

MECHZONE

INNOVATION & TECHNOLOGY FOR THE FUTURE
A MECHANICAL ENGINEERING BIENNIAL MAGAZINE

VOLUME 6 | ISSUE 1 | MAY 2026

THE RISE OF THE DRONES:

LOW-COST DRONES

How low-cost drones are changing the scenario of global conflict

THE SILICON FRONTLINE
DRONE TECHNOLOGY

BEYOND THE ARC
ADVANCED JOINING TECHNIQUES

BREAKING THE MOLD
GENDER EQUALITY IN MECHANICAL ENGINEERING

Department of Mechanical Engineering
SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY
Karukutty, Ernakulam, Kerala

From the Chief Editor



It is a profound pleasure to introduce this latest edition of our student magazine. As I look at the corridors of our department, I don't just see students attending lectures; I see the next generation of architects of motion.

Mechanical engineering has always been the "bedrock" of industry, but today, that bedrock is shifting in exciting ways. We are no longer just the people of gears and steam; we are the pioneers of **sustainable energy, soft robotics, and advanced manufacturing**.

This magazine serves as a testament to your curiosity. However, I want to challenge you to take that curiosity further. Don't let your learning stop when the bell rings.

"Engineering is not merely a profession; it is a way of seeing the world. It is the persistent belief that any system, no matter how complex, can be understood, improved, and mastered."

I encourage you to get your hands dirty in the labs, participate in national competitions, and—most importantly—don't be afraid to fail. A broken prototype is often a better teacher than a perfect textbook.

As you flip through these pages, celebrate the achievements of your peers and find inspiration in the technical breakthroughs documented here. You are here to do more than just find a job; you are here to design the machines that will define the 21st century.

Keep questioning, keep building, and keep pushing the boundaries of what is possible.

Onward and upward,

Dr. Vidya Chandran

Head of the Department

Mechanical Engineering

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FACULTY

Expert Perspectives

*Contributions from the faculty of
Mechanical Engineering.*

ARTICLES IN THIS SECTION

- The Silicon Frontline: How Drone Technology is Redefining Global Conflict
- Breaking the Mold: Gender Equality in Mechanical Engineering
- Beyond the Arc: Advanced Joining Techniques

STUDENT

Emerging Voices

Essays from students.

ARTICLES IN THIS SECTION

- Pinnacle of Speed
- Beyond the Campus

Vision and Mission

Vision and Mission of the Institute

Vision

1. To be a premier institution moulding ethical and socially responsible engineers with emphasis on 'Service Learning'.
2. To be among the top ten institutions in India by 2040, shaping technology innovators and leaders for spearheading research relating to sustainable development goals

Mission

Innovative education and research for shaping techno-leaders.

Vision and Mission of the Department

Vision

To be a leader in Mechanical Engineering education through sustainable innovation and impactful research.

Mission

1. Integrate service-learning into Mechanical Engineering education to solve local and global challenges.
2. Upskill students in emerging technologies to lead design, manufacturing, and allied industrial sectors.
3. Promote innovative and interdisciplinary research in Mechanical Engineering, emphasizing sustainable and ethical practices

FEATURE ESSAY · CONFLICT & TECHNOLOGY

The Silicon *Frontline*

How drone technology is redefining global conflict — and what the wars of 2024–2026 reveal about the future of warfare

By **Nikhil Asok N** · Assistant Professor, ME

AT A GLANCE

4M

Drones produced by
Ukraine annually

\$500

Cost of an FPV
kamikaze drone

\$4M

Cost of a Patriot
interceptor missile

70%

Frontline logistics
handled by UGVs

The landscape of modern warfare has been fundamentally rewritten by the rise of Unmanned Aerial Systems (UAS). In the ongoing conflicts involving the United States, Iran, Ukraine, and Russia, drones have evolved from niche surveillance tools into the primary instruments of strategic attrition and tactical dominance. As of early 2026, these “silicon soldiers” are no longer just supporting traditional forces — they are frequently replacing them on the frontlines.

SECTION 01

Ukraine–Russia: The Birth of Industrialized Drone Warfare

The conflict in Ukraine has become the world’s largest laboratory for drone innovation. What began as the use of commercial quadcopters has evolved into a massive, state-sponsored industrial effort with consequences that are reshaping military doctrine worldwide.

FPV (First-Person View) kamikaze drones — costing as little as \$400–\$600 — have become the “poor man’s precision artillery.” By early 2026, Ukraine reached a production capacity of nearly 4million drones annually, using them to hunt everything from individual soldiers to multi-million dollar tanks. The cost asymmetry alone represents a revolution in how wars are fought.

“The side that can produce the most expendable intelligence wins the war of attrition.”

