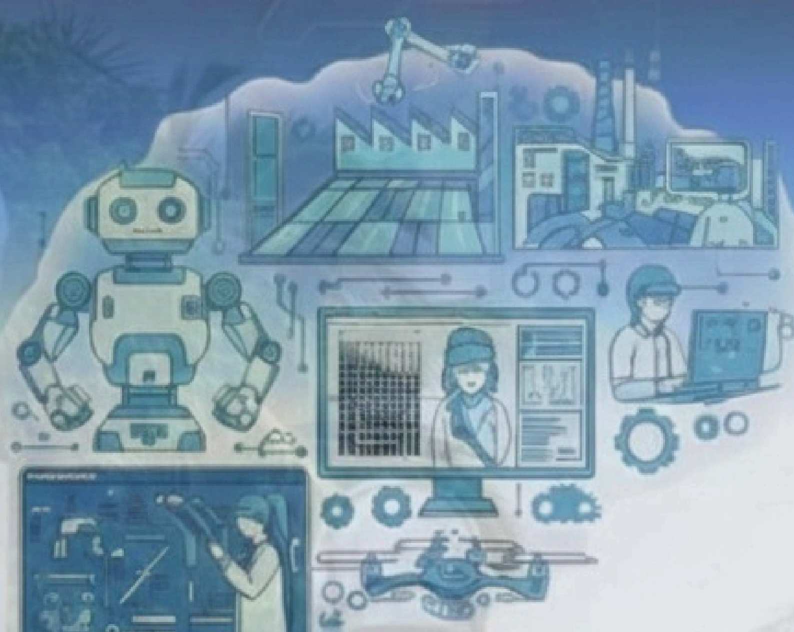
DEPARTMENT OF MECHANICAL ENGINEERING

KARMIKA

(TECHNICAL MAGAZINE)



2026

VOLUME-1

AHALIA SCHOOL OF ENGINEERING & TECHNOLOGY

ISO 9001: 2015 Certified Institution | Approved by AICTE & Affiliated to A. P. J. Abdul Kalam Technological University

Ahalia Campus, Palakkad I Ph: 04923 226666

KARMIKA

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Ahalia School of Engineering & Technology (ASET)

ABOUT

Ahalia School of Engineering & Technology (ASET), Palakkad, an ISO 9001:2015 certified institution, is approved by All India Council for Technical Education (AICTE) and is affiliated to the A. P. J. Abdul Kalam Technological University, Kerala. We provide world-class technical education and training in the fields of Science, Engineering, Technology and Management to meritorious students from diverse socio-economic backgrounds. The college is located in a lush green campus with a beautiful view of the Western Ghats. It provides a peaceful and congenial atmosphere, ideal for students for their overall holistic development. Ahalia School of Engineering and Technology offers Six Bachelor of Technology (B.Tech.) courses in Artificial Intelligence and Machine Learning, Civil Engineering, Computer Science and Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering and Mechanical Engineering, that is complemented by various co- curriculur and extra- curriculur activities. ASET is one of the several institutions in Ahalia Campus.

Vision

Grow as a center of learning and research, transforming students to professionals with knowledge, skill, competence, commitment, confidence through decisive learning and contribute to the sustainable development of the society.

Missioin

To instil technical expertise in order to address current and emerging challenges in the quest for creating sustainable and high-quality livelihoods. To foster a culture of research, innovation, and entrepreneurship through determined learning. To promote an environment that supports the welfare of society through ethical and professional conduct.

Mechanical Engineering

ABOUT

The Department of Mechanical Engineering at the AHALIA School of Engineering and Technology, Palakkad was formed in the year 2012 along with the start of the institution. The Mechanical Engineering department provides an outstanding academic environment complimented by excellence in teaching. The department offers B.Tech. degree. The department has a comprehensive syllabus on topics covering all the aspects of production, manufacturing, thermal, fluid mechanics and Design. The department also emphasizes on practical learning. The course structure includes courses on Computer aided machining and manufacturing to equip our students with the latest developments in the field of production and manufacturing.

Vision

The Department of Mechanical Engineering will create professionals with sound technical knowledge and innovative approaches, and are competent to pursue diverse and successful careers

Mission

To nurture students with moral and ethical values so as to excel in academics and innovative research activities that meet the industrial and societal challenges

To motivate staff and students for creative thinking, thereby enriching the teaching-learning experience

Chairman’s Message

Dr. V S Gopal

It gives me great satisfaction to witness the release of the first edition of KARMIKA, the technical magazine of the Mechanical Engineering Department. This initiative reflects the academic strength, creativity, and forward-thinking approach of our institution. Ahalia, we believe that academic excellence and creative inquiry must go hand in hand in shaping the engineers of tomorrow. Our vision at the Ahalia International Foundation has always been to nurture an environment where knowledge, innovation, and values converge to empower young minds for real-world challenges.

Mechanical engineering plays a crucial role in shaping the technologies of tomorrow — from energy and automation to manufacturing and sustainable solutions. In today’s competitive and rapidly evolving world, it is important that students go beyond classroom learning and actively engage in research, innovation, and knowledge sharing.

The inaugural edition of KARMIKA marks the beginning of a meaningful academic tradition. It provides a valuable platform for students and faculty to present their ideas, showcase technical insights, and stay connected with emerging trends in engineering. Such efforts help nurture analytical thinking, creativity, and professional growth. It reflects our commitment to promoting inquiry, creativity, and excellence in technical education.

I congratulate the Department of Mechanical Engineering, the editorial team, and all contributors for their dedication in bringing out this first issue. I am confident that KARMIKA will grow into a vibrant forum for technical excellence in the years to come.

I extend my best wishes for its continued success.

Principal's Message

Dr. Suresh P R

It is a matter of great pride and pleasure to learn that the Department of Mechanical Engineering of Ahalia School of Engineering and Technology is launching its first technical magazine, KARMIKA. I congratulate the department for taking this valuable initiative.

The name KARMIKA reflects engineers as creators and builders, symbolizing the spirit, dedication, and innovation that define the engineering profession. In today's fast-changing technological landscape, powered by Industry 4.0, Artificial Intelligence, Robotics, Additive Manufacturing, Electric Vehicles, and Renewable Energy, mechanical engineers play a vital role in developing innovative, sustainable, and intelligent solutions for the future.

This magazine will serve as an excellent platform for students to express their technical knowledge, research ideas, creativity, and innovative thinking. I encourage all students to actively contribute, stay curious, and continuously upgrade their skills to meet global standards.

I extend my sincere appreciation to the Head of the Department, faculty members, and students for their efforts in bringing out this inaugural edition. I wish KARMIKA every success in the years ahead.

Vice Principal's Message

Dr. Krishna Kumar Kishor

It gives me immense pride to introduce the first edition of Karmika, the technical magazine of the Department of Mechanical Engineering. The name itself-rooted in the concept of 'action' and 'labor' perfectly encapsulates the spirit of a mechanical engineer.

In an era defined by Industry 4.0, robotics, and sustainable energy, the field of mechanical engineering is undergoing a massive transformation. Karmika is designed to be a platform where our students and faculty can document this evolution, sharing insights on emerging technologies and creative design solutions.

