THAKUR COLLEGE OF ENGINEERING & TECHNOLOGY

MECHANICAL DEPARTMENT PRESENTS

EDITION 4
ISSUE 1

MECHON 2020

AEROSPACE AND MILITARY

MESSAGE BY DEAN

DR. R.R.SEDAMKAR

It is a moment of pride for me to announce the release of 'MECHON' magazine's sixth issue. The magazine portrays the writers' intellect and enables them to share their innovative ideas. I gladly acknowledge the efforts taken by the students and staff of Mechanical Department who have taken the initiative to promote the writing and publishing skills of students. I'm sure the magazine has helped the students to share and express their thoughts in an articulate manner.

Achievements of students have also been mentioned which will be a motivational factor for other students to achieve the standard of excellence. I am immensely pleased to say that that we have achieved our aim of turning this into reality. I would like to congratulate the students, teachers, alumni and everyone else involved in publishing its sixth edition. I wish everyone loads of success and a bright future.

MESSAGE BY MENTOR

DR. SANJAY KUMAR

I feel esteemed to be a part of the sixth issue of the e-magazine of the Mechanical Engineering Department. With 5 batches being passed out, the Department has shown great potential. Our students have shown tremendous potential not only in academics but also in co-curricular activities and extra-curricular activities.

At the International conference, faculties and students have published technical papers in International journals. Some of the papers were also published in Tata McGraw Hill Publication. For the overall personality development of students, apart from academics, participation in co-curricular and extra-curricular activities is the need of the hour. Students are encouraged to participate in National level competitions,and have won 1st prize at hackathon. All these activities help in their holistic development, as a result of which they get admitted into reputed universities and get placed in prestigious companies. I commend all faculties, students and staff members for their hard work in publishing the e-magazine, which represents the insights of the Mechanical Department. I wish them Best of Luck !

MESSAGE BY HEAD OF DEPARTMENT

DR. SIDDHESH SIDAPPA

I am delighted to know that our students have succeeded in publishing the sixth issue of 'MECHON' for the academic year 2019-2020. 'MECHON' the departmental magazine hasthe prime objective of providing aspiring engineers a wide platform to showcase their technical knowledge and to pen down their illustrative and innovative ideas.

This magazine is intended to bring out the hidden literary talents in the students an teachers to inculcate strong technical skills among them. I congratulate and thank all the students and faculty coordinators who have made untiring efforts to bring out this magazine. I wish them all the very best for releasing more such magazines in the future.

MESSAGE BY FACULTY IN-CHARGE

MR. PAWAN TIWARI

It gives me immense pleasure to present the sixth issue of 'MECHON' e-magazine of the Department of Mechanical Engineering. It is the talent and outlook of our students which is portrayed through this magazine. This is one of the best platforms for our students to present multifaceted personalities and innovative ideas. It also enables the students to be aware of their changing surroundings and to consistently learn about new technologies.

I take this opportunity to thank our respected Principal Dr. B. K. Mishra, Dean of Academics Dr. R. R. Sedamkar, Dean Mentor Dr. Sanjay Kumar, Head of Department Dr. Siddesh Siddapa, and all the faculty members for their perpetual inspiration and kind support. I believe that this edition will prove to be a success. I express my heartfelt gratitude to the editorial committee for their relentless efforts, the young writers for their valuable articles and all those who have been a part of 'MECHON'

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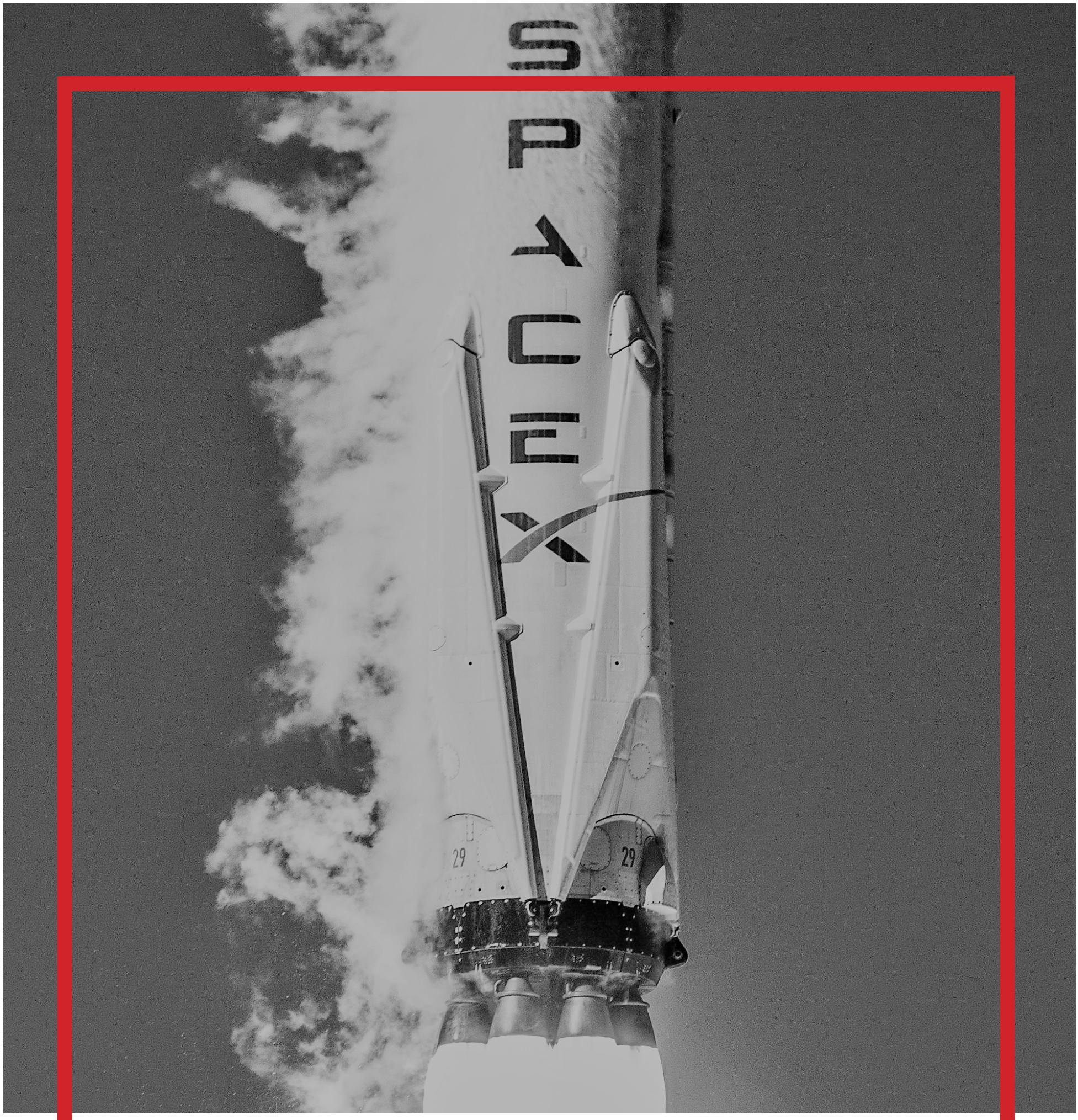


FLYING FLEETS

HYPERSONIC TRAVEL

Abstract:

For the past few years, research which dealt with hypersonic flight has been restricted to military applications. Hypersonic travel could be an affordable and super-fast means of transport. Also, there is interest from many private companies for commercial development in this path. There was a research which was carried out which made the hypersonic aircraft proficient enough to take off on it's own and also improved various of it's features. The technique of Ramjet exhaust development helps to produce adequate thrust. The disciplines of aerodynamics and thermodynamics are coupled by aerodynamics. The conventional subsonic modes of commercial transport can be replaced by hypersonic travel with newly designed fleet of vehicles which could lessen the time taken for long-range as well as short-range flights. Hypersonic flights have the ability to fly at exceptionally high speeds i.e. above Mach 5. There have been constant improvements in hypersonic flight research over past few decades. The improvements took place in the aircraft design domain as well as in the aerodynamic domain. The Lockheed SR-71, which used turbine based engine combined with ramjet or scramjet to steer the aircraft, attained speeds from Mach 3 to Mach 3.5 as it was powered by best quality engines, which made it the fastest aircraft to take off under its own power. The limitations of design, uncontrollable fuel consumption, and reoccurring issues regarding maintenance are largely responsible for limiting the studies of hypersonic flight to missiles and research aircrafts.

High-Speed Commercial Transportation:

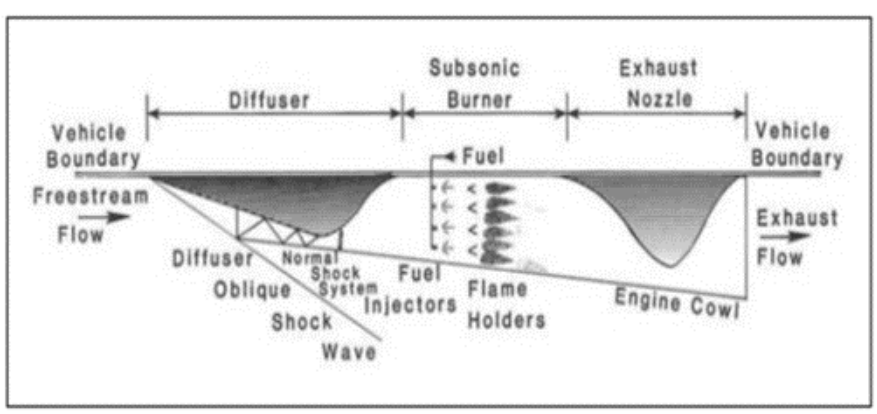
An aircraft called as Concorde was the first successful high speed flight which could travel from London to New York in under 3.5 hours. This aircraft was invented by France and Britain. The Tu-144 aircraft which was less successful and short-lived was invented in Soviet Union. Currently, for the impending revival of supersonic or better yet hypersonic travel, there exists a huge economical gap in the society. Today, achievement of hypersonic speeds is possible by focussing on available resources on the design and development of airliners.

Hypersonic Propulsion:

The air in which Hypersonic air-breathing vehicles operate is used to boost the speed range of vehicles at speeds higher than Mach 5. Generally, rocket- based systems which produce thrust to push the aircraft forward have been utilised for propelling hypersonic aircrafts. Nevertheless, sustained atmospheric flights prefer engines which are propelled by hot exhaust gases, which reduces the weight and space of the aircrafts and thus allow a fair amount of larger payload to be carried.