— The defining lesson of 2024–2026

To counter Russia’s constant stream of loitering munitions, Ukraine has deployed “interceptor drones” — cheap UAS designed specifically to ram or shoot down other drones, preserving expensive Patriot or NASAMS missiles for higher-priority ballistic threats. Meanwhile, Unmanned Ground Vehicles (UGVs) now handle up to 70% of frontline logistics in some brigades, evacuating the wounded and even clearing trenches with mounted machine guns.

SECTION 02

Iran's Swarms of Attrition

Iran has positioned itself as a global superpower in low-cost, long-range loitering munitions. Their strategy relies on mass — forcing adversaries to spend millions of dollars in defense to stop a few thousand dollars' worth of hardware. It is economic warfare waged through aeronautics.

The Shahed-136, and its Russian-produced variant the Geran-2, remains a primary threat. These “moped drones” use simple piston engines and GPS/GNSS navigation to strike targets over 1,000km away. Recent iterations like the Shahed-238 now feature turbojet engines, significantly increasing their speed and shortening the reaction time for air defenses.

2026 ESCALATION — MIDDLE EAST

Iran demonstrated the ability to launch multi-layered swarms combining slow drones, jet drones, and ballistic missiles simultaneously — saturating and effectively “blinding” even the most sophisticated radar systems in the region.



Shahed-136 kamikaze-type drone

SECTION03

The U.S. Response: Intelligent Defense and Counter-UAS

For the United States, drone technology has shifted from an offensive focus — like the Reaper and Predator — to a desperate need for Counter-UAS (C-UAS) capabilities. The proliferation of cheap drones has exposed a critical vulnerability in Western military doctrine: the cost of defense vastly exceeds the cost of attack.

The U.S. military now utilizes a “nested” layered defense approach. This includes MADIS (Marine Air Defense Integrated System) for electronic jamming and high-power microwave weapons that can disable a drone's electronics without firing a single bullet. SOCOM is actively developing “Acoustic Rainbow” technology, allowing drones to alter or redirect their sound signature — making them nearly impossible to detect by acoustic sensors on modern battlefields.

Autonomous turret systems like the Bullfrog are being integrated onto maritime and ground platforms. These use AI to identify, track, and destroy incoming drones with minimal human intervention — addressing the critical “human-in-the-loop” bottleneck that becomes catastrophic during swarm attacks.

SECTION04

The New Economic Reality: Cost-Imposition Warfare

The defining characteristic of recent drone warfare is what analysts now call the Cost-Imposition Ratio. The table below illustrates the radical economic shift that has made cheap drones a strategic — not just tactical — weapon.

COST - IMPOSITION RATIO — WEAPON VS. COUNTERMEASURE

WEAPON SYSTEM	EST. COST	COUNTERMEASURE	COUNTERCOST
Shahed-136 (Iran)	~\$30,000	Patriot Missile	~\$4,000,000
FPV Drone (Ukraine)	~\$500	Electronic Jammer	\$10,000–\$50,000
Reaper Drone (US)	~\$30,000,000	S-400 Missile	\$200K–\$1,000,000

The asymmetry is staggering. A nation spending \$30,000 on a drone can force a rival to expend \$4 million in response. At scale, this is not just battlefield tactics — it is national treasury depletion as a military strategy.

“As AI continues to integrate into these systems — enabling drones to navigate without GPS and make terminal strike decisions autonomously — the era of the human pilot as the primary arbiter of the battlefield is rapidly coming to an end.”

— Nikhil Asok N

The lessons from 2024 to 2026 are unambiguous: the future of conflict is unmanned, expendable, and increasingly autonomous. Nations that fail to adapt their industrial base, doctrine, and defense architecture to this new reality risk being outpaced not by a superior military power, but by a superior manufacturing line.

FOUR PILLARS OF THE NEW WARFARE

01 Mass Production Ukraine’s 4Mdrone/year capacity shows industrial scale, not technology alone, determines battlefield outcomes.	02 Economic Attrition Forcing adversaries to spend \$4M to stop a \$30K drone is the explicit strategy of modern drone warfare.	03 Autonomous AI GPS-denied navigation and terminal strike AI are removing the human pilot from the decision loop entirely.	04 Layered Defense No single countermeasure suffices. Nested, multi-domain architectures combining jamming, kinetics, and AI are the future.
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FEATURE ESSAY · MANUFACTURING & MATERIALS

Beyond the Arc

Advanced joining techniques in modern manufacturing — how solid-state, electromagnetic, and hybrid processes are rewriting metallurgy

Mr. Deepak Xavier · Assistant Professor, ME

AT A GLANCE

5× Faster welding with Laser-Arc Hybrid	300 m/s Impact velocity in Magnetic Pulse Welding	0.3 mm Minimum sheet thickness for CMT	40 kHz Ultrasonic frequency in UMW
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The manufacturing landscape is undergoing a paradigm shift, moving away from traditional manual arc welding toward high-precision, automated, and energy-efficient joining processes. As industries like aerospace, electric vehicle production, and renewable energy demand higher structural integrity with lighter materials, novel welding techniques have emerged to bridge the gap between traditional metallurgy and modern engineering requirements.