I congratulate the editorial team for their tireless effort in bringing this vision to life. May this inaugural issue be the first of many milestones in the department's journey toward excellence.

HoD’s Message

Dr. Bhavin K Bharath

It gives me immense pride and satisfaction to introduce the first edition of KARMIKA, the technical magazine of the Department of Mechanical Engineering. This initiative has been launched with the vision of creating a platform where our and faculty members and students can showcase their technical knowledge, innovative ideas, and creative thinking beyond the boundaries of the classroom.

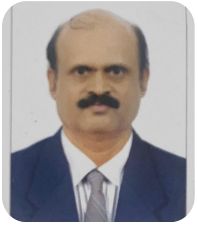
Mechanical Engineering drives technological and industrial progress. Through KARMIKA, we encourage students to share their ideas and innovations. Through KARMIKA, we aim to encourage students to explore emerging trends, share their insights, and cultivate a strong culture of learning, research, and innovation.

I am particularly happy that this magazine has taken shape through the enthusiastic efforts of our students and faculty members. Their dedication and teamwork have transformed this idea into a meaningful publication that reflects the intellectual spirit and technical excellence of our department.

I sincerely appreciate the editorial team and faculty coordinators for their commitment and hard work in bringing out this inaugural edition. I am confident that KARMIKA will continue to grow as a valuable platform for knowledge sharing and creativity in the years to come.

I extend my heartfelt congratulations and best wishes to everyone involved in this wonderful initiative.

Artificial Intelligence and Engineering Technology: Pioneering the coming Era of Discovery



Dr. Rajeev N
Dean Academics

Dr. Rajeev N, Professor and Dean Academics, Department of Mechanical Engineering, Ahalis School Engineering and Technology

Artificial Intelligence (AI) has emerged as one of the most transformative forces in modern engineering and technology. By enabling machines to learn from the real data, recognize possible patterns, and make decisions with minimal human intervention, AI is reshaping how engineers design, analyze, and innovate. Far from being just a tool for automation, AI has the potential to drive pioneering discoveries across all branches of engineering. This is achieved by accelerating problem solving capacity, expanding human capability, and opening entirely new domains of logical exploration.

One of the most profound contributions of AI in engineering lies in design and optimization of concepts and parameters. Conventional engineering design relies heavily on human intuition, heuristics experience, and iterative trial and error methods. AI driven techniques such as machine learning, generative design, evolutionary algorithms etc. can explore millions of design possibilities within constraints like cost, strength, weight, and sustainability. For example, in mechanical and aerospace engineering, AI can generate lightweight yet strong structures that outperform conventional designs solutions that human designers may never have conceived. This capability allows engineers not only to optimize existing systems but also to discover fundamentally new design principles.

AI is also revolutionizing simulation and modeling, which are central to modern engineering discovery. Highly reliable simulations in areas such as fluid dynamics, materials science, structural analysis etc, to name a few are often computationally expensive and time consuming. AI models can learn from simulation data and act as fast, accurate replacements, enabling rapid prediction of system behavior. This speed allows engineers to test hypotheses, explore extreme conditions, and identify hidden relationships within complex systems, significantly cut the path from concept to breakthrough.

In materials and manufacturing engineering, AI is a powerful engine for discovery and rapid innovations. By analyzing vast datasets of material compositions, processing parameters, and performance outcomes, AI can predict new alternative materials with desired properties such as higher strength, better biocompatibility, improved energy efficiency etc, to name a few. In manufacturing, AI-driven smart factories use real-time data to optimize processes, reduce defects, and adapt mechanization and automation. This not only improves efficiency but also enables novel manufacturing techniques that were previously impractical.

AI further enables pioneering discovery through integration of interdisciplinary knowledge. Modern engineering challenges such as renewable energy systems, smart cities, and biomedical devices are inherently complex and inter-disciplinary. AI excels at integrating data from diverse sources, allowing engineers to uncover connections between electrical, mechanical, biological, and environmental factors. This holistic perspective is critical for solving many challenges and developing innovative technologies that address real-world needs and problems.

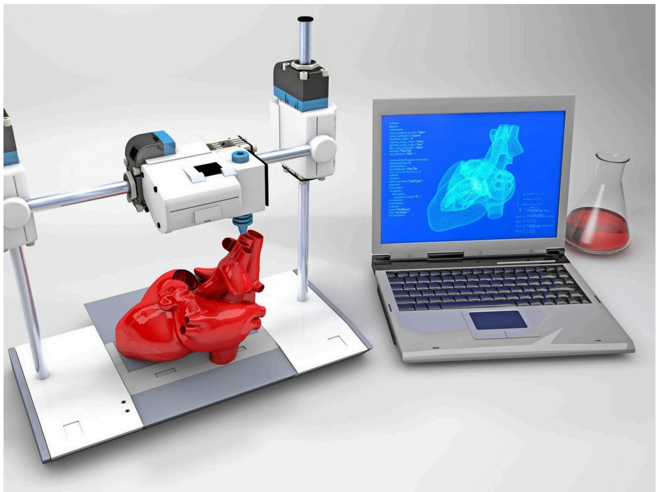
Finally, AI augments human creativity rather than replacing it. Engineers remain responsible for defining problems, setting ethical boundaries, and interpreting results. AI acts as a cognitive amplifier handling complexity, while humans provide judgment, context, and purpose in a more meaningful ways. Together, this partnership has the power to redefine and revolutionalize engineering discovery. In a nutshell, artificial intelligence is not merely enhancing engineering technology; it is redefining how discovery itself occurs. By accelerating design, enabling new simulations, exploring novel materials, and integrating complex knowledge, AI stands poised to lead a new era of pioneering breakthroughs in engineering, one where innovation is faster, deeper, and more transformative than ever before.

Healing in Layers: The Promise of Medical 3D Printing

Dr. Bhavin K Bharath
HOD ME

Medical 3D printing is being increasingly adopted in both clinical practice and healthcare research. Medical 3D printing is a multidisciplinary field where mechanical engineering principles such as design optimization, material selection, manufacturing processes, and structural analysis play a critical role in translating medical data into functional physical models and devices. Medical 3D printing involves producing physical models of anatomical structures through 3D printing technologies. These models are created from digital computer designs, which are often generated using patient-specific data obtained from medical imaging techniques such as MRI and X-ray computed tomography (CT). The adaptable, rapid, and economical nature of 3D printing allows efficient fabrication of even single-unit or small-batch components. The resulting models assist hospitals and other point-of-care (POC) facilities in surgical planning and also serve as effective tools for education and for explaining complex medical conditions or procedures, particularly to patients preparing for surgery.

Being able to see and handle complex anatomy as a real three- dimensional object gives medical professionals a powerful support tool that was not available earlier. In clinical practice, 3D-printed models help doctors better understand anatomical structures and medical conditions. These models allow surgeons to test the placement of implants and medical devices and to



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plan surgical procedures in advance. advances such as multi-color and multi- material 3D printing further improve realism, making the models closer to actual surgical conditions and useful for both pre-surgical planning and use during surgery. Overall, 3D-printed models work alongside on-screen images to improve understanding and increase confidence in clinical decision- making.