A scramjet system is required by Air-breathing engines for hypersonic vehicles to operate and such systems are often proposed in combined cycle form which also contains a ramjet and a simple gas turbine. The aircraft thus is able to change speeds according to its requirements. Therefore, all three are required for successful operation at hypersonic speeds. Ramjet engines are classified as engines which compress the air which is required to oxidise air and which is being pumped continuously through the inlet at high velocity. The aerodynamic diffusion (ram) process created by the diffuser and inlet helps to achieve compression. The aircraft's forward momentum was utilised for compressing the air.

Figure below shows an ideal ramjet. The engine consists of an exhaust nozzle, combustion chamber and a diffuser. In a typical ramjet, an air inlet and a diffuser is included allowing the air which is at speed greater than that of sound to slow down at a speed less than that of sound. There is creation of rise in temperature in the engine which provides plentiful conditions for the filling the combustion chamber with air.



The compressed air is blended with fuel and combusted and supplied straight to the exhaust system for expansion, as opposed to gas-turbine engines, where gas having high temperature is passed through the turbines which help in the working of the compressors. The nozzle helps in increasing speed of the high temperature gas creating a high velocity exit jet, which thus produces the required positive momentum for thrust generation from the overall engine. The applications of Ramjet engine are generally military-based as they assist the impulsion of missiles. Nevertheless, ramjets are also being used by aircrafts for propulsion. Examples comprise the SR-71 Blackbird, which is capable of achieving speeds up to Mach 3.5 due to presence of ramjet propulsion system. Recently, a concept aircraft which is controlled by a combined cycle hypersonic propulsion system consisting of an arrangement of gas turbine, ramjet, and scramjet was being studied. The focus was on maximising the thrust element from the ramjet as an important condition and predecessor to allowing the aircraft to attain hypersonic speeds. In order to achieve this goal, three different nozzle types were investigated: conical, dual bell, and bell nozzles. Various tests were carried out on these nozzles to investigate the potential available to the designer of the propulsion system with respect to nozzle type choices and their precise features. Extensive computational fluid dynamics (CFD) was undertaken to draw attention to the most capable design through a parametric examination.

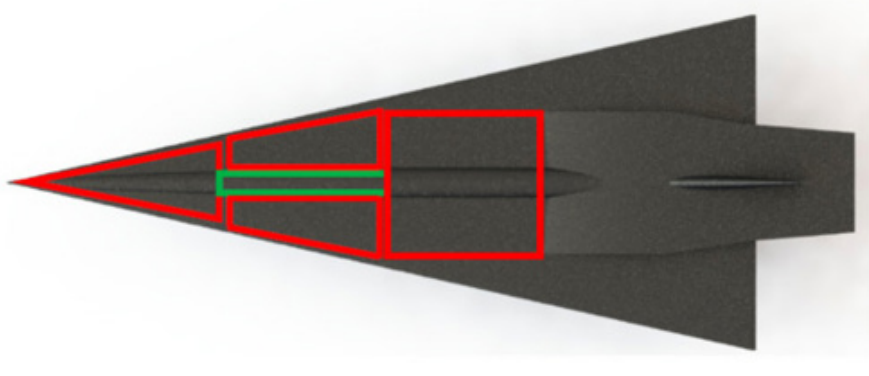
Aircraft Design :

The aircraft designing process is usually separated into three discrete phases: the design created entirely out of the concepts, the design created in details sufficient enough for the determination of costs of construction, and the design in created in detail considering all the aspects and specifications. The following performance specifications should be met in order to design a hypersonic aircraft:

1. At least 100 passengers must be accommodated in the aircraft.
2. On current airports and runways, the aircraft should be able to sustain the take-off and landing process, thus labelling the aircraft proficient for this process
3. An altitude of 1000, 000ft and at speed of Mach 8 should be the minimum requirements acquired by the aircraft.
4. 12,000km should be its minimum range.

Basic Stability Analysis :

At Hypersonic speeds, it is expected that the aircraft will experience nose up pitching moments as opposed to the nose down pitching moment which is approved as longitudinal stability. The trim settings must be correctly adjusted for the trim tabs which are present at the rear end of an aircraft and are used to counteract aerodynamic forces and stabilise the aircraft in the desired altitude. At hypersonic speeds, to help in the management of the moments the Centre of Gravity of the aircraft with the payload could be located further ahead to increase the static margin of the aircraft which is the distance between the centre of gravity and the neutral point. To overcome this obstacle, a conceptual aircraft design was made to situate fuel tanks and passengers in the aircraft. The areas outlined in red colour are where the fuel tanks would be placed and those with green will be where the passengers and the cargo would be placed. The centre of gravity value of the hypersonic aircraft, by means of the position of the fuel tank and the passengers and their corresponding weight, was found to be 41.27 m when it is completely loaded. The consequent distance between the centre of gravity and the neutral point also known as static margin was found to be 22.7% .



Conclusion :

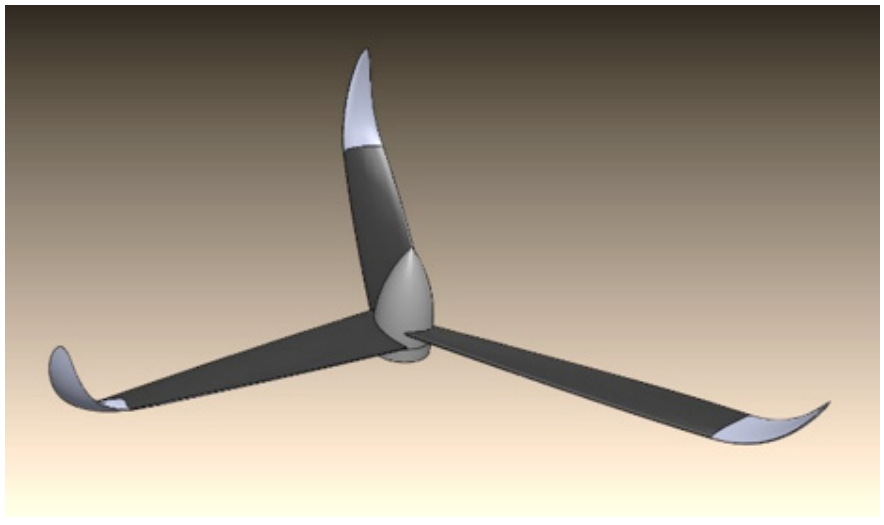
India performed its first test of a Hypersonic Scramjet Engine on 29, August, 2016 in a sub-orbital test flight to carry on its Reusable Launch Vehicle (RLV) development program that has the crucial target of developing a fully reusable Two-Stage Orbit launch vehicle flying sometime in the next 15 years. However, the concept of hypersonic passenger aircraft is still waiting to be researched and implemented here.

- Anushka Moharir
S.E. MECH A

TURBOPROP HELICOPTERS

Turboprop Helicopter are propellers having propulsion system mounted at tip of the blades. The vital aim of turboprop helicopters is to provide high endurance than that of the normal helicopter blades, offer greater speed than planes and to reduce the travel cost per passenger owing to their efficiency. The helicopter consists of single main rotor with the addition of two turbo propellers mounted onto the wings. The turbo propellers will provide the propulsive force on movement, anti-torque moment to maintain stability and serve the purpose of conventional tail rotor. However, the issue of high noise levels due to the propellers needs to be addressed. This problem can be overcome by redesigning the blades.

Conventional blades have a parallel vortex interaction where entire blade is subjected to blade vortex interaction resulting in high noise levels. Q-tip shaped or blue-edged blades can be used for propellers. Here small parallel blade vortex interaction occurs which is limited to the redesigned tips. Thus, the high impulsive noise domain is eliminated reducing noise levels. The turbulence in these blades is minimised in comparison to the traditional counterparts thus minimizing the noise. Owing to the above factors, helicopter turboprops will be capable of increasing efficiency, maximize speed and reduce noise.



Another modification in turboprop helicopters is that the tail rotor is eliminated (eliminating the long shaft through which power is transferred) which is replaced by a pair of turbo propellers. The turbo propeller on the wings will provide the anti-torque required to keep the body stable during hover conditions and upward and downward descent. Increasing power to the main rotor engine increments the torque supplied to the two turboprops. They provide propulsive force for forward movement and at low speed compensate for the anti-torque. The blades facilitate in eliminating the turbulent flow of air which otherwise would have been produced at the tip of flat blades which led to noise generation.

A major breakthrough in the helicopter industry has been achieved by Airbus helicopters who built the prototype of a hybrid helicopter- The Eurocopter X3.

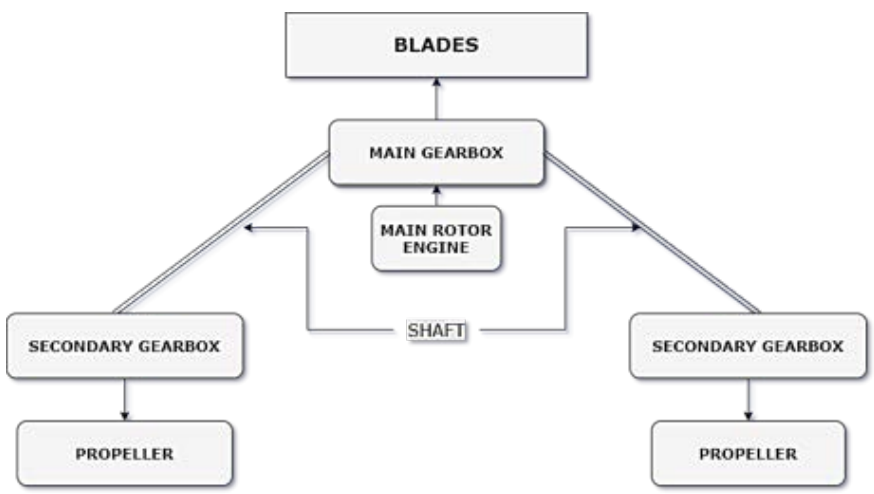
Eurocopter X3

The Eurocopter X3 is a one of its kind high speed, long range experimental compound helicopter developed by Eurocopter Airbus Helicopter. The test flight of Eurocopter X3 on 7th June 2013 set a speed record by achieving a maximum speed of 255 knots (472 km/h) and thus was a head turner in the helicopter industry. Eurocopter aimed at designing a prototype with the speed of a turboprop-powered aircraft and the full hover-flight capabilities of a helicopter.