01 SOLID - STATE PROCESS

Friction Stir Welding

FSW

A radical departure from convention — the base metal never reaches its melting point.

MECHANISM

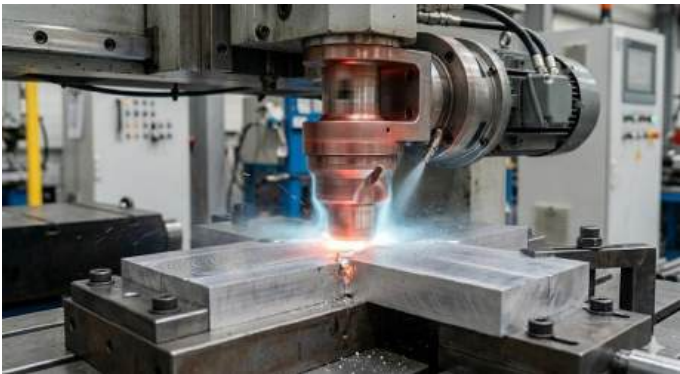
A rapidly rotating, non-consumable tool is plunged into the joint interface. Frictional heat and mechanical stirring plastically deform the material, forging the two pieces together.

KEY BENEFIT

Because there is no melting, defects like porosity, solidification cracking, and extreme thermal distortion are virtually eliminated.

APPLICATION

The gold standard for high-strength aluminum alloys in aerospace fuselages and EV battery trays, where maintaining parent material properties is critical.



Friction Stir Welding

02 HYBRID PROCESS

Laser-Arc Hybrid Welding

LAHW

Combining laser precision with arc gap-bridging into a single, synergistic process zone.

THE SYNERGY

The laser creates a deep, narrow keyhole for maximum penetration; the electric arc provides filler metal to stabilize the weld pool and manage joint tolerances.

EFFICIENCY

LAHW achieves welding speeds up to five times faster than standard arc welding while significantly reducing the heat-affected zone (HAZ).

APPLICATION

Extensively used in ship building and long-span bridge girder construction, where deep penetration and minimal distortion are paramount.



Laser-Arc Hybrid Welding (LAHW)

“The evolution of welding from a high-heat, manual craft to a high-precision, energy-controlled science is essential for the next generation of infrastructure.”

— Beyond the Arc

03 ELECTROMAGNETIC PROCESS

Magnetic Pulse Welding

MPW

A high-speed, cold joining technique that uses electromagnetic forces — not heat — to bond materials.

THE PHYSICS

A massive electrical discharge through a coil creates an intense magnetic field, inducing eddy currents that launch a flyer part toward the target at over 300m/s.

THE BOND

The high-impact collision creates a metallurgical jet that cleans the surfaces and forms a solid-state bond in microseconds.

APPLICATION

Uniquely suited for joining dissimilar metals — aluminum to steel or copper — without the brittle intermetallic layers that form during thermal welding.



Magnetic Pulse Welding

WHY DISSIMILAR METAL JOINING MATTERS

Traditional thermal welding of aluminum to steel produces brittle intermetallic compounds at the joint boundary — a structural liability. Magnetic Pulse Welding bypasses this entirely, enabling the multi-material architectures that lightweight EV platforms and aerospace assemblies require.

04 LOW-HEAT MIG VARIANT**Cold Metal Transfer**

CMT

Ultra-low heat input, achieved by incorporating a mechanical element directly into the wire feed system.

MECHANISM

When the wire touches the weld pool, the system detects the short circuit and physically retracts the wire — pulling the droplet in rather than blasting it off with high current.

PRECISION

A nearly spatter-free weld with exceptionally low thermal input, ideal for joining very thin sheets from 0.3 mm to 2 mm.

APPLICATION

A foundational technology for Wire Arc Additive Manufacturing (WAAM) — allowing engineers to 3D-print large-scale metal components layer by layer.

05 MICRO & GREEN ENERGY**Ultrasonic Metal Welding**

UMW

A solution for joining delicate, highly conductive materials in the era of micro-electronics and green energy.

THE PROCESS

High-frequency ultrasonic vibrations (20–40 kHz) are applied under pressure, shearing off surface oxides and enabling atomic-level bonding well below the melting point.

KEY BENEFIT

No heat, no filler, no distortion — perfect for materials where thermal damage would compromise electrical or structural performance.

APPLICATION

The industry standard for lithium-ion battery pack assembly — welding multiple layers of copper and aluminum foils to battery tabs with micron-level precision.



Ultrasonic Metal Welding

“Whether through the mechanical stirring of atoms in FSW or the electromagnetic velocity of MPW, these techniques allow for the creation of lighter, stronger, and more complex structures than ever before.”

— Beyond the Arc

The Road Ahead

As computational modeling and AI-driven process control continue to mature, the boundary of what materials can be joined — and how efficiently — will continue to expand. The common thread across all five techniques is the reduction or outright elimination of heat as the primary bonding mechanism, replacing brute thermal energy with precision physics: mechanical, electromagnetic, acoustic.