3D printing technologies offer potential for small-scale production of tablets with multiple drugs, enabling real-time, point-of-care fabrication of tailored medicines. This approach can overcome limitations and challenges associated with traditional mass-produced manufacturing methods, such as lack of personalization, extended production timelines, and rigid formulation constraints For medical device manufacturers and healthcare researchers, medical 3D printing offers a cost-effective way to improve designs and processes through rapid prototyping. It allows new ideas to be quickly created, tested, and refined. 3D printing can also be used at an early stage to check and confirm the results of computer-based simulations. By using these printed models, developers can gain more confidence in new designs before moving on to costly physical testing or studies involving living subjects. From Scan to Structure: How Medical 3D Printing Works To create a patient- specific 3D-printed model, the process begins with capturing the patient's actual anatomy in digital form using medical imaging techniques such as MRI, X-ray CT, or 3D ultrasound, which generate detailed three-dimensional images of internal structures. These images are then processed for segmentation, where the anatomical regions of interest are identified and separated to build an accurate CAD model. The methods used for segmentation vary depending on the imaging technique, the anatomy being studied, and the quality of the images. Once the digital model is created, it is prepared for 3D printing. The model, which may consist of multiple parts, is converted into surface meshes and enhanced with features such as connectors and color information. In some cases, the model is divided into sections so that the final printed object can be taken apart, allowing clearer visualization of specific anatomical features or medical conditions.

The completed surface data are then exported (commonly STL file format) to the 3D printer. Printer software interprets this information, adds necessary support structures, and calculates the printing paths. The printer then builds the model layer by layer, transforming the digital design into a precise physical replica of the patient's anatomy.

Transforming Healthcare in Kerala with 3D Printing In Kerala, several healthcare institutions are now using medical 3D printing to enhance patient care and surgical planning. Amrita Hospital, Kochi hosts one of India's first point-of-care medical 3D printing and virtual reality laboratories, where surgeons create precise anatomical models from patient scans to improve surgical preparation and outcomes across multiple specialties. These 3D technologies have been used in complex cases and have helped reduce surgery times and enhance precision. Other hospitals in the state have also begun adopting 3D-printed, patient-specific solutions, including customized implants and surgical aids, particularly in complex orthopedic and spinal procedures. These real-world applications highlight Kerala's growing role in embracing medical 3D printing to improve surgical accuracy, personalize treatment, and enhance overall healthcare outcomes.

Mechanical Engineering Perspectives in Medical 3D Printing Mechanical engineering plays a pivotal role in the successful adoption of medical 3D printing. From translating medical imaging data into printable designs, selecting suitable materials, optimizing printing parameters, to validating mechanical performance, mechanical engineers act as the link between medical requirements and manufacturing reality. This convergence opens new opportunities for mechanical engineers in healthcare innovation, product development, and point-of-care manufacturing.

For mechanical engineering students and professionals, medical 3D printing presents an emerging and impactful career domain, combining advanced manufacturing, design engineering, and real-world healthcare applications.

Additive Manufacturing Facility at Mechanical Engineering Department ASET

Reference

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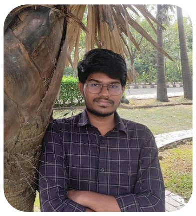
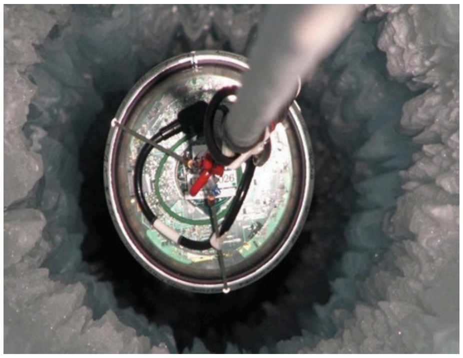
QUANTUM GRAVITY AND NEUTRINOS



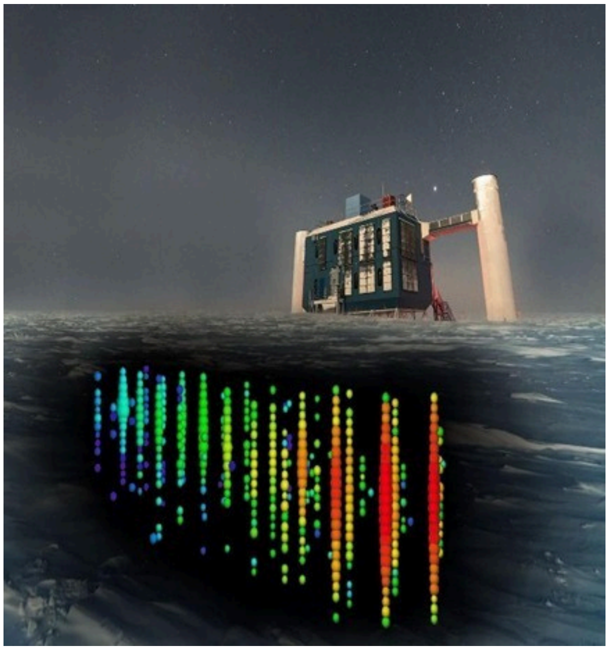
Prathyush M
(2022-26)

Quantum gravity is one of the most important unanswered questions in modern physics, as it seeks to unify two fundamental but incompatible theories: quantum mechanics and general relativity. While quantum mechanics successfully explains the behaviour of particles at microscopic scales, general relativity describes gravity and the structure of spacetime on cosmic scales. However, under extreme conditions such as black holes or the early universe, these theories fail to work together. Understanding how gravity behaves at the quantum level is essential for achieving a complete description of nature, making quantum gravity a central goal of contemporary scientific research. Neutrinos play a crucial role in the experimental search for quantum gravity. A neutrino is an electrically neutral, nearly massless subatomic particle that interacts very weakly with matter, allowing it to travel vast distances through space almost undisturbed. Because neutrinos preserve their quantum properties over long journeys, they are highly sensitive to tiny changes in spacetime. If spacetime possesses a quantum structure, as predicted by quantum gravity theories, it could subtly affect neutrino motion or their oscillation between different flavours, making neutrinos ideal probes for studying such effects.



The challenge in studying quantum gravitylies in the extremely small scale at which its effects are expected to occur. Direct experimen s at the Planck scale are currently impossible with existing technology. As a result, scientists rely on indirect observational methods that can amplify tiny quantum gravitational effects over large distances or long time periods. Astrophysical particles such as neutrinos provide a natural laboratory for such studies, as they originate from high-energy cosmic events and travel across vast regions of space before reaching Earth.One of the most significant experimental efforts in this field is the use of large neutrino detectors such as the IceCube Neutrino Observatory.

at the South Pole. IceCube consists of thousands of optical sensors embedded deep within Antarctic ice, designed to detect faint flashes of light produced when neutrinos interact with atoms in the ice. By analysing the energy, direction, and oscillation patterns of neutrinos that pass through the Earth, researchers search for deviations from standard quantum behaviour that could indicate the influence of quantum gravity.