X3 comprises of a five-blade main rotor system and two turbo-propellers mounted on each of the short span wings. Two turboshaft engines (Rolls-Royce Turbomeca RTM322) are used to drive the turbo-propellers and also the main five-blade main rotor system. During hover in the HCH (Hybrid Compound Helicopter) configuration, the system requires greater rotor power to overcome the aerodynamic load of the wing and most of the of the anti-torque moment is provided by the starboard propeller. In low speed flight, the power levels of the turboprop rotor and the starboard propeller are similar indicating similar low speed anti-torque performance. As flight speed increases, a combination of the wing offloading the main rotor and the main rotor slowing down to avoid adverse compressibility effects, reduces the main rotor power. However, this is met with an increase of power required by the two propellers, to overcome the fuselage drag and to maintain a near level pitch attitude to promote a favourable wing angle of attack. The prototype does not consist of any anti-vibration systems and can fly without any stability systems.

Eurocopter X3 took the first flight in 2010 from a French facility. In 2011, it demonstrated a speed of 232 knots consuming less than 80 percent of available power. The helicopter has set a record speed of 255 knots in level flight and 263 knots in shallow dive. A broad scope for utilization of X3 lies in military missions like special force missions, troop transport, evacuations owing to its high cruise speed and commendable take-off and landing performance. The primary objective of Eurocopter X3 is to create a system which has high speed, smooth flight, effective operational costing and define the future of rotary-wing aircraft.

- Shravani Dighole
S.E. MECH A



HAL TEJAS

The MiG-21 series is soon going to be replaced by Tejas, India's first indigenous Light Combat Aircraft (LCA). Tejas is a result of several years of design and development and nearly 3 decades work from the DRDO.

Right from the beginning, the intention of the LCA program was to deliver the best single engine lightweight fighter. In 1980s Light Combat Aircraft (LCA) program began whose aim was to replace India's ageing MiG-21 fighters. The name "Tejas" was officially given to this LCA in 2003, by the then Prime Minister Shri Atal Bihari Vajpayee.

The total cost of this project was just Rs 7,000 crore (USD 1 Billion Dollar), which is very less when compared to costs of similar aircraft in the world. The Defense Research and Development Organization (DRDO) are also working on making an advanced medium aircraft with twin engines. DRDO and its partner Agencies are developing four versions of Tejas- LCA for the Indian Air Force (IAF), LCA Trainer for the IAF, LCA for the Indian Navy (IN) and LCA Trainer for the IN. A shore based testing facility was created in Goa to aid the development of the navy variants of the aircraft. It also included a ramp that mimicked the take-off/landing deck of an aircraft carrier.

Tejas is best in the world it is a four plus generation aircraft the wings are made entirely of composite structures. A totally digital fly by wire control system is incorporated into this contemporary aircraft. Another feature that is special to Tejas is its 'Unstoppable configuration technique' with which it has been built. The design of Tejas includes a delta wing configuration (wing shaped like a triangle) with no tail planes for canard and a single dorsal fin.

The aircraft is, by design unstable. The unstable design makes it extremely maneuverable giving a distinct edge over its competitors when it comes to dog flights. To explain it in layman terms, between bike and car, a car is much more stable but is unable to exhibit the same maneuverability as a bike. Combat aircraft needs to be highly maneuverable. Tejas has a pure double Delta wing configuration (wing root leading edge sweep 50 °, outer wing leading edge sweep 62.5 °and trailing edge forward sweep 4°),with no tail planes or canard and a single dorsal fin. Technologies such as relaxed static stability, fly-by-wire flight control system, multi-mode radar, integrated digital avionics system, composite materials structures and a Flat rated engine are integrated by it. It is the smallest & lightest in its class contemporary supersonic combat aircraft. After the HAL HF-24 Marut, Tejas is the second Supersonic fighter developed by Hindustan Aeronautics Limited (HAL).

As of 2016 Tejas MK1 was introduction for Indian Air Force and the naval version was undergoing flight test for Indian Navy (IN).The projected requirement for Indian Air force is 200 single seat Fighters and 20

twin seat trainers, while the Indian Navy expects to operate 40 single seat fighters. The first Tejas IAF unit No. 45 Squadron IAF 'Flying Daggers' was formed on 1st July 2016 with two aircraft. Initially being station at Bangalore, the first squadron will be placed at its home base at Sulur, Tamil Nadu.

With all major military in western significantly in radar to detect incoming aircraft an air defence system to shoot them down, stealth is the new cornerstone for any new aircraft development. The idea is to keep Radar Cross Section (RCS) as low as possible. Tejas employees various features to keep the RCS low including Y-shaped air inlet, extensive use of composite material (which do not reflect radar waves) and a generous coating of radar-absorbing material over the control surfaces. Tejas has 8 weapon hard points (a special station on the air frame design to carry an external load) - 3 under each wing, 1 under the central body and 1 under the air inlet on the left side of the plane. This allows Tejas to use a wide range of weapon systems. This includes mid and close range air-to-air missile, precision- guided weapons, air-to-surface (including anti-ship) missiles, conventional bombs, cluster bombs and unguided rockets. The pylons can carry a maximum of 4 tons of weapons. This is in addition to the plane's main gun, a 23 mm twin barreled canon with 220 round The Tejas also incorporate a 'glass cockpit' in which information is displayed real-time to the pilot. Tejas also has open architecture software for avionics. DRDO can update it as and when required.

The capability of any advance platform can only be proven through relentless and repeated testing. In fact the LCA prototype had completed over 1000 test flight and over 530 hours of flight testing by January 2009. In 2013 alone there were over 450 test flights. The various prototypes underwent rigorous hot weather training in Jaisalmer in the height of summers. For cold weather and high altitude test, the planes were taken to Ladakh. Tejas has the Multi-Mode Weapon multirole capability that can fire Laser Guided Bombs, and has passed the entire test for 'All Weather Clearance' and has been cleared for fly without telemetry support. It will enable the Indian Air Force to carry out its air superiority and offensive air support missions, forward air field operations all-weather multirole operation, electronic counter measure and night flying operations. Moreover, Tejas is proficient enough to travel about 1700 km non-stop and its radius of action is up to 500 km depending on the nature and duration of actual combat.

- Vinay Verma
S.E. MECH A

JOINT STRIKE FIGHTER PROGRAMME

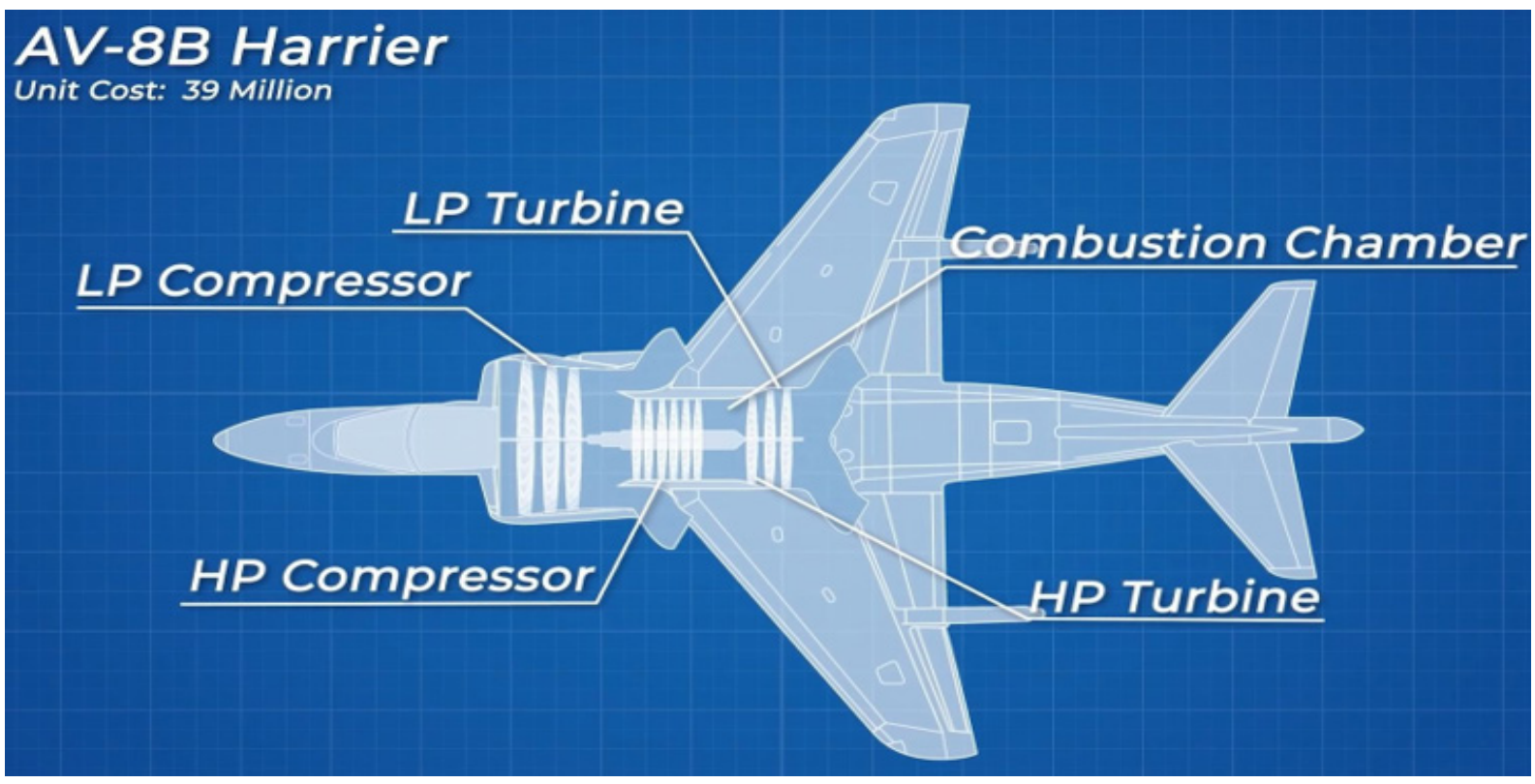
The F-35 is the most expensive military system to be ever developed. It had a development period of 27 years and was developed by Lockheed Martin. At times it even got mixed up between political feuds and was a significant topic of debate. Luckily it was developed privately for the US government. It wouldn't have become a reality if the development was overseen by the government due to strong opposition and the astronomical development costs.

It is a US-built killer machine that is being developed to replace the F16s, A10s and it takes lessons from the B2 bomber programs. It also develops on the stealth technology by Lockheed martin learned from the F22 raptor and F117 Nighthawk. It's a carrier-capable fighter capable of firing supersonic missile and VTOL and would also replace the FAA18s of the US navy.