The manufacturing floor of the next decade will not be defined by the intensity of the arc, but by the intelligence of the process. Engineers who master these techniques will find themselves equipped not merely to join metals, but to design entirely new material systems that were previously impossible to fabricate.

FIVE PILLARS OF ADVANCED JOINING

Solid-State FSW and MPW achieve bonding without melting —eliminating porosity, cracking, and intermetallic defects.	Precision Energy CMT and UMW minimize heat input to sub-millimetre tolerances, enabling thin-gauge joining.	Hybrid Speed LAHW combines laser depth with arc fill —achieving up to 5×speed with less distortion.	Future AI AI-driven process control and thermal modeling are making these techniques smarter and more adaptive.	New Materials Multi-material architectures —aluminum-to-steel, copper-to-foil — previously impossible are now routine.
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FEATURE ESSAY

Breaking the *Mold*

Gender equality in mechanical engineering — why the future demands every voice at the table

Mr. Dinil Babu · Assistant Professor, ME

AT A GLANCE

13%

Women in mechanical engineering

35%

Innovation boost from diverse teams

50%

Of human talent currently overlooked

The world of mechanical engineering, long a male-dominated field, is undergoing a profound transformation. As we stand on the precipice of a new era of technological advancement, it is imperative that we break the mold and embrace gender equality. The perspective, creativity, and ingenuity of women are essential to fully unlocking the potential of this critical discipline — and building a more inclusive and sustainable future.

This transformation is not merely about achieving a statistical balance; it is about fundamentally challenging ingrained biases, dismantling systemic barriers, and fostering a culture where every individual, regardless of gender, can thrive and contribute. When we talk about gender equality in mechanical engineering, we are talking about leveraging the full spectrum of human talent to solve the complex challenges that our world faces.

“A diverse workforce is inherently more creative and better equipped to understand the needs of a diverse society.”

— On the cost of exclusion

The Self-Perpetuating Cycle

For decades, the image of a mechanical engineer has been almost exclusively male. This has created a self-perpetuating cycle, discouraging women from pursuing careers in the field and reinforcing existing biases. From the toys that children are given to the media they consume, girls are often steered away from STEM subjects. This early lack of exposure, combined with a lack of visible role models, creates a significant barrier to entry for women in mechanical engineering.

The consequences of this gender imbalance are far-reaching. When we fail to tap into the talents of half the population, we miss out on a wealth of ideas, perspectives, and innovative solutions. By excluding women, we limit our collective potential and hinder our ability to solve complex problems.

KEY INSIGHT

Studies have consistently shown that diverse teams are more innovative and perform better. By bringing together individuals with different backgrounds, perspectives, and experiences, we can foster a culture of creativity and problem-solving that is essential for success in today's rapidly changing world.

The Tide Is Turning

There is a growing recognition of the importance of gender equality in STEM fields, and mechanical engineering is no exception. A variety of initiatives, programs, and organizations are working to bridge the gender gap and create a more equitable and inclusive environment.

One of the most significant efforts focuses on encouraging girls and young women to pursue STEM education — from targeted outreach programs in schools to mentorship opportunities with female engineers. By providing girls with access to role models, hands-on experiences, and a supportive network, these programs aim to spark an interest in engineering at a young age.

These efforts are not just about recruitment; they are also about retention. Once women enter the engineering workforce, they often face a variety of challenges, including unconscious bias, lack of mentorship opportunities, and difficulty balancing work and personal life.

The Mechanics of Bias

Unconscious bias — often subtle and unintentional — can have a significant impact on women's experiences and career progression in engineering. It can manifest in performance evaluations, project assignments, and leadership opportunities. By raising awareness of these biases and providing tools to mitigate them, companies can create a more equitable work environment.

Mentorship is also crucial for women in engineering, providing guidance, support, and access to networks. A strong mentor can help a woman navigate the challenges of her career, identify opportunities for growth, and build confidence. Companies that prioritize mentorship programs are not only investing in their female employees but also building a more diverse and resilient workforce.

“The future of mechanical engineering lies in our ability to harness the full potential of human talent — every last bit of it.”

— Mr. Dinil Babu

Structural Solutions

Companies can implement gender-blind hiring practices, where identifying information such as names and genders is removed from resumes. This helps reduce the impact of unconscious bias in the initial screening process, ensuring that all candidates are evaluated based on their skills and qualifications alone.

Transparency in compensation is another critical aspect of achieving gender equality. When pay structures are clear, it is easier to identify and address disparities. Companies that are committed to equal pay are not only doing the right thing but also building trust and loyalty among their employees.

Engineering a Better Future

The importance of gender equality in mechanical engineering extends beyond the workplace. It is also a matter of social justice and economic opportunity. When women are excluded from high-

paying and innovative fields like engineering, it reinforces existing inequalities and limits their ability to achieve economic independence.

