2024 Technical Digital Poster competition.



Syoda Anamika Jahan, joint secretary of ASME, achieved a 60% Scholarship in the PTAK case competition 2022. She is recognized for her outstanding academic accomplishments and contributions to the ASME IUT Student Section. She was awarded 1st prize for capstone project 2023 “Design and Fabrication of GraphiCNC a Machine”.

Md. Jawad Rahman Chowdhury, our dedicated Secretary of Creative Contents, achieved positions in Certified Supply Chain Analyst, Ennovators 6.0 in Banglalink, and was among the top 140 participants in ISCEA PTAK Prize (2022).

Bismy Illian Maeem, a senior executive within the IT team, achieved Bronze Honour in the International Astronomy and Astrophysics Competition 2023.

Md. Ibrahim Hossain Khan, our senior executive member of research and development, is recognized for his and design abilities. He secured the 1st Runner Up position in Ignition 2023 and was Champion in Calibration 1.0 2024.

Tanzim Ahmed, a member of ASME IUT student section, attained the 1st Runners Up position in the AUST Mechcellence Industrial Case Competition (2023) and also received a 60% scholarship in ISCEA PTAK Prize 2023.

Maysha Anan, a senior executive of creative contents, exhibited extraordinary talent in Autofest 2024 organized by BUET automobile club. She and her team, Team TURBO, secured the 1st Runners Up position in the Casecraft Autorealm segment.



Sazidur Rahman Chowdhury, senior executive of the strategy and planning division, has actively shared his skills to broaden the expertise he embodies. With Team KitCADS, he became the champion of Techno CAD at MindSparks 2023 organized by Ahsanullah University of Science and Technology's Innovation and Design Club (AUST IDC).


Sawda Muntaha's exceptional management and leadership abilities are widely acknowledged on our campus. Her team's outstanding performance in the LFR Segment of the AUST Rover Challenge earned them the 1st Runners Up position.

Md. Samiul Ibn Safayet, a senior executive of the research and development department at ASME IUT Student Section, earned Bronze honors in IYMC 2022 and IAAC 2023. Additionally, he secured a 60% scholarship in the ISCEA PTAK Prize 2023 for the CSCA course.

# ASME IUT Student Section

# Panel Tree

**MD. Hasibur Rahman Hamim**
**Chairperson**

**Nazmus Sakib**
**Vice Chair**

**Serniabat Wasit Tawassaf**
**General Secretary**

**Syoda Anamika Jahan**
**Joint Secretary**

**Mehedi Hasan**
**Treasurer**

**Tanzim Hasan**
**Secretary**
**Strategy and Planning**

**Mohammed Khalid Bin Sayeed**
**Secretary**
**Public Relations**

**Arafat Ahmed**
**Secretary**
**IT**

**MD Jawad Rahman Chowdhury**
**Secretary**
**Creative Content**

**Masruf Zaman**
**Secretary**
**Research & Development**

**Aynul Haiyat Seyam**
**Secretary**
**Social Media**

**Hasibur Rahman Shammo**
**Secretary**
**Administration**

**MD. Mahmudul Hasan Bhuiyan**
**Assistant General Secretary**

**Nazia Tasnim**
**Organizing Secretary**

**Shadman Arif Rohan**
**Assistant Joint Secretary**

**Iftekhar Rahman Ifty**
**Assistant Treasurer**

**Sazidur Rahman Chowdhury**
**Senior Executive**
**Strategy and Planning**

**Sawda Muntaha**
**Senior Executive**
**Public Relation**

**Tanzim Ahmed**
**Senior Executive**
**Public Relation**

**Maysha Anan**
**Senior Executive**
**Creative Content**

**Bismy Illian Maeem**
**Senior Executive**
**IT**

**Rawas Saad**
**Senior Executive**
**IT**

**MD Ibrahim Hossain Khan**
**Senior Executive**
**Research & Development**

**MD Samiul Ibn Safayet**
**Senior Executive**
**Research & Development**

**Mir Tasnuva Sara**
**Senior Executive**
**Social Media**

**Naoshin Anzum Islam**
**Senior Executive**
**Social Media**

**Samiuzzaman Sami**
**Senior Executive**
**Administration**

**Mahreen Zaman**
**Executive**

**Tasmiah Zaman**
**Executive**

**Maliha Rahman**
**Executive**

**Ahmed Intekhab Rohan**
**Executive**

**Hasan Abdullah Talha**
**Executive**

**Ramisa Alam**
**Executive**

**Shahriar Abdullah**
**Executive**

**Afif Ajjan**
**Executive**

**MD Arif Hossen Saikat**
**Executive**

**Tasfia Chowdhury**
**Executive**

**Safrat Samia**
**Executive**

**Fariha Khan**
**Executive**

**Nafis Ayman**
**Executive**