The plan was to develop a single fighter plane for the navy, marines, and the airforce of the USA and even its allies under the Joint Strike Fighter program. This plane unlike the US exclusive F-22s, would be commercially available. The program began as a competition between McDonnell, Douglas, Northrop Grumman, Lockheed Martin and Boeing, with only Lockheed and Boeing moving forward with the development phase as finalists in the competition. The prize of this competition was one of the most lucrative contracts they could ever sign.

Boeings' X-32 :

Boeing lost the contract, mostly as a result of the decision to develop two prototypes instead of one. One was capable of supersonic flight while the other was capable of VTOL.



The X-32 was a rather odd-looking aircraft with a massive intake port in the front. It used the same vectored thrust technique from the Harrier which it was supposed to be replacing.

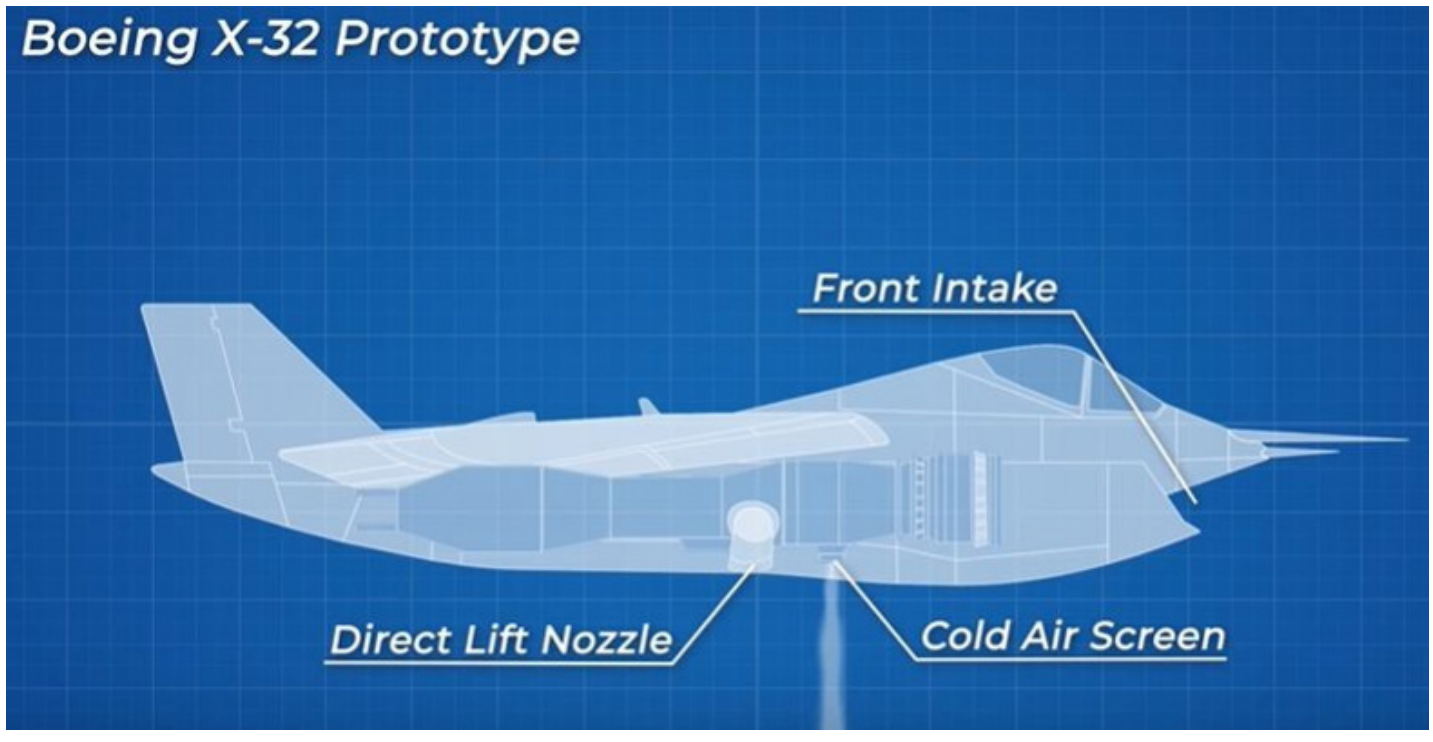
X-32 :

Despite using a similar design, the X-32 did give make significant improvements over the harrier. During normal flight the cruise nozzles would be open allowing for the thrust from the engine to be directed at the rear. Then during transition the nozzles would close forcing the thrust downwards. This allowed for a greater degree of roll control. This was also achieved by placing the larger roll control nozzles further from the center of mass of the plane. The most significant design improvement was the placing of a cold air screen just forward of the lift nozzles to stop hot turbulent air from the direct lift nozzles from entering the front intake. Jet engines need cold and smooth air to operate at maximum thrust and this was especially difficult during the landing when the thrust was pointing downwards. Despite these efforts and design developments, Boeing lost the contract to Lockheed Martin's F-35. The F-35 developed by Lockheed Martin did a great job in impressing the JSF program.

The Harrier :

The harrier was one of the popular versions of VTOL planes. It consists of the turbines and compressors as shown above. The thrust is vectored using four control nozzles located in close proximity to the center of gravity of the plane. The plane precariously balances on these four columns of air. This didn't make the harrier an easy to control aircraft and at times turbulence from its own downwash caused the plane to flip over the cockpit and crash, killing the pilot. The harrier did have small roll control nozzles at the tip of each wing but these were entirely manual. Putting such controls in the hands of the pilot who was already focusing on other factors while landing was an unwise decision.

- Balaji Murthy
T.E. MECH A



JOINT STRIKE FIGHTER PROGRAMME - II

Boeing made great improvements to the conventional VTOL Harrier. However, they were no match for what Lockheed Martin had in store.

Major developments :

The X-35 proposed by Lockheed incorporated a "Lift Fan system" for the engine thrust. The engine thrust escaped the plane rom single exhaust nozzle during normal flight, much like that in the harrier. However, when the X-35 begins to transition into VTOL it showcased its true potential. The X-35 was capable of doing some transformations that look like its straight out of a science fiction movie. Hatches opened both above and below the aircraft revealing its Lift-Fan system right behind the cockpit. Two hatches opened on the top revealing contra-rotating fans and two more doors opened just beneath the wings. These ports at the bottom were responsible for controlling the roll of the aircraft. As the plane continues to land the primary cruise nozzle at the rear of the aircraft redirects the thrust down pointing the nozzle downwards. The lift fan system solved many issues that the harrier was being plagued with; it was responsible for the majority of the thrust and unlike the Harrier, it did not heat up the air quite significantly. The heating up of air due to thrust leads to a turbulent thrust which is unstable and unreliable support for the plan to stand upon. The turbulent hot air from the nozzle of the harrier is uncontrollably dangerous and has been a reason for many accidents during landings which have resulted in the deaths of several pilots. Boeings candidate did use cold thrust nozzles to balance the thrust column but this technique integrated by the X-35 was far more effective and reliable. Another major improvement in the X-35 was the development in roll control. The roll control in the X-35 was better mechanically and the roll control was divvied majority of the control to a computer, unlike the Harrier which put the controls, which were already complicated and too unstable, in the hands of the pilot who was already drowning in many parameters to control and analyze.

Finally, the most influential and impressive technological improvement in the X-35 was that the plan was capable of both vertical landings (VTOL) and supersonic flight. This was the kind of innovation that the JSF program was looking for.

Lift fan system :

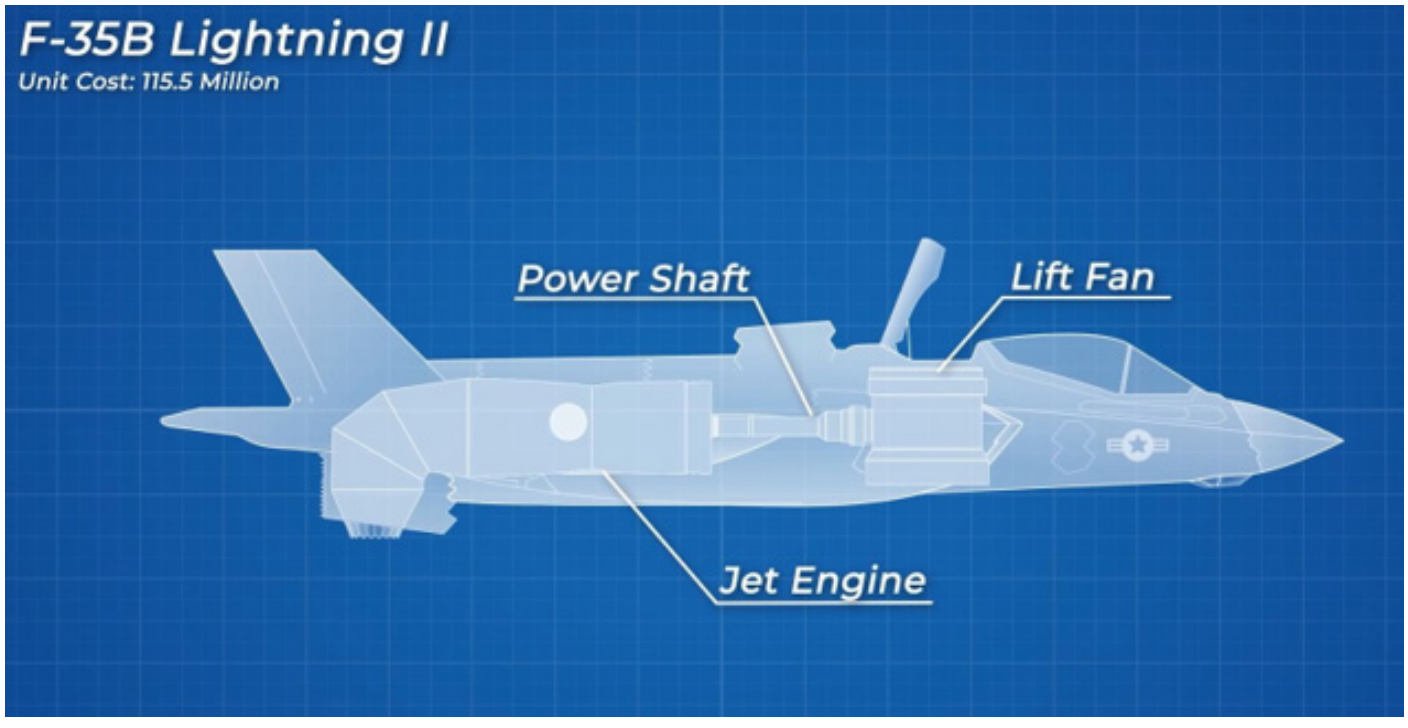
The lift fan system the X-35 consisted of turboprop or turbo-shaft Rolls-Royce T406 engine which is commonly found in the V-22 Osprey. The propellers are powered by the drive shaft which can be disengaged whenever required. The driveshaft transfers power to the jet engine turbines. When disengaged the lift fan is dead weight. But when coupled with the engine it makes up for its increase in weight. With the help of the lift fan, the X-35 is able to

produce 185KN of thrust as compared to the 106KN of thrust in the Harrier. The Harrier was limited in its take-off and landing weights, so it used to direct its thrust at an angle of 45 degrees to allow it to take off from shorter runways with greater loads but this trick didn't work during landings. Using the lift fans the F-35B can have a max take-off weight at 31,800 kg whereas the Harrier 14,100 kg. This extra 11,000kg can be used for fuel and ammunition.