The field of mechanical engineering is constantly evolving, driven by advancements in robotics, artificial intelligence, and sustainable energy. To fully leverage the potential of these technologies, we need a workforce that is diverse, adaptable, and forward-thinking. By embracing gender equality, we are not only building a more just society but also positioning ourselves for success in the 21st century.

The transformation of mechanical engineering towards gender equality is not just about achieving metrics; it is about fundamentally changing the culture and values of the profession. It is about creating a more humane, compassionate, and inclusive environment, where every individual, regardless of gender, can reach their full potential.

The world needs the ingenuity and passion of all individuals to solve the pressing challenges that face us. By breaking the mold and ensuring that every individual has the opportunity to contribute, we can build a truly innovative, resilient, and equitable future for mechanical engineering — and for society as a whole.

THREE PILLARS OF CHANGE

Education

Outreach in schools, hands-on STEM programs, and early mentorship are the foundation — reaching girls before biases take hold.

Retention

Recruiting women is only half the battle. Flexible policies, sponsorship, and bias mitigation ensure they stay and advance.

Systemic Reform

Lasting change requires updating hiring norms, compensation structures, and leadership pipelines — not just goodwill.

FEATURE ESSAY · AUTOMOTIVE & MOTORSPORT ENGINEERING

Pinnacle of *Speed*

The complete engineering history of Formula 1 — from front-engined pioneers to ground-effect monsters to 1000-horsepower hybrid machines

Adithyan Ajith: S4 ME

AT A GLANCE

75+ Years of Formula 1	~1000 bhp Modern F1 power unit output	360 km/h+ Top speed on circuit	< 2s Modern pit stop record
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Formula 1 is, at its core, an engineering competition with racing attached. For over seven decades, the world’s finest automotive engineers, aerodynamicists, materials scientists, and power unit specialists have converged on a single question: how do you make a vehicle go faster around a circuit than anything else on earth? The answers they have produced — often breathtaking, sometimes deadly, always ingenious — form one of the most extraordinary design histories in the history of technology.

From the front-engined, supercharged machines of the 1950s to the ground-effect cars of the 1970s, from the turbocharged monsters of the 1980s to the 1000-horsepower hybrid power units of today, every era of Formula 1 has been defined by an engineering breakthrough that rewrote what was thought possible. This is the story of those breakthroughs.

SEVEN DECADES OF DESIGN EVOLUTION

1950s <u>The Pioneers</u> Front-engined, tubular space frame chassis, supercharged engines up to 1.5L	1960s <u>The Revolution</u> Rear-engine layout, monocoque construction, aerodynamic wings introduced	1970s <u>Ground Effect</u> Venturi tunnels, skirts, and the birth of aerodynamic down force dominance	1980s–90s <u>Turbo & Tech</u> Turbocharged engines, active suspension, semi-auto gearboxes, traction control	2000s+ <u>Hybrid Era</u> Carbon fibre monocoques, kinetic energy recovery, 1.6L V6 hybrid power units
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THE 1950S**Front Engines & the Birth of Grand Prix Racing**

The inaugural Formula 1 World Championship took place in 1950, with the first race held at Silverstone. The cars of this era were largely derived from pre-war Grand Prix machinery: long-nosed, front-engined machines built around tubular steel spaceframe chassis. The dominant constructor in the early years was Alfa Romeo, whose supercharged 1.5-litre Tipo 158 —nicknamed the Alfetta — was effectively unbeatable in 1950 and 1951.

The engineering orthodoxy of the era placed the engine at the front of the car, ahead of the driver, connected to the rear wheels via a long driveshaft. The chassis was a ladder or spaceframe of welded steel tubes, offering structural rigidity through triangulation rather than through sheet material. Suspension was primitive by modern standards — often a combination of torsion bars and swing axles — and tyres were narrow, crossply structures with modest mechanical grip.

THE ALFETTA — ENGINEERING BENCHMARK OF 1950

The Alfa Romeo 158/159 used a supercharged 1.479cc straight-eight engine producing approximately 350–425 bhp depending on tune. Its supercharger boosted power dramatically but at enormous cost in fuel consumption — the car carried nearly its own weight in fuel. Yet for two full seasons it dominated the championship entirely, a testament to its pre-war engineering pedigree translated into the jet age.

The transformation of this era came from Ferrari and Maserati, who developed naturally aspirated 2.5-litre engines to challenge the supercharged Alfas. When the regulations changed for 1952–53 to Formula Two specification, these cars' superior fuel efficiency and mechanical reliability proved decisive. The lesson — that raw power without reliability and efficiency is fragile — would be learned and relearned throughout F1's history.