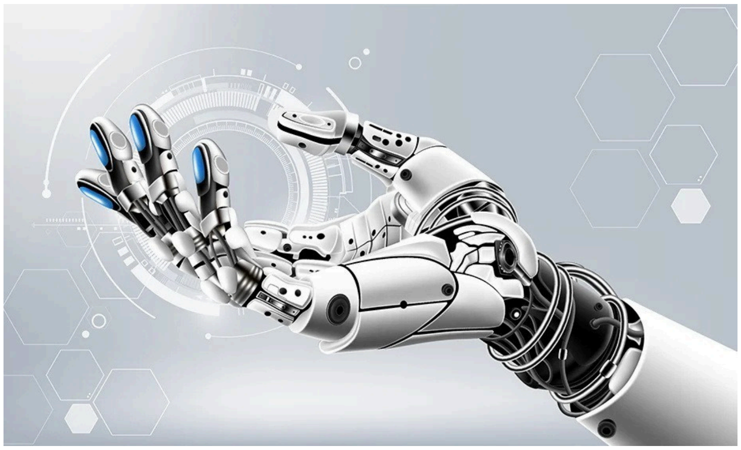
Recent analyses of atmospheric neutrinos have shown that their observed behaviour is largely consistent with existing quantum mechanical predictions. Although no direct evidence of quantum gravity has been detected so far. these studies allow scientists to place strict limits on possible quantum gravitational ereffeincets. Such results help theoretical models and eliminate scenarios that predict stronger effects than those observed experimentally.

In conclusion, the search for quantum gravity represents a fundamental pursuit in modern physics aimed at unifying our understanding of the universe across all scales Neutrinos, due to their weak interaction with matter and ability to travel vast distances, offer a unique and powerful tool for probing the quantum nature of spacetime. While experimental confirmation remains elusive, continued advancements in neutrino detection and observational techniques hold promise for uncovering deeper insights into the fundamental structure of reality.

Artificial Muscles and Soft Robotics – The Next Generation of Mechanical Systems

Rahul R
(2023-27)

The field of mechanical a engineering is undergoing major transformation with the emergence of artificial muscles and soft robotics. Traditional robotic systems are built using rigid components such as metal links. bearings, and electric motors. Although these systems



are highly accurate and powerful, they are limited when working in complex, unstructured, or human-centred environments. Artificial muscles and soft robotic technologies overcome these limitations by imitating the structure and function of biological organisms, enabling machines to move with flexibility, safety, and adaptability.

Artificial muscles are materials or devices that contract, expand, or bend when stimulated by external inputs such as heat, electricity, air pressure, or chemical reactions. Their behaviour closely resembles that of natural muscles found in the human body. Common forms of artificial muscles include pneumatic artificial muscles made from rubber tubes and braided meshes, shape memory alloys such as nickel-titanium that change shape when heated, dielectric elastomers that deform under electric fields, and twisted polymer actuators produced from nylon fibres. These actuators provide smooth and silent motion while being significantly lighter than conventional motors.

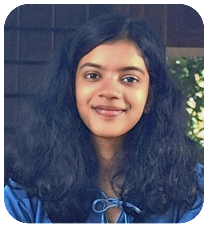
Soft robotics is an interdisciplinary field that combines mechanical engineering, material science, electronics, and biology. Unlike traditional robots with rigid frames and joints, soft robots are built from highly flexible materials such as silicone elastomers, hydrogels, and fabric-reinforced polymers. These materials allow the robot to deform continuously, similar to natural organisms like octopus arms or human muscles. As a result, soft robots can safely interact with humans and operate effectively in confined or unpredictable environments.

Artificial muscles and soft robotics have wide-ranging applications across various industries. In the medical field, they are used in prosthetic limbs, rehabilitation devices, and wearable exosuits that assist patients with mobility. In industrial automation, soft grippers handle fragile products such as fruits or electronic components without causing damage. In defence and rescue operations, soft crawling robots can navigate through debris during disaster response. They are also finding applications in agriculture, space technology, and human-assistive wearables.

Despite their advantages, these technologies face several technical challenges. Artificial muscles typically exhibit limited load-carrying capacity, and their lifespan is shorter compared to traditional mechanical actuators. Accurate control of soft robots is complex due to the non-linear behaviour of flexible materials. Furthermore, advanced materials required for these systems are still expensive, limiting their large-scale commercial adoption.

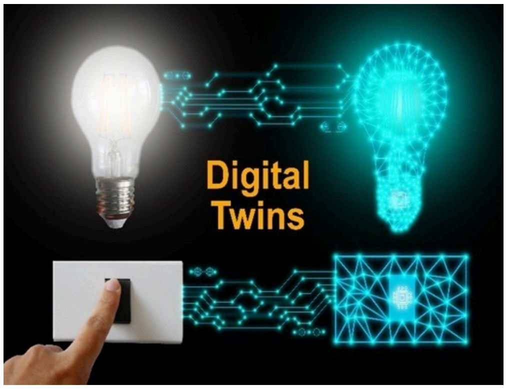
In conclusion, artificial muscles and soft robotics represent the future of mechanical engineering by combining the principles of biology with modern engineering technology. They provide safer, lighter, and more adaptable alternatives to conventional robotic systems. With continuous research in smart materials and control systems, these technologies are expected to revolutionise healthcare, manufacturing, and human–machine interaction in the coming years.

The Living Machine: Revolutionising Maintenance via Digital



Medha P J
(2023-27)

For decades, mechanical maintenance followed two primary, yet inefficient, paths: reactive (fixing it when it breaks) or preventative (replacing parts on a fixed schedule). Reactive maintenance leads to unplanned downtime, while preventative maintenance often discards functional components. The emergence of the Digital Twin—a dynamic, virtual representation of a physical asset—is fundamentally changing this calculation by moving maintenance from reactive to proactive.



A Digital Twin is a live entity fueled by real-time data from IoT sensors embedded in physical machinery. These sensors monitor parameters like vibration analysis, thermal fluctuations, acoustic emissions, and fluid pressure. Modern Digital Twins utilize a hybrid approach to predict failure: Physics-Based Modeling uses Finite Element Analysis (FEA) to predict how stresses affect materials, while Machine Learning (ML) identifies historical patterns to "recognize" breakdown before it happens. In a recent application at a chemical plant,

Digital Twin technology monitored high- speed centrifugal pumps and detected increase in high frequency vibration invisible traditional SCADA thresholds. By identifying a brewing bearing defect, maintenance was scheduled during a planned shift, preventing a failure that would have cost an estimated $120,000 in lost production. Despite these benefits, the barrier to entry remains high. Challenges include interoperability (connecting legacy hardware to cloud platforms), data fidelity (ensuring sensor calibration), and a significant skill gap as mechanical engineers must now become proficient in data science.For the modern engineer, it represents a profound shift in identity: they are no longer just masters of the physical machine, but the architects of its digital shadow, ensuring that the "living machine" operates at peak efficiency through every stage of its lifecycle.