Variants :

The F-35 comes in 3 variants. Each variant custom designed to suit the needs of each division of the military. The F-35A is designed for the air force and is lighter as it as scraped much of the extra weight like in the F-35B required for short runways. It is designed to take off from conventional runways as the air force does not have a shortage of those runways. The F-35B was designed for the marine forces. They don't have large aircraft carriers and their ships are so small they're usually referred to as helicopter carriers. The F-35C is the navy variant which has 40% larger wings. This extra wingspan allows for greater thrust at slower speeds which allows for easier landings and take-offs. It has much stronger and heavier landing gears which allow it to have the largest fuel capacity and allows for rough landing using arresting wires. Due to all these variations in a single product which is sophisticatedly designed to meet the needs of all three divisions together has pushed the prices significantly. The cost of the project was $24 million per unit in 1996; or $39 million if adjusted for inflation.The F-35 will be mass-manufactured and the final price of the planes has dropped by an average of 5%. The A variant costs $89 million; B costs the maximum at $115 million and the C variant at $108 million dollars. Once the mass manufacturing of these variants gains momentum it will create more jobs and will also boost the economy of the country when the allies start buying them. These planes will surely prove to be a feared contender in the skies.

- Balaji Murthy
T.E. MECH A



LASER PRODUCED AIRCRAFT SKINS

Mankiewicz, the leading aircraft paint supplierand4JET,thelaserspecialist;havecome together to introduce a new laser process for the creation of fuel saving riblets automatically lasered onto painted aircraft surfaces.

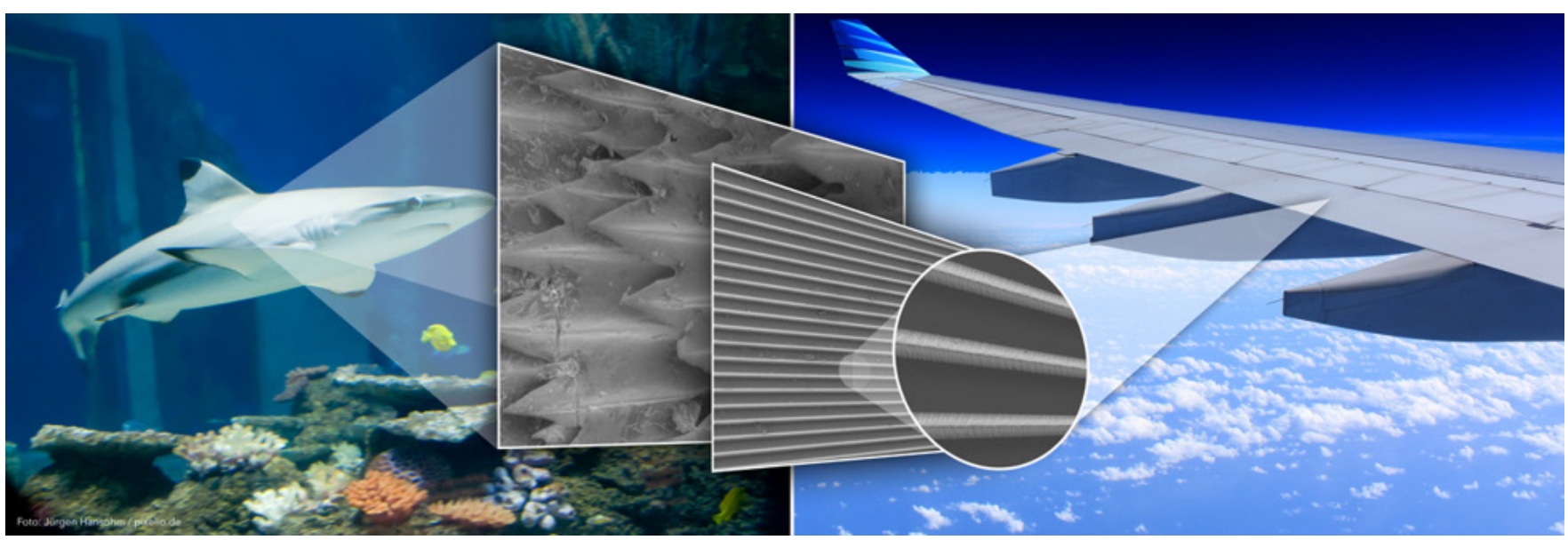
The technology- dubbed Laser Enhanced Air Flow or LEAF- uses the principle of laser interference patterning to quickly create fine lateral grooves in the uppermost layer of aircraft paint. The process while still in the development stage- already yields industrial throughout levels and passed initial qualification for durability.

Different from the known laser technologies 4JET has now found a way to speed up the process by a factor of about 500 using the principle of laser interference patterning. The laser beam is split up and recombined on the surface in such a way that the electric field oscillations of the light waves superpose in a controlled manner. This enables the creation of 15km of riblets – equal to about 1m2 of riblet surface- within less than one minute.

The riblets produced by lasers have been proven to reduce drag by up to 10%, which results in fuel savings for commercial long-haul airlines by more than 1%, equaling tremendous potential savings on total global kerosene spending of US $150 billion annually.

Adding even more benefits, LEAF is working dry without any consumables. It allows adjustments of riblets geometries depending on their location on the aircraft. The paint dust & vapor created during the process is evacuated and the process does not require post processing. The technology is able to process curved or riveted surfaces and can be integrated with existing robotics used for paint removal or printing operations in aircraft maintenance.

“We are looking forward to actively writing another chapter in the history of aviation coatings and shaping the future of sustainable aircraft.” says Mankiewicz executive managing director aviation.

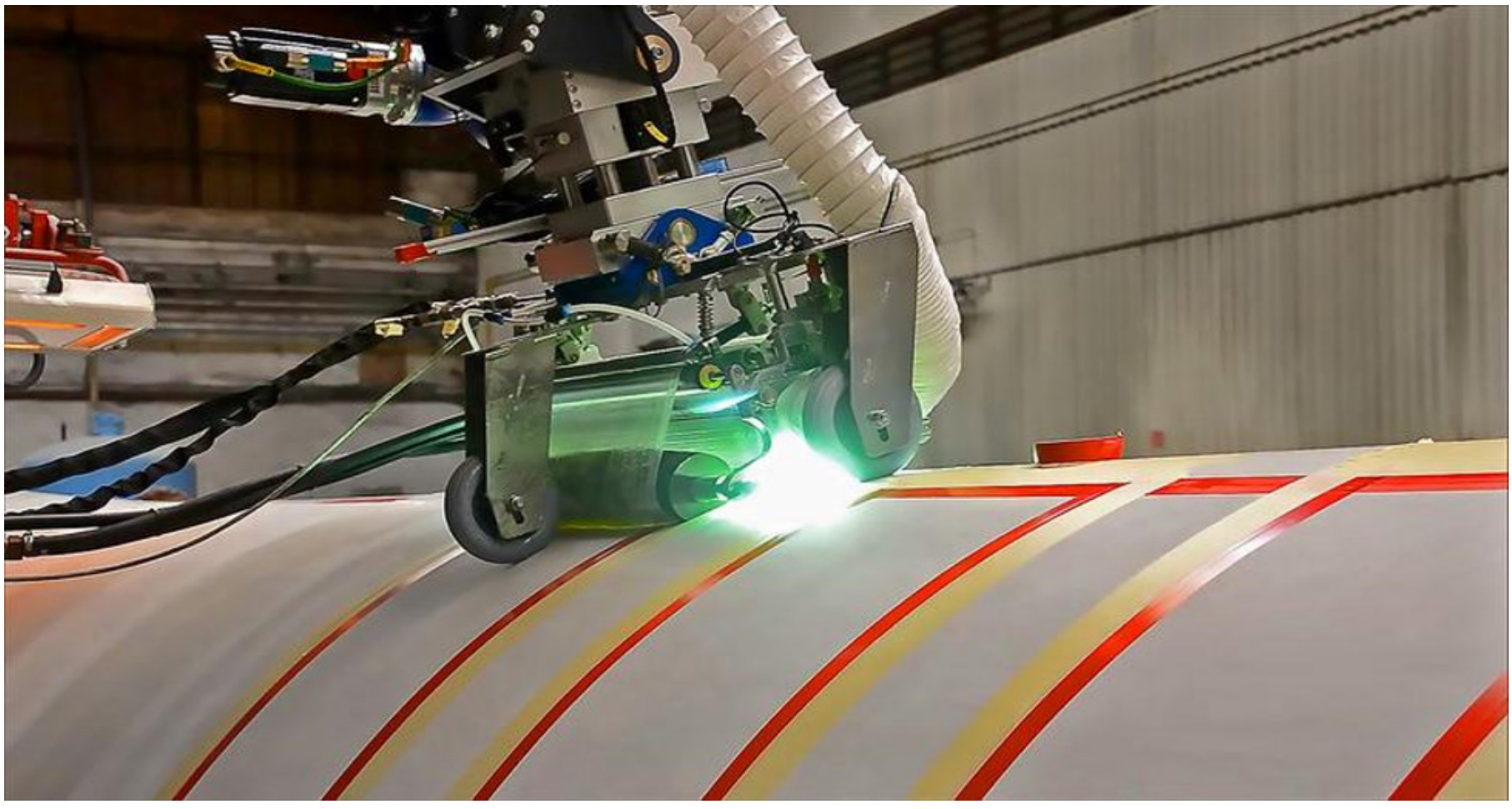


In addition to this future technology, the focus on weight reduction has always played an important role for Mankiewicz. The lowest possible dry film thicknesses and the smoothest possible surfaces which do not offer dirt any chance of adhering to the surface and keep air resistance as low as possible are just two aspects of its product. The company takes care during the development of its coating to ensure that they develop their full property profile and are completely covering even in very thin film thicknesses.