THE 1960S**The Rear-Engine Revolution & the Monocoque**

The defining engineering revolution of Formula 1's first decade came not from the establishment, but from a small British constructor: Cooper Car Company. Jack Brabham's 1959 and 1960 championship wins in the rear-engined Cooper T51 and T53 conclusively proved that placing the engine behind the driver — lowering the centre of gravity, improving weight distribution, and reducing the frontal area — was the correct layout for a racing car.

"The rear-engine revolution was not merely a packaging change. It was a complete reconception of what a racing car could be."

— On the Cooper Revolution

The second transformative development of the 1960s came from Lotus. Colin Chapman, one of the most intellectually audacious engineers in motorsport history, introduced the monocoque chassis with the Lotus 25 in 1963. Rather than a space frame of tubes, the monocoque used stressed aluminium sheet to form the structural backbone of the car — exactly as aircraft fuselages are constructed. The result was a chassis of far greater stiffness-to-weight ratio than anything previously seen in the sport.

Chapman's Lotus 25 was also the first F1 car to feature inboard suspension on all four corners, a full-width nose, and a reclined driving position that reduced frontal area. Jim Clark won the 1963 championship in the 25 with a dominance that reflected the car's generational advantage over its competitors. The monocoque has remained the fundamental structural philosophy of every F1 car built since.

THE 1970S

Wings, Wedges & the Ground Effect Era

Aerodynamic wings appeared on Formula 1 cars in 1968, initially as tall, spindly structures mounted high above the bodywork on struts. Their purpose was to generate downforce — negative lift — pressing the car into the track surface and dramatically increasing cornering speeds. The problem was structural: several high-mounted wings failed catastrophically at high speed, and the FIA mandated that wings be mounted directly to the chassis by the end of the 1969 season.

What followed over the next decade was one of the most intense periods of aerodynamic innovation in motorsport history. Cars became wider, lower, and more wedge-shaped, with every surface sculpted to manage airflow. Front and rear wings evolved from simple flat planes into complex multi-element structures. But the most revolutionary development was yet to come.

GROUND EFFECT — THE ENGINEERING BREAKTHROUGH OF THE 1970S

Lotus engineers Peter Wright and Tony Rudd discovered that by shaping the underside of the car as an inverted aerofoil — using the Venturi effect to accelerate air beneath the car and create a low-pressure region — massive downforce could be generated without corresponding drag. The Lotus 78 and 79 of 1977–78 exploited this with side pods containing venturi tunnels and flexible rubber skirts that sealed the car to the track surface. The downforce generated was so great that drivers reported cornering loads of 3g and above — forces that pushed the limits of human physiology.

Ground effect transformed lap times overnight but introduced new dangers: the cars were extremely sensitive to ride height, and any failure of the skirts — a common occurrence on bumpy tracks — caused an abrupt and total loss of downforce. Several serious accidents resulted, and ground effect was eventually banned from 1983. It would return, in regulated form, in 2022.

THE 1980S

The Turbo Era & Electronic Intelligence

Renault introduced the first turbocharged engine to Formula 1 in 1977 with their RS01. Initially unreliable and derisively nicknamed the ‘yellow teapot’ for its propensity to produce great clouds of steam, the concept proved its potential and triggered an arms race that would define the decade. By the mid-1980s, every leading constructor had adopted forced induction, and the power outputs achieved were extraordinary.

Honda’s 1.5-litre RA168E engine, used by McLaren in 1988, produced approximately 685 bhp in race trim — and reportedly over 1,000 bhp in short qualifying trim. The McLaren MP4/4, driven by Ayrton Senna and Alain Prost, won 15 of 16 races in 1988, a record of dominance unmatched in the sport’s history.

“The 1988 McLaren MP4/4 was not a racing car. It was a statement that engineering, when given sufficient resources and talent, can simply overwhelm competition.”

— On McLaren’s 1988 season

Equally significant was the development of electronic systems during this era. Active suspension — hydraulically actuated dampers controlled by onboard computers — allowed the ride height and attitude of the car to be optimised in real time. Traction control, semi-automatic sequential gearboxes, and data telemetry systems transformed the car from a pure mechanical device into a mechatronic system. Williams’ FW14B of 1992, driven by Nigel Mansell, was perhaps the apex of this development — a car so electronically sophisticated that it prompted the FIA to ban most driver aids from 1994.

THE 1990S – 2000S**Carbon Fibre, Safety & Aerodynamic Complexity**

The carbon fibre monocoque — first introduced by McLaren with the MP4/1 in 1981 — became the universal standard for F1 chassis construction through the 1990s. Carbon fibre reinforced polymer (CFRP) offered a strength-to-weight ratio unmatched by any metal, and its energy-absorbing properties in a crash proved dramatically superior to aluminium. The survival cell that forms the core of a modern F1 car can withstand impacts of over 300g without structural failure.

The aerodynamic complexity of cars in this era increased year on year, with designers exploiting every regulatory grey area to generate more downforce. Multi-element front wings, bargeboards, vortex generators, and complex diffuser arrangements proliferated. By the mid-2000s, the aerodynamic appendages of a Formula 1 car had become so complex — and so sensitive to following another car in its turbulent wake — that overtaking had become nearly impossible, prompting a series of regulatory interventions that continue to shape the sport.