The New Frontier of Fluid Power

Ahamed H
(2023-27)

As the global industrial sector pivots toward a hydrogen economy, mechanical engineers face a significant hurdle: Hydrogen is not just a "cleaner fuel"-it is a mechanical nightmare. Its unique atomic properties create extreme challenges for the pumps, valves, and seals that make up our modern infrastructure.The Problem of Hydrogen Embrittlement The most critical technical challenge is Hydrogen Embrittlement (HE). Becausehydrogen is the smallest element on the periodic table, H_2 molecules can diffuse into the crystalline latticeofhigh-strength steels. Once inside, they increase internal pressure andreducethe material's ductility. This leads to: Sub-critical crack growth: Cracks form at stress levelsfarbelow the material's rated yield strength. Catastrophic Fracture: Unlike standard fatigue, which provides warning signs,embrittlement can cause sudden, "glass-like" failures in pipeline steel and storage tanks.

Tribology and LubricationinDry Environments In traditional internal combustion or hydraulic systems, the fluid often providessomelevel of lubrication. Hydrogen, however, is "dry." It lacks the lubricating properties of hydrocarbons. For mechanical engineers, this requires a total rethinkof Tribology (the science of friction and wear): Non-Metallic Solutions: Moving toward advanced polymers like PTFE (Teflon)orPEEK for valve seats and seals, as these are immune to hydrogen embrittlement.

Diamond-Like Carbon (DLC) Coatings: Applying ultra-hard, low-friction coatingstopiston rings and cylinder walls to prevent metal-on-metal contact in the absence of traditionaloils. Precision Sealing: TheLeakage Issue Hydrogen's low viscosity means it can leak through gaps that would be airtight foroxygenor nitrogen. In high-pressure storage (often exceeding 700 bar), even a microscopic surface scratch onaflangecanlead to a significant leak.

Engineers are now turning to "Conical-Seating" and specialised metal-to-metalgasketsthat utilise high-contact pressure to deform the seal surface into a gas- tight barrier at themolecular level

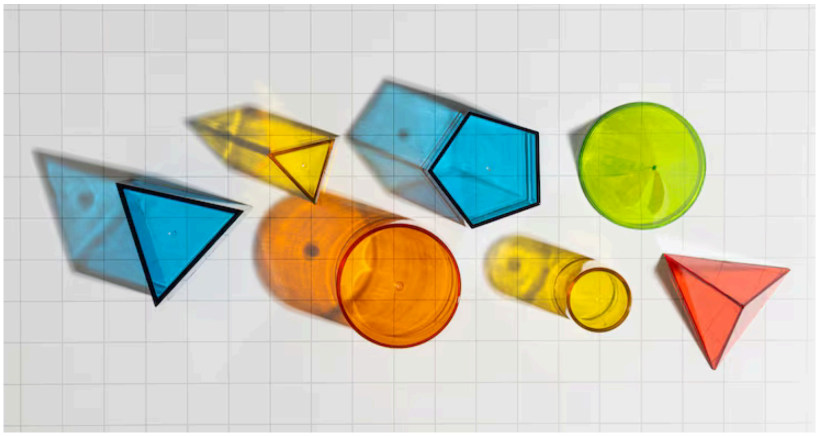
The End of Geometric Constraints

Aswin B
(2023-27)

For overacentury,mechanical design has beendictated by the limitationsofthe"subtractive"or "formative"process. We designed parts that could be milled byaCNC machine or released from an injection mould. Today, the combination of Design and Additive Manufacturing (AM) is breaking

those rules, allowing for "biomimetic" structures thatarelighter, stronger, and more efficient. What is GenerativeDesign? Unlike traditional CAD, where an engineer draws a specific shape, generativedesign uses AI-driven algorithms. The engineer inputs specific constraints: Loading conditions (force,torque, pressure). Material properties (tensilestrength, density). Spatial boundaries (the"keep-out" zones). Target weight. The software then iterates through thousands of permutations to find the mathematically optimal geometry. The result often looks "organic" or "bone-like," placing material only where it is physicallynecessary to support the load.

Tusoepdology Optimisationvs. Generative Design While often interchangeably, there is a technical distinction: Topology Optimisation: Takes an existing design and "shaves away" unnecessary material. Generative Design: Starts with the requirements and builds the geometry fromscratch, often providing multiple solutions based on different manufacturing methods.



The Role of Additive Manufacturing (AM) A generative design is often too complex for a 5-axis mill. This is where Industrial 3D printing (Direct Metal Laser Sintering or Electron Beam Melting) comes in. By building the part layer-by-layer, we can create: Internal Lattice Structures: Reducing weight byup to 70% while maintaining structural integrity. Integrated Fluid Channels: Conformal cooling channels in turbine blades or moulds that follow the shape of the part, significantly improving heat transfer. Part Consolidation: Turning an assembly of 20 bolts and brackets into a single, printed component.

Real-World Impact: Aerospace and Automotive In the aerospace sector, "buy- to-fly" ratios are a critical metric. Traditional machining often wastes 80% of a titanium block. With additive manufacturing, waste is reduced to nearly zero. Furthermore, every gram saved in a bracket's mass translates to thousands of dollars in fuel savings over the aircraft's lifespan.

The biggest challenge certification. Traditional NDT (Non-Destructive Testing), like X-rays, can struggle with the complex internal geometries of 3D-printed parts. Engineers are now developing "in-situ"monitoring systems that use high-speed cameras and thermal sensors to check for defects during theprinting process itself. We are entering an era where the "shape" of a machine is no longer limited bythe reach of a drill bit. As generative tools become more accessible, the role of the mechanic al eng ineer is shifting froma draf tsman" to a "curator of constraints."

Hydrogen Engines- Are They the Future?

Irin Ranju
(2023-27)

Introduction

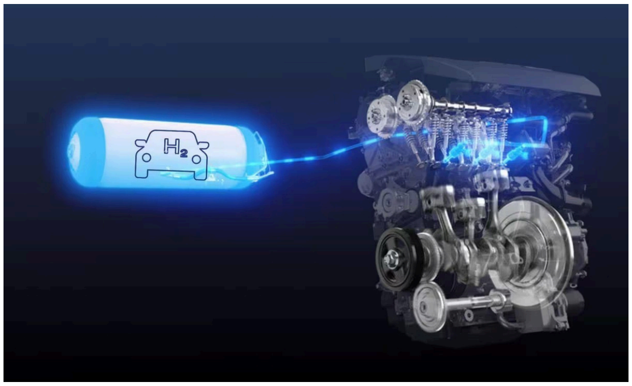
With rising concerns over climate change, fossil fuel depletion, and stringent emission norms, the automotive and energy sectors are under pressure to adopt cleaner alternatives. Among the emerging solutions, hydrogen engines have gained significant attention. But can hydrogen truly replace conventional fuels and become the future of mobility? From a mechanical engineering perspective, this article explores the working principles, advantages, challenges, and future prospects of hydrogen engines.

What Are Hydrogen Engines?

Hydrogen engines primarily exist in two forms:

1. Hydrogen Internal Combustion Engines (H_2-ICE) These engines operate similarly to petrol engines but use hydrogen as fuel. Hydrogen is mixed with air and combusted inside the cylinder to produce power. Key Mechanical Components: Modified fuel injection system Reinforced combustion chamber Backfire-resistant intake design High-temperature exhaust valves

2. Hydrogen Fuel Cell Vehicles (FCV) Fuel cells convert chemical energy directly into electrical energy, which powers an electric motor. There is no combustion involved.