Mankiewicz is one of Germany's traditional paint manufacturers and is said to lead the field in the production of both solvent-based and water- dilutable high-tech coating systems for industrial series production.

www.mankiewicz.com

- Para Saraiya
S.E. MECH A



THE 1.5 BILLION DOLLAR MISTAKE

April 25, 1990: Every astronomer around the world was full of excitement as Space Shuttle Discovery deployed the Hubble Space Telescope into a low earth orbit. With an aim of expanding human understanding of the universe, NASA built this reflector-type telescope with contributions from ESA (European Space Agency) and STSci (Space Telescope Science Institute). At the time, Hubble was supposed to be the savior of the US Space program since the nation was still in mourning after Challenger Space Shuttle disaster of 1986 which claimed lives of 7 crew members aboard the shuttle.

Ground based telescopes were the only source of astronomical observations till the 90s. But the problem with these telescopes is that they cannot nullify atmospheric distortions (stars appear to twinkle due to this effect). The only solution is, putting a telescope outside the atmosphere in an orbit around Earth. Charlie Pellerin (Former Director of Astrophysics, NASA) was in-charge of this difficult task.

Everything went according to the plan as Hubble was deployed in the required orbit. NASA's Goddard Space Flight Centre, who controlled the telescope, decided to point the Wide field and planetary camera (WFPC1) at M100 (a spiral galaxy) and take images. Around 8 weeks after its deployment, the images that arrived were observed to be out of focus. There is a term used in optics called 'spherical aberration' which means 'light which is supposed to be focused at a single point, is spread out over a small region'. This is the reason why imperfectly ground spherical mirrors produce out-of-focus images. Charlie was returning from an overseas trip when he was informed about this flaw. Poor Charlie was waiting at an airport lounge when he read the front page article titled 'National Disaster: Hubble launched with flawed mirror'.

NASA was embarrassed. Charlie Pellerin and his entire team were mocked as Hubble

telescope became the butt of many jokes. If a mirror is poorly ground, it is useless. As it turned out, Hubble's primary mirror was perfectly ground, just to the wrong prescription. When our eyes develop blurry vision, we use eye-glasses. All Hubble needed was an optical device that could compensate for the error. As a result, COSTAR was built. COSTAR stands for Corrective Optics Space Telescope Axial Replacement. It would take a space-walk to mount COSTAR on Hubble as it was already in orbit around Earth. Seven astronauts had to risk their own lives for fixing this telescope.

The crew for Servicing Mission 1 flew aboard Space Shuttle Endeavour in December, 1993 and replaced a High Speed Photometer with COSTAR. Although, they had to wait for weeks before they would come to know if their mission was a success. On January 13, 1994, NASA announced that SM1 was a success and Hubble was fixed. Finally, astronomers got the sharp images they had hoped for. Since then, Hubble Space telescope has been providing magnificent images of star clusters, galaxy clusters, nebulae, etc.

There is a reason why the JWST (Hubble's successor) launch is postponed frequently. NASA cannot afford another mistake. Still Hubble was within reach so it could be repaired. JWST will be orbiting around a Lagrange point, L2. Hence, if flawed, it can't be repaired as it would cost millions of American dollars. This real-life story serves as an example of how much a small human error can cost. But at the same time, it shows how capable are the scientists and engineers who shape our world.

- Rutwik Kachare
T.E. MECH A

TAILLESS AIRCRAFTS

The tail which is also known as the empennage is an assembly at the rear of an aircraft that provides stability during flight, in a way analogous to the feathers on an arrow. Vertical and horizontal surface-stabilizing empennages are incorporated in most aircrafts. These empennages stabilize the flight dynamics of yaw and pitch. Many early aircrafts, having effective control surfaces, were virtually unflyable due to the lack of a stabilizing empennage. The tailless aircrafts also have a tail fin (usually a vertical stabilizer). Aircrafts, without any kind of empennage, such as the Northrop B-2, are rare.

Drawback in Traditional Design :

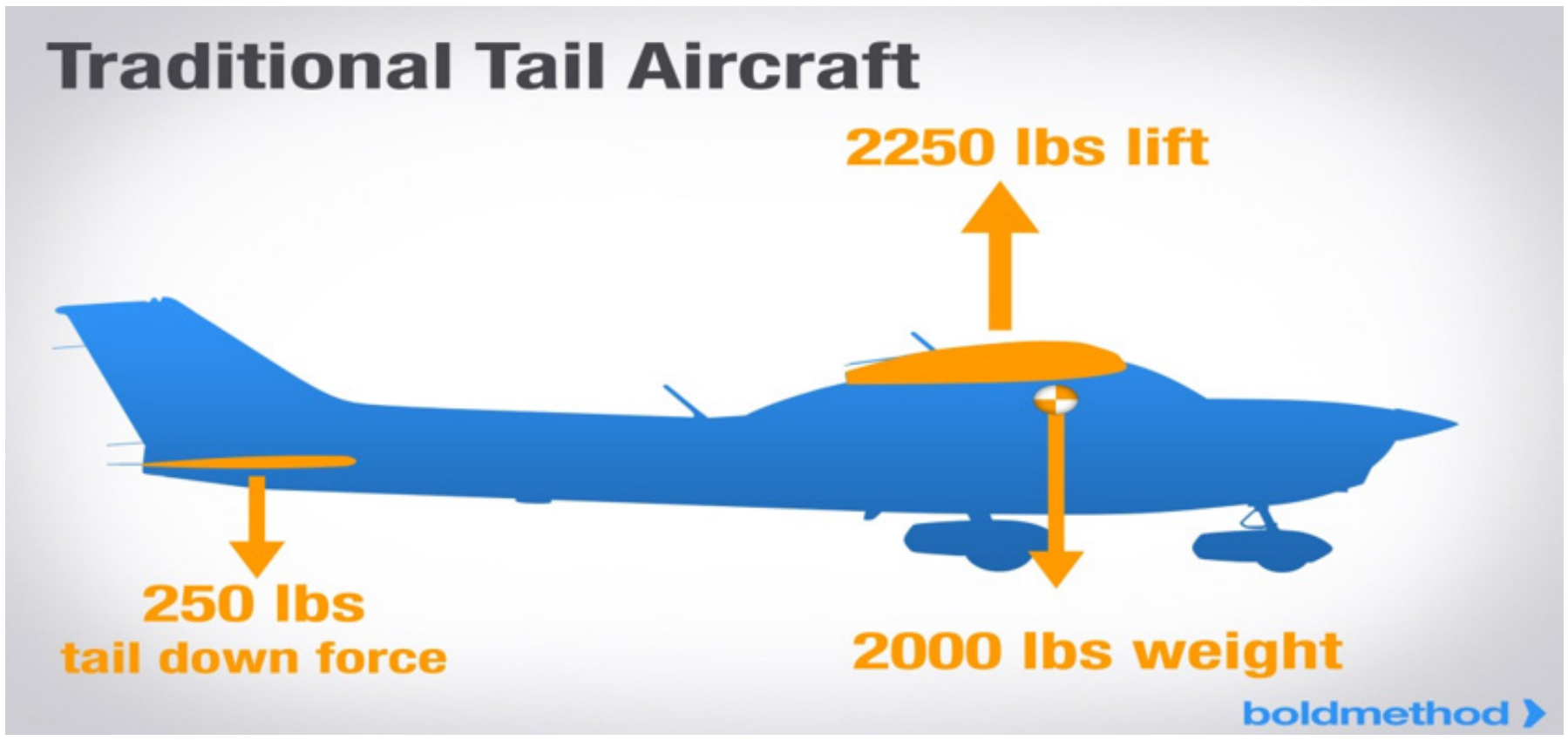
Enough lift must be generated by the wing in order to oppose both the weight and the stabilizer's tail down force. The wing needs to generate 2250 lbs. of lift, if an aircraft weighs 2000 lbs. and the tail generates 250 lbs. of tail downforce. That extra 250 lbs. of lift creates more drag - decreasing performance and efficiency.

The Canard Design :

The wing only needs to generate 1050 lbs. of lift, if your aircraft weighs 1300 lbs., and the canard generates 250 lbs. of lift to balance the aircraft. The Cessna has to generate 500 lbs. more than the total weight to fly , (2250 lbs. from the wing, and 250 lbs. from the tail) - which is, as related to the 1300 lbs. of lift needed to fly the 1300 lbs.

Why Tailless Aircrafts :

There is no tail assembly and no other horizontal surface, in a tailless aircraft, besides



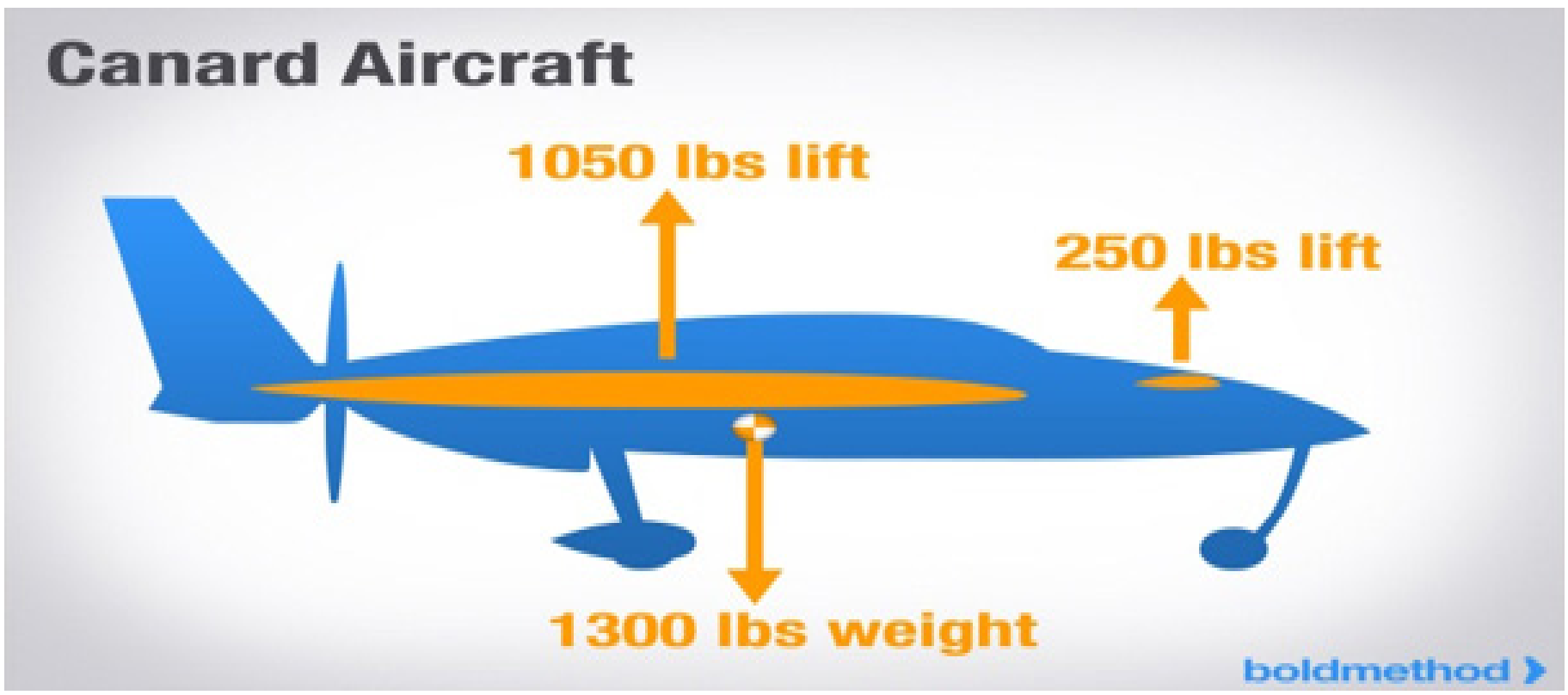
its main wing. The aerodynamic control and stabilization functions in both pitch and roll are incorporated into the main wing. Low parasitic drag as on the Horten H.IV soaring glider and good stealth characteristics as on the Northrop B-2 Spirit bomber are few of the hypothetical advantages of the tailless configuration. Tailless aircraft are light weight and more faster than traditional aircraft with comparatively less fuel consumption.