Formula 1 2026 F1 McLaren Livery Concept 3D Model

2014 TO PRESENT**The Hybrid Power Unit & Sustainable Speed**

The introduction of the 1.6-litre V6 turbocharged hybrid power unit regulations in 2014 represented the most radical technical change in Formula 1's history. The new power units combined a turbocharged internal combustion engine with two motor-generator units — the MGU-K (kinetic) and MGU-H (heat) — creating a system of extraordinary complexity and efficiency.

The MGU-K recovers kinetic energy under braking and deploys it as additional drive torque, contributing up to 120kW (161bhp) of additional power. The MGU-H, unique to Formula 1, is integrated directly with the turbocharger shaft: it can either harvest energy from exhaust gas spinning the turbo, or drive the turbo to eliminate turbo lag — a function that makes the power delivery of these hybrid units smoother and more responsive than any purely mechanical turbosystem.

THERMAL EFFICIENCY —F1'S UNLIKELY GREEN CREDENTIAL

Modern Formula 1 power units achieve thermal efficiencies above 50% — meaning more than half the energy contained in the fuel is converted to useful mechanical work. For comparison, the best conventional road car petrol engines achieve approximately 38–40% thermal efficiency. This extraordinary figure is the result of direct injection, ultra-high compression ratios, precisely controlled combustion, and the MGU-H's ability to eliminate pumping losses through the turbocharger. The technology is directly relevant to road car development.

The 2022 technical regulations introduced a further revolution: the return of ground effect aerodynamics, this time in a controlled form using a regulated floor tunnel design. The new cars generate the majority of their downforce from the underfloor rather than from complex external aerodynamic appendages, making them far less sensitive to the turbulent wake of a car ahead —and dramatically improving the quality of racing.

The story of Formula 1's engineering is, ultimately, the story of human ingenuity under constraint. Every regulation introduced to slow the cars has been met by engineers who found ways to go faster within the new rules. Every material science advance, every computational tool, every manufacturing technique developed for aerospace or defense has eventually found its way onto the Formula 1 grid. The result, seven decades on, is a machine of such sophistication that it stands as one of the most complex engineered objects ever built for a purpose that is, at its heart, elegantly simple: to go around a circuit faster than anyone else.

THREE PILLARS OF F1 ENGINEERING**Aerodynamics**

Every surface of an F1 car generates downforce. At speed, aerodynamic grip exceeds the car's own weight — theoretically enabling it to drive inverted through a tunnel.

Power Unit

Modern F1's 1.6L V6 hybrid power unit combines an internal combustion engine with two motor-generator units, achieving over 50% thermal efficiency —the highest of any production-relevant powertrain.

Materials

The carbon fibre monocoque, Kevlar bodywork, and titanium fasteners of a modern F1 car represent a direct transfer of aerospace materials science into motorsport — and eventually into road cars.

BEYOND THE CAMPUS STUDENT EXPERIENCE

Beyond the *Campus*

How a Formula Kart Racing Competition transformed textbook knowledge into real-world engineering — and four days in Coimbatore into a lifetime of lessons

K U Haripriya · S2ME, Team Mechzico · Documentation Head

AT A GLANCE

4 Days on the track	Mar 16–19 AIMS, Coimbatore	1 Go-kart built from scratch	∞ Lessons beyond the textbook
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There is a particular kind of thrill that no lecture hall can replicate — the moment an engine you helped design roars to life on an actual track. For four days in March, from the 16th to the 19th, I had the privilege of living that moment as part of Team Mechzico at the Formula Kart Racing Competition conducted by AIMS, Coimbatore. What followed was not simply a competition. It was an education in the truest sense of the word.

From the first bolt we torqued to the final lap our kart completed, every stage of this journey demanded something that no examination ever had — the ability to act under pressure, communicate under stress, and solve problems in real time, with real consequences.



The author at the event

“Working alongside such a passionate and dedicated team taught me the true value of collaboration and engineering application beyond textbooks.”

— K U Haripriya · Team Mechzico

From Blueprint to Build

Long before the starting flag dropped, Team Mechzico was deep in the process of designing and building our go-kart from the ground up. This phase — often invisible to spectators — is where the real engineering happens. Every design decision carried weight. Every component choice had to

be justified, not just in theory but under scrutiny from technical judges who knew exactly what to look for.

The design-and-build process forced the team to confront a fundamental truth of engineering practice: the gap between what works on paper and what works on a chassis. Tolerances that seemed acceptable in CAD became sources of vibration. Assumptions that held in calculations were challenged by the realities of material behaviour and assembly. We adapted, iterated, and learned.