Working Principle (H_2-ICE) -Hydrogen is injected into the combustion chamber. -Spark ignition initiates combustion. -Rapid flame propagation occurs due to hydrogen's high flame speed. -Power is transmitted via crankshaft just like in IC engines.

Major Exhaust Product: Water vapor Secondary Emissions: Trace NOx (due to high combustion temperature)

Advantages of Hydrogen Engines

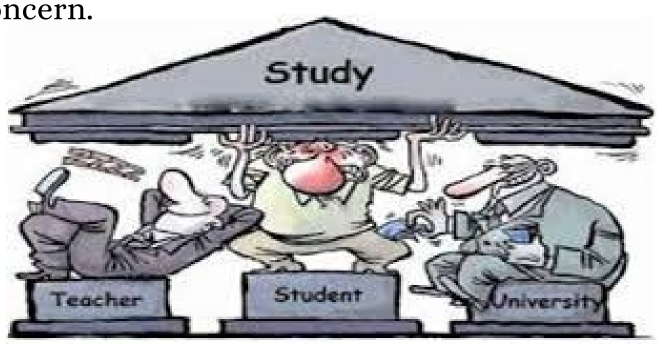
Mechanical & Environmental Benefits
-Zero carbon emissions at the tailpipe
-High thermal efficiency compared to petrol engines -
Lightweight fuel improves power-to-weight ratio
-Compatible with existing IC engine architecture
-Faster refueling compared to battery EVs

Engineering Adaptability
-Conventional IC engines can be retrofitted for hydrogen use -Reduces dependency on rare-earth materials (unlike EVs)

Engineering Education and the Student Mind

Shyam Krishna
(2024-28)

Engineering education is often presented as a clear, structured path: attend classes, study the syllabus, clear exams, and secure a job. On paper, this trajectory looks logical and safe, but in reality, the experience for many students feels of very different. Behind the scenes, confusion, lack motivation, and silent mental struggles are far more common than is openly discussed. This article reflects on how students truly experience this journey, why many feel disconnected from their studies, and how mental health often quietly becomes a secondary concern.



A significant source of disappointment stems from the gap between student expectations and academic reality. Students are often inspired by visuals of advanced robotics, electric vehicles, and startups they see online. However. when they step into the classroom, they frequently encounter heavily theoretical syllabi and outdated examples. For those who did not enter the field out of pure passion, this mismatch can make subjects like mechanical engineering feel monotonous. Over time, students begin to associate learning with fatigue rather than curiosity, leading to long lectures and heavy textbooks that slowly drain their motivation.

This "Syllabus-Reality Gap" is a major contributor to student burnout. Instead of building or innovating as they had hoped, students spend the majority of their time memorizing derivations and formulas solely for examinations. This leads to mental exhaustion, stagnation, and a decline in self-confidence. A less-discussed byproduct of this environment is "mental masturbation"—the habit of excessive overthinking without meaningful action. This mental loop of replaying scenarios and comparing oneself to others creates an illusion of progress while actually draining energy and increasing anxiety.

Social and external pressures further complicate the student experience. Many struggle with communication, particularly those who are naturally introverted, leading to feelings of isolation and the false belief that speaking confidence is the only measure of intelligence. Furthermore, there is an increasing and dangerous normalization of substance use, such as smoking or drinking, as a casual response to stress. While these may offer a temporary escape, they do not address the root causes of stress and eventually weaken natural coping mechanisms, leading to reduced focus and emotional instability.

True growth begins when students choose responses that protect long-term stability over short-term escapes. Instead of normalizing unhealthy habits, students can adopt effective stress-management methods like physical activity, listening to music, or practicing honest self-reflection. As the author notes, improvement is not about achieving perfection, but about becoming a more disciplined and aware version of oneself, step by step.

SpinLaunch: A Rocketless Approach to Space Launch Engineering

Akhilesh P
(2022-26)

For more than half a century, space launch systems have relied almost entirely on chemical rockets to overcome Earth's gravity. Although reliable, rocket launches are mics, governing angular velocity, acceleration, and energy storage

Expensive, fuel- intensive, and environmentally taxing. In response to these challenges, innovative alternatives are being explored—one of the most promising among them is SpinLaunch, a rocketless space launch concept that applies core engineering principles to achieve orbital access more efficiently. SpinLaunch is a novel technology developed by SpinLaunch Inc., a U.S.-based aerospace startup. Instead of lifting payloads using combustion-driven rockets, SpinLaunch accelerates payloads mechanically using rotational motion. This approach represents a fundamental shift in space launch engineering, replacing propulsion-heavy systems with ground-based mechanical acceleration.

Principle of Operation The SpinLaunch system functions as a large-scale centrifugal accelerator housed inside a vacuum chamber. A payload is mounted at the end of a rotating arm, which is driven by powerful electric motors. As the arm rotates, the payload experiences increasing centripetal acceleration. When the desired launch velocity is reached, the payload is released tangentially and propelled upward at hypersonic speeds. From an engineering standpoint, the system converts rotational kinetic energy into translational kinetic energy. The vacuum environment minimizes aerodynamic drag during acceleration, allowing the system to reach extremely high angular velocities efficiently. Mechanical Engineering Aspects SpinLaunch is deeply rooted in mechanical engineering fundamentals. Key areas involved include: Rotational dyna

Stress and strain analysis, particularly in the rotating arm subjected to enormous tensile forces Rotor dynamics and vibration control, essential for system stability Material science, to ensure strength, durability, and fatigue resistance The rotating arm and structural components must withstand accelerations exceeding 10,000 g, making precision design and advanced materials critical. Materials and Structural Challenges One of the biggest engineering challenges in SpinLaunch is handling the extreme mechanical loads generated during operation.

High-strength, lightweight materials such as carbon-fiber composites and advanced metal alloys are used to maintain structural integrity while minimizing mass. In addition to mechanical stress, payloads experience significant thermal stress during atmospheric ascent due to high velocities. Protective casings and thermal-resistant materials are necessary to ensure payload survival. Energy Efficiency and Environmental Benefits Unlike conventional rockets that burn large quantities of propellant, SpinLaunch relies primarily on electric power. This drastically reduces fuel consumption and greenhouse gas emissions.

The ground-based launcher is fully reusable, lowering operational costs and improving sustainability. From an energy systems perspective, SpinLaunch demonstrates improved efficiency by avoiding the energy losses associated with combustion and discarded rocket stages. Limitations and Practical Constraints Despite its advantages, SpinLaunch is not a universal replacement for rockets. The extreme acceleration limits payloads to small, compact, and mechanically robust systems, such as nanosatellites.

Fragile equipment and human passengers cannot tolerate the high G-forces involved. Additionally, scaling the system to handle heavier payloads presents significant engineering challenges, including increased structural stress and higher material costs.

From Student to Professional: My Path Shaped by Persistence and Purpose

Ramakrishnan PA (2012-2016 - Mechanical Engineering)

When I look back at my journey, I realize it has never been about shortcuts or overnight success. It has always been about consistency, patience, andbelievingin myself-even during moments of uncertainty. Each phase of my life has taught me valuable lessons, shaping not just my career, but also my character.