Tailless B2 Aircraft achieving stability:

A tailless aircraft has no separate horizontal stabilizer. Because of this an instability pitch is created as the aerodynamic center of an ordinary wing lies ahead of the aircraft's center of gravity. The B-2 spirit bomber is an American heavy strategic bomber. Four General Electric F-118-GE-100 jet engines are contained by the B-2. Each engine generates 17,300 pounds of thrust. It has elevons and rudders along the trailing edge of the plane. The plane's pitch (up and down movement) and roll (rotation along the horizontal axis) are changed by the elevons. The plane's yaw (rotation along the vertical axis) is also controlled by the elevons and the rudders. The flaps are adjusted when the pilot passes commands on to a computer. The computer adjusts a small wedge-shaped flap present in the middle of the trailing edge. This flap, called the gust load alleviation system (GLAS), to counteract air turbulence forces.

Tailless Aircraft are a Pioneer to new Warfare:

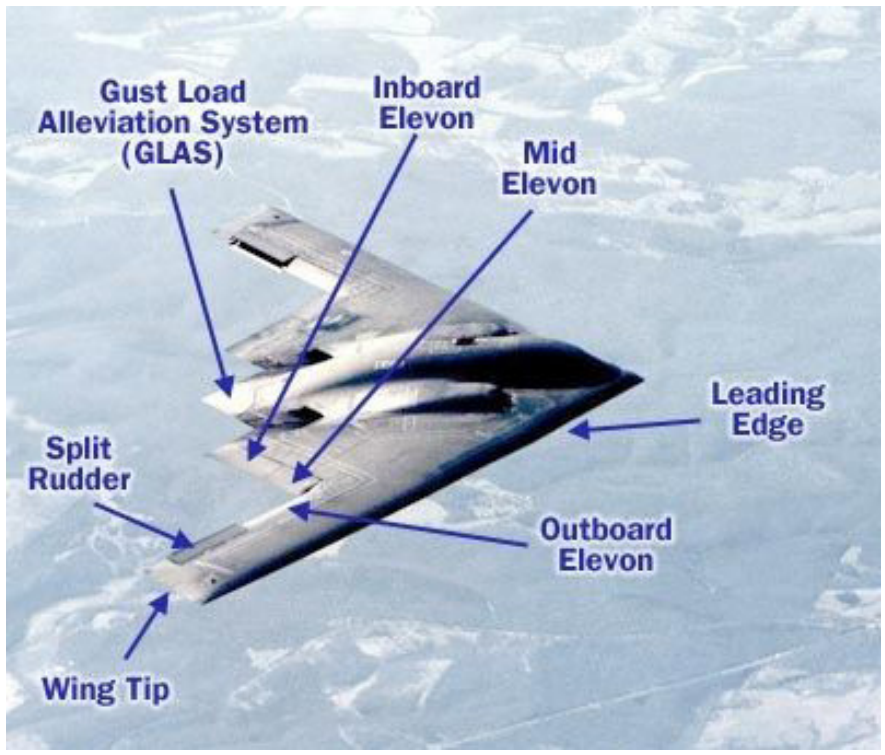
Newer stealth aircraft, like the F-22, F-35 and the Su-57, have performance characteristics that meet or exceed those of current front-line jet fighters due to advances in other technologies such as flight engines, control systems, materials and airframe construction. The skins of stealth aircraft are made with Radar-absorbent materials or RAMs. Some of these RAMs contain tiny



iron spheres whereas others contain carbon black particles. The concept of using F-35s with directed-energy-weapons for anti-ballistic missile patrols is also being explored, though the idea may be impractical due to the limited loitering ability of the short-ranged stealth fighter. In the fall of 2018, the Missile Defense Agency handed out contracts ranging from $29-37 million to Lockheed Martin, General Atomics and Boeing to develop a "Low Powered Laser Demonstrator."

The sixth-generation fighters are expected to use advanced engines such as Adaptive Versatile Engine Technology to allow longer ranges and higher performance. Engine development can start around 2020. It would include stealth against low or very high frequency radars (like those of the S-400 missile system), which requires an airframe with no vertical stabilizers. Another requirement is significantly larger payload than current air superiority aircraft like the F-22. Adaptive cycle engine technology is an option under consideration for the PCA, given the fact that the alternative would be a very large aircraft with a tailless aerodynamically stable design eg: B-2 bomber.

- Vedant Awasthi
T.E. MECH A



RISK FACED IN A&D

As the global economy undergoes several ups and downs and different countries change their defense priorities to face terrorism and political disruption, the risk universe in A&D (Aerospace and Defense) keeps on changing. As A&D players design and implement strategies to grow in this business environment, they need to adjust their plans considering the key risk drivers.

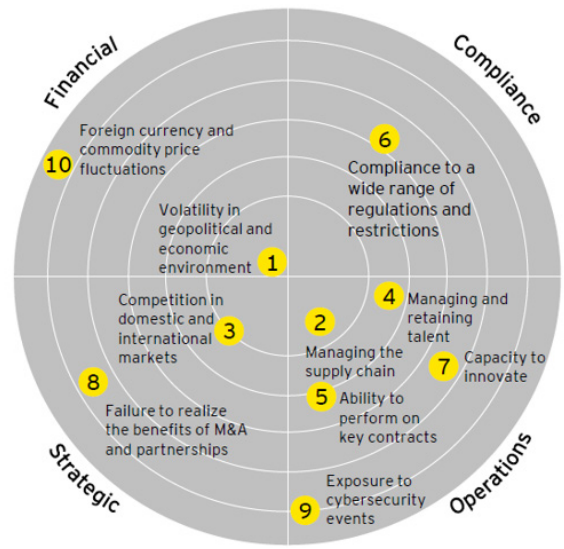
A&D growth has turned the aviation, space, and defense industries into lucrative markets. Demand for increased security, quality, efficiency, and durability has taken off in recent years, resulting in high margins and operating profits. Aerospace poses to be the next gigantic market opportunity for manufacturers and service providers due to the exponential growth potential and a long-term prognosis for success. Although constant rising demands are good for business, they bring some challenges for aerospace manufacturers.

The risk radar below depicts the top 10 risks faced by A&D industries. They are divided into respective quadrants:-

- Compliance threat:- originating in politics, law, regulations or corporate governance.
- Operational threats:- impacting the process, systems, people and overall value chain of business.
- Strategic threats:- related to customers, competitors and investors.
- Financial threats:- stemming from volatility in the markets and in the real economy.

Top 10 risks in A&D

1. Volatility in geopolitical and economic environment.
2. Managing the supply chain.
3. Competition in domestic and International markets.
4. Managing and retaining talent.
5. Ability to perform on key contracts.
6. Compliance to a wide range of regulations and restrictions.
7. Capacity to innovate.
8. Failure to realize the benefits of M&A's and partnerships.
9. Exposure to cyber security events.
10. Foreign currency and commodity price fluctuations.



VOLATILITY IN GEOPOLITICAL AND ECONOMIC ENVIRONMENT

The operational as well as financial performance of most of the A&D companies depend significantly on the geopolitical and economic conditions of their key markets. For the aerospace sector, sustained economic growth and political stability are fundamental factors to drive long-term growth in air traffic. On the defense side, political and economic conditions of the developed as well as emerging countries play a major role in prescribing the allotment of funds for military purpose by the government.

The European financial markets have undergone significant disruptions in recent times, due to concerns regarding the ability of certain countries in the eurozone to reduce their budget deficits and repay their sovereign debt obligations. In the other side of the globe, China has reduced its GDP growth target, suggesting apprehensions of a slowdown of the world's largest growing economy.

The world is more unstable - the fastest growing defense markets about regions of significant national security tension. Terrorist activities are incrementing, particularly in the Middle East, Africa and Asian countries. The resurgence of the military power of Russia has started to destabilize the political situation in Eastern Europe. On the other hand, unstable geopolitical situations in the Middle East and North Africa are leading to heightened threat levels, insecurity and border uncertainty with increased migration. The ongoing need to monitor and protect borders in Europe, North America and Asia is leading to higher expenditure for defense and homeland security by nations with an emphasis on intelligence, detection and monitoring.

All these geopolitical factors are expected to lead to growth of expenses for defense in most parts of the world. The changing geopolitical environment is also driving changed priorities for expenses on defense. While the 2000s had the US and partners fighting "asymmetric wars" against terrorists and insurgents, the focus now is more on high-value assets, reinvestment in fleets and command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR).

An economic slowdown in any of the key markets for A&D can potentially result into stiffening, low liquidity and volatility in credit, currency, commodity and equity markets. Owing to the declining financial health of their customers, A&D companies would need to provide improved sales financing to the customers to support their purchases. The reduced spending for defense, homeland security and space activities could further result into loss of sales. In addition, changes in the economic environment and a reduction in defense budgets may adversely affect the financial stability of the key suppliers and their ability to meet their performance requirements.