Team Mechzico with their go-cart at the competition

THE COMPETITION FORMAT — AIMS COIMBATORE

The AIMS Formula Kart Racing Competition required participating teams to design, build, and race a fully functional go-kart — subjecting each vehicle to rigorous technical inspection before any team was permitted on the track. Design decisions had to be documented, justified, and defended in a formal technical interview. It was engineering school compressed into four days.

The Role of Documentation Head

Within Team Mechzico, I took on the role of Documentation Head — a position that sits at the intersection of engineering and communication. My responsibility was to prepare and organise all technical documents that formed the official record of our design process: specifications, material choices, structural analyses, and the rationale behind every significant decision the team made.

In motorsport engineering, documentation is not a formality. It is the language through which a team's thinking is judged. A poorly documented decision — however sound the engineering — can fail at the first challenge. Getting the documentation right meant understanding the engineering deeply enough to explain it to someone who would question every assumption.

COMPETITION TIMELINE

- **PRE-EVENT**
Design & Build Phase
 Concept development, CAD modelling, component sourcing, assembly and iterative testing of the go-kart.
- **MARCH 16**
Competition Opens — AIMS, Coimbatore
 Registration, scrutineering, and initial technical checks. Teams present documentation for preliminary review.
- **MARCH 17–18**
Technical Interview & Track Events
 Haripriya represents Team Mechzico in the technical interview, defending design decisions before the judging panel. Dynamic events on track.
- **MARCH 19**
Final Runs & Closing
 The kart takes to the track in final competition runs — the culmination of months of preparation made visible in motion.

Under the Microscope — The Technical Interview

Attending the technical interview was, perhaps, the single most formative experience of the four days. Standing before a panel of evaluators and presenting our team's work — every calculation, every design choice, every trade-off we made — required a quality that engineering programmes rarely test directly: the confidence to defend your thinking.

The interview was not adversarial. It was a professional exchange in the truest sense — a structured conversation between engineers where the currency was clarity of reasoning. Questions probed not just the what, but the why. Why this material over that one? Why this geometry? What were the failure modes considered? What would you do differently?

“Every moment pushed us to learn, adapt, and grow. This experience has definitely strengthened my interest in automotive engineering and motorsports.”

— K U Haripriya

When the Kart Moved

For all the intensity of the documentation work and the technical interview, nothing quite prepared me for the feeling of watching our kart move under its own power on the track. Months of decisions — made in classrooms, workshops, and late-night team meetings — compressed into a machine that moved with purpose and speed.

The efforts our team took finally paid off in that moment. It was not just pride in the result; it was the visceral confirmation that engineering, when done with care and collaboration, produces something real. Something that works.

Activities at the Department

19 Jan 2026	IKS Guest Session on "Amazing Realms of Space Transportation" conducted for ME students.
17 Jan 2026	Add-on course on "Energy Systems – Generation, Consumption and Sustainability" commenced for 64 students of S4 and S2. Completed in same period.
17 Feb 2026	Awareness session on "Career in Shipping" by Dr. George Abraham, Head of Department, Marine Engineering Training Institute, Cochin Shipyard Ltd. 29 S8 ME students participated. Faculty coordinator: Dr. Jose Sheril Dcotha.
18–19 Feb 2026	Sessions on Module 4 of Advanced Energy Engineering for S8 ME students by Professor of Practice, Dr. Ajith Gopi, Additional Chief Technical Manager (Retd.), ANERT Kerala. (Also listed as March 3, 2026).
23 Feb 2026	Open House Meeting of S8 ME conducted.
03 Mar 2026	Organized sessions on 'Module 4 of Advanced Energy Engineering' (MET458) for S8 ME students. The sessions were handled by Professor of Practice, Dr. Ajith Gopi, Additional Chief Technical Manager (Rtd), ANERT Kerala.
04 Mar 2026	Organized an industry session titled 'CFD as a Career' presented by Mr. Kunjunni M, CFD Expert and Ex-DRDO Research Fellow. Coordinated by Mr. Ajith Kumar R. Attended by 29 students of S8 ME and 34 students of S4 ME.
05 Mar 2026	Conducted a workshop under the Ek Bharat Shreshtha Bharat (EBSB) initiative titled 'Building Strengths: Towards Democratic Living Practices'. The session was led by Dr. Sheeba K M, Professor, Dept. of History, Sree Sankaracharya University of Sanskrit, Kalady. Coordinated by Mr. Dinil Babu C; attended by 50 participants.
12 Mar 2026	Conducted an open-house interactive meeting for parents and teachers of S4 ME to discuss student progression. Attended by 12 out of 34 parents.
18 Mar 2026	ASME SSET Student Section organized ASME Kerala Section Project Expo ENGINEX 2026.
28 Mar 2026	Organized an alumni talk on 'Smart Manufacturing and Automation' by Mr. P Sabari Vishnu (Batch 17), Demand Planner at Dabur India Ltd., as part of the Department Association Day. Coordinated by Mr. Ajith Kumar R; attended by students from S2 to S8 ME.



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