I was born and raised in Palakkad.Myacademic journeybeganat MES EMHSS, Palakkad, where I studied from 1st to 12th standard. Those formative years laid a strong foundation for my future. School life taught me discipline, curiosity, and the importance of putting in sincere effort every single day. It was here that my interest in learning and self-improvement truly took root. In 2012, I joined Ahalia School of Engineering and Technology, Palakkad to pursue B-Tech in Mechanical Engineering, securing admission through the KEAM examination.

Engineering college was a turning point-it challenged me to think critically and pushed me beyond my comfort zone. I should say college was my second home. The eco-friendly campus, along with its well-equipped laboratories and comprehensive library facilities, created an excellent atmosphere for focused learning and skill development. The highly qualified and dedicated faculty members whose mentorship helped me gain in-depth technical knowledge and prepared me to face the challenges of a dynamic corporate environment. During this period, I completed In-plant training at Cochin Shipyard, which gave me my first exposure to the industrial environment and helped me understand how engineering principles are applied in real life.

My final year thesis at BPCL (Kochi Refinery) became one of the most defining experiences of my undergraduate journey. It demanded discipline, problem-solving, and a professional approach to work. The consistent effort I put in throughout my B-Tech paid off when I secured 1st Rank at the Department level and 26th Rank at the University level. These achievements reinforced my belief that dedication and focus always yield results.

Behind all these milestones stood the unwavering support of my parents, who played a vital role in grooming me into the person I am today. Their constant encouragement, values, and belief in my abilities gave me strength during challenging times.

They taught me the importance of humility, perseverance, and hard work-principles that continue to guide me in every stage of life. Driven by a desire to deepen my technical knowledge, I prepared for GATE and successfully qualified GATE 2017. This achievement opened the door for higher studies, leading me to pursue M-Tech Engineering Design from Amrita Viswa Vidyapeetham, Coimbatore. Postgraduate education refined my analytical thinking and strengthened my technical foundation. I was honored with a silver medal for my performance in M.Tech. During this time, I was fortunate to complete an Internship at Volvo GTT India, Bangalore, where I gained exposure to global engineering standards, teamwork, and professional excellence. While keeping up with my studies, I also immersed myself in publishing my five research articles in international journals, including SAE International, and ARAI Journal.

Being able to contribute to the global engineering community and engage with cutting-edge innovations has been one of the most rewarding parts of my journey. My professional career began in 2019, when I joined ASM Technologies, Bangalore as a Junior Engineer. This role helped me understand real-world responsibilities and the importance of continuous learning. Through consistent performance and commitment, I was deputed to Volvo GTT India, Bangalore, as a Consultant NVH Engineer, a major milestone that enhanced both my technical expertise and confidence. Later, I took the next step in my career by joining Mercedes-Benz R&D India Pvt. Ltd. (MBRDI), Bangalore as a Senior CAE Analyst - NVH, marking another phase of growth and responsibility. In 2023, my life took a beautiful turn when I got married. Today, being a father to a daughter has added a deeper sense of purpose to everything I do. My family continues to be my greatest source of motivation, reminding me daily why dedication, integrity, and perseverance truly matter.

If there is one message I wish to leave with students, it is this: success is a journey, not a destination. Challenges are inevitable, but consistency, self-belief, and the willingness to learn will always carry you forward. Trust the process, stay grounded, and never stop striving for excellence-because every small step you take today shapes the future you dream of tomorrow.

From Dreams to Reality

What was the inspiration behind joining the Air Force? First of all, regarding inspiration, I've had an interest in joining the Defense services since my school days. A few people in my family were in Defense—my grandfather and an uncle were in the Army. Seeing them created a fascination in me from a young age. Also, while studying, I had a keen interest in the technical field. I felt the Technical Branch of the Air Force was the right fit for me. Then there was the attraction toward the challenge, the lifestyle,

Gopikrishnan
Air Force Lieutenant

Even with an interest in Defense, why did you choose B.Tech? I have a huge passion for engineering. Since childhood, I was the type of kid who would sit at home and dismantle toys or tinker with things. An uncle of mine noticed this and said I had a talent for it, suggesting I look into that field. Later, in Plus Two (12th grade), I found the applications of Physics very interesting. At that time, my interest in defence was still strong, and for Technical Entries, a B.Tech is Physics very interesting. At that time,my interest in Defense was still strong, and for Technical Entries, a B.Tech is mandatory. I chose Mechanical Engineering because it is considered the "Mother of all Engineering."

Did you choose this career immediately after B.Tech? I started trying right after Plus Two. But that journey continued throughout my engineering years. I kept preparing even while studying; during lunch breaks, I would head to the library. I failed two or three attempts after Plus Two and eventually hit the age limit for those entries. Then, in my final year, there was a University Entry Scheme (UES) which I tried, but I wasn't shortlisted. I kept studying throughout my degree. I graduated in 2019. In between, I worked as a teacher while continuing my preparation for various exams. It wasn't until 2022—after almost three years and on my third attempt—that I finally cleared it.

How was your experience at the workplace after joining?

During the first month, I actually felt like I had made a mistake! That's how the training is. You won't get enough time, enough sleep, or even enough food. You'd be preparing your uniform at 12:00 or 1:00 AM and studying at midnight because the day starts at 4:00 AM. It begins with PT (Physical Training), then lectures and parades. It's completely engaging. During training, we aren't even allowed to walk—we have to run everywhere. You get completely exhausted; the moment you hit the room, you fall asleep instantly. Initially, there was the homesickness of leaving family, but then I found great company. Being around people with the same passion made it fun. Some people find it very difficult, but there is proper counseling available for those struggling mentally. Otherwise, there were no issues. I really enjoyed my training period; it is truly the best time.

What was your best experience in college?

First of all, I met my wife at college! Aside from that, the time spent with friends was wonderful. I had a great circle of friends here. Regardless of seniority, I got along well with everyone and had many great moments. I was also active in sports and was the Individual Champion during my time. The moments in class and with friends are the best memories.

I don't particularly enjoy or care to remember the actual studying part! I loved the time spent eating together, singing, and even "stealing" food from the hostel boys. We conducted a tech fest here called Saga, where we did many programs for the Mechanical department. Those are the best moments.

What were some good moments at your workplace?

In this line of work, we operate in various locations. One great experience was operating in Phalodi. It's a remote base in Rajasthan, very close to the border. I was operating there during a flash flood. One morning, the technicians were supposed to arrive for aircraft servicing. They stayed a bit far away and didn't show up. As the supervisor, I called to ask why, and they said, "Sir, there is water everywhere here, we can't come." When I went to check, the water was up to my neck. Because it was a low-lying area, the water was flowing with immense force. A school bus had gotten stuck there—one side was in the mud and the other on the road, leaving it completely tilted. There were about five or six children, a staff member, and the driver inside. People were watching from both sides, but no one dared to approach. I tried at first, but the force of the water was enough to sweep someone away, so I had to turn back. Then I found a large Army truck. I took the truck and drove into the water. I rescued all the children and the staff. Shortly after, the truck actually tipped over into the water. It was an intense experience.

The Chief Engineering Officer, a Senior Officer, and the Commanding Officer all called and appreciated me. If even a little more time had passed, those children might have been swept away. The bus was "caged"—it had grills to protect against stone-pelting—so there was no way out. We had to break the doors to get them out. That is a very memorable experience. I also had great experiences during Operation Sindhu, but since many details are classified, I cannot share them.

What was your most dangerous experience?

It was dangerous, but we are trained for it. We handle 1000 kg and 2000 kg bombs. Part of the job is disposal—handling bombs that have expired or "misfired" (bombs dropped from an aircraft that failed to explode). We have to go and see why it didn't explode. That responsibility falls on the Station Armament Officer. I am a Station Armament Officer. Once, right after I finished training, we had a 1000-pounder bomb. We set the fuse—sort of like lighting a firecracker—and then had to move about 2.5 kilometers away because of the blast radius. After lighting it, you have to wait for a specific period (about 10 minutes). If it doesn't go off, you have to investigate why. That time, it didn't explode after the waiting period. As we were approaching it, it finally went off. Luckily, we were at a safe distance and behind some "traverses" (hill-like structures). Because we were behind the mounds, nothing happened when it exploded. It was a great experience—definitely a dangerous one!

The Unseen Laws

Why is a refrigerator hot on the outside?
To make the inside cold, you aren't "adding cold"-you're removing heat. According to the Second Law of Thermodynamics, that heat (plus the energy used by the compressor) must be dumped into the kitchen air.

Why do airplane windows have rounded corners?
Square windows create "stress concentrators" at the corners. Under repeated cabin pressurization, these corners develop microscopic cracks that lead to explosive decompression-a lesson learned the hard way by the de Havilland Comet in the 1950s.

Why do golf balls have dimples?
It seems counterintuitive, but a "rough" ball flies further. The dimples create a thin layer of turbulence that keeps the airflow attached to the ball longer, reducing the "wake" behind it and significantly lowering pressure drag.

Why does a shower curtain blow inward toward you?
The Bernoulli Principle suggests that the fast-moving water and air inside the shower create a lower pressure zone than the still air outside, sucking the curtain in.

Why do metals "fuse" in space?
If you touch two pieces of the same highly polished metal together in the vacuum of space, they will instantly bond into a single piece. On Earth, a thin layer of oxidation covers every metal surface, acting as a barrier. In a vacuum, there is no oxygen to form this layer.

Why does hot water freeze faster than cold water?
A tray of boiling water will turn to ice sooner than a tray of room-temperature water. Hot water creates much more vigorous internal circulation, bringing heat to the surface faster than still, cold water. Evaporation reduces the mass of the hot water, leaving less "stuff to freeze.

Why are power lines loose and saggy?
It looks sloppy, but it's a life-saver. Metal contracts when it gets cold. If engineers pulled power lines perfectly tight in the summer, the first cold snap of winter would cause the metal to shrink, increase the tension, and snap the wires or pull down the utility poles. That "sag" is a calculated safety margin for thermal contraction.

Why do airplane windows have a tiny hole at the bottom?
It's called a "bleed hole." At 35,000 feet, the pressure outside is much lower than inside. Windows have three layers; that tiny hole allows pressure to equalize between the cabin and the middle pane.

why computer keyboards aren't in alphabetical order?
The QWERTY layout was designed to prevent mechanical jams on early typewriters by separating frequently used letter pairs (like "ST" or "TH") so their metal arms wouldn't collide and stick together.

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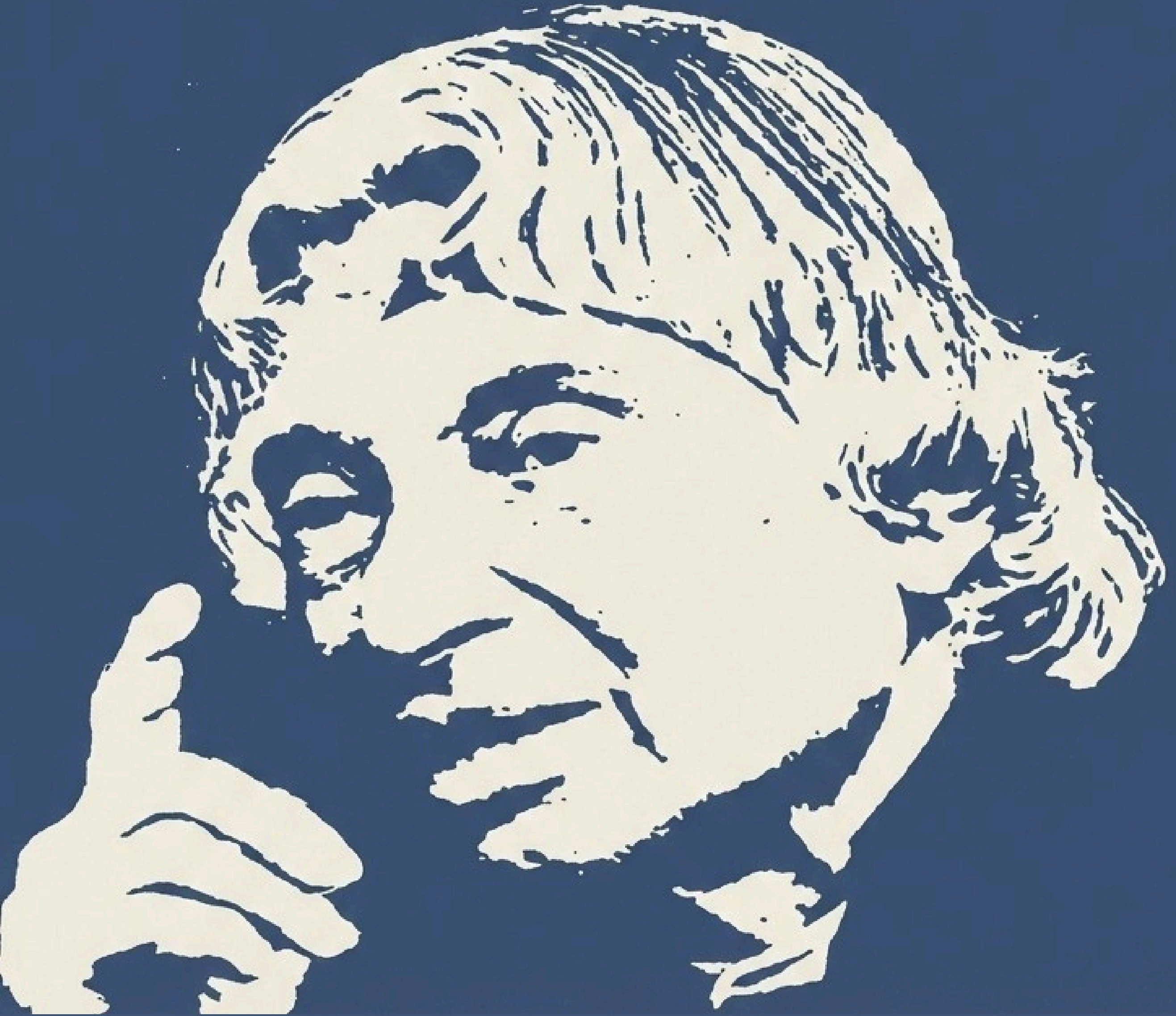
"Dream is not that which you see while sleeping it is something that does not let you sleep."

- Dr APJ Abdul Kalam

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