- Faraz Khan
T.E. MECH A

MANAGING THE SUPPLY CHAIN

Large supply chain network lead to risks of product delays and cost over-runs :

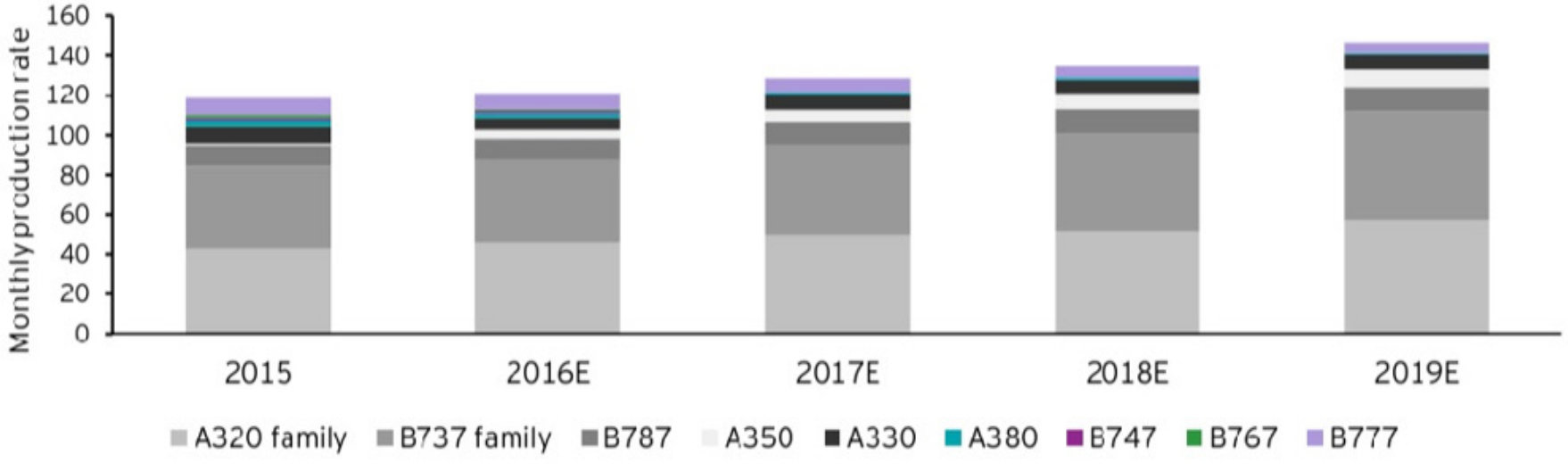
Commercial original equipment manufacturers (OEMs) support forward production for 8-10 years. Aeronautic giants like Airbus and Boeing plan aggressive build up in production of narrow- and wide-body models. Additionally, the growth in Airbus A330 is expected to be accelerated due to new engine options.

As OEMs boost their production to deliver the large backlogs, suppliers across different levels in the supply chain feel pressurized for timely delivery, while maintaining quality and keeping costs under control. Achieving the right level of operational excellence and ability to access capital to support the production growth can be key challenges to A&D to keep up the pace with the growing demand.

The dependency of A&D companies thousands of suppliers and subcontractors is quite high. They depend on them to procure raw materials, parts and subassemblies, and outsourced processing, e.g., treatment required for manufacturing their products, to meet performance specifications, quality standards and delivery schedule of the products and services. The costs associated with each stage of the supply chain need to be as per the cost budgets so that the overall costs of production remain in control. The diagram below lists the key processes associated with a distinct A&D supply chain.

While the aerospace industry does not have the production processes standard as in automotive, the supply chain is global and interlinked. Ability of OEMs to deliver on time and within quality standards is dependent on no suppliers failing to provide the right product

Monthly production rate forecast for Airbus and Boeing programs



E: estimates
Source: EY Analysis.

or part at the right time. The chances that the company has disputes with the suppliers or subcontractors related to the quality of supply, work specifications or customer concerns are not neglectable. The inability of key suppliers to perform can result in cost overruns and delays in production schedule. For example, when the when a key supplier failed to meet its delivery schedule, the Airbus's A350 deliveries were delayed. Supply chains of A&D companies are also subject to risks related to their network and supply design strategies. Furthermore, due to the integration of their supply chain network; different parts of the supply chain network of companies become well connected with one another. Consequently, disruption of any part of the supply chain might lead to a cascading effect on the entire supply chain. Such disruptions may be related to technical glitches, cyber threats or data privacy.

Niche parts and processes pose higher risk to on-time delivery:

In certain cases, rather than depending on a number of suppliers, companies depend on a single supplier for a particular part or process in the supply chain which are niche in nature such as composite components and seat track assemblies. In case of a disruption of supply for these niche parts or processes, companies have to look for an alternate supplier, at the cost of incurring additional expenses. Thus, a disruption from those single suppliers poses a greater risk in terms of production disruptions and cost overruns. Engagement with customers to understand supplier stability and those suppliers are making a "reasonable return" on work packages is critical. For certain scarce commodities, OEMs have developed in-country joint ventures to secure supply.

Further risks related with the move to low cost countries :

To capitalize on the demand and lowcost environment, OEMs have expanded their footprint in emerging countries. In certain instances, OEMs work with local suppliers. Working with the local suppliers has significant cost benefits but also gives exposures to additional risks such as political instability, intellectual property right violations, production delays as well as quality issues. More recently, labour price inflation in emerging markets and foreign exchange changes have led to a refocus on "right-shoring", returning production to home markets.

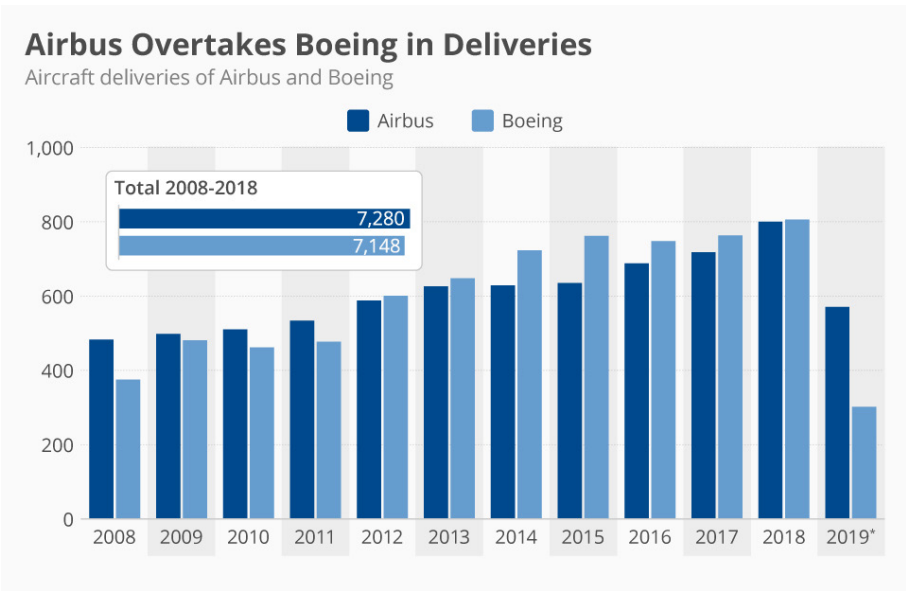
Investment to fund new programs and technologies ;

New programs require massive capital investment and OEMs moved to a model where suppliers are expected to co-fund development in exchange for access to long-term production contracts. Development costs are recouped on volume production. Further new programs are likely to require similar access to capital and also in new technologies e.g. additive manufacturing that leads to rapid new product induction.

- Abhinav Nair
T.E. MECH A

Dominance of Boeing and Airbus in the commercial aircraft market :

The commercial aircraft market comprises of various giants with Boeing and Airbus holding approximately 80% of the market share collectively. Both these A&D companies have pursued orders with growing market airlines with approvable financing terms. Boeing and Airbus are the only players in the wide-body segment dominating the narrow-body segment. Bombardier and Embraer are present in the regional aircraft segment. The narrow-body aircraft manufacturers have to face the Bombardier's C-Series. New entrants, COMAC in particular is likely to succeed given its ability to aid a captive domestic market and Bombardier has secured an investment in C-Series by the province of Quebec in return for equity. However, in the medium term, opportunities for the new industries are likely to be limited given the dominance and long order books of the Airbus-Boeing duopoly, which has effectively locked out new entrants. Consolidation has continued within the fragmented commercial aerospace supply chain, with the support of OEMs seeking more potent suppliers with access to capital as partners, which can aid and partly fund new program development. Tier one and tier two suppliers have incremented bargaining power with the OEMs given constrained production capacity. This leads to expanded margins at the expense of the OEMs. It has also driven increased M&A activity and higher pricing as strategic and private equity groups compete for scare assets. Structural headwinds have created challenges in maintenance, repair and overhaul (MRO) and broader aftermarket. New sensor technology allows engine OEMs to control timing of maintenance. A Aftermarket-focused businesses with long-life programs have seen traditional high-margin pricing impacted by the growth in the surplus parts market, supported by increased supply of parts as older aircraft are on verge of retirement.



Rebalancing of portfolio and consolidations in defense industry :

The defense industry comprises of a small number of huge players, major US defense primes such as Boeing, Lockheed Martin, Northrop Grumman, General Dynamics, Raytheon, and BAE Systems, Leonardo and Thales which are European ventures dominate the global market, followed by national companies in the main spending countries. Safran, Rolls-Royce and Airbus are some of the major European players

with balanced existence in both commercial and defense sectors. Large A&D players are rebalancing their portfolios and merging to improve their capabilities and enhance their competitive position. Thus, the industry is witnessing integration. More than 200 M&A deals have been completed every year on average since the last five years, as part of this ongoing consolidation in the industry.

Selection of best bid to participate is an important consideration :

It is important that A&D companies participate in the right bidding competitions, given the large costs and efforts associated with the bidding processes for large contracts. Competition within the industry also leads to increased bid protests as companies in the peer group, at certain instances, pressurize government bodies to provide the rationale of giving a contract to a specific player. For instance, Lockheed Martin filed a petition with the US Government Accountability Office (GAO) in 2015 against a US$67 billion contract awarded to Oshkosh for the Joint Light Tactical Vehicle (JLTV), triggering 100-days halt on production of the JLTV. Such bid protests at times result into a delay in starting the contract activities and might also lead to the decision being overturned in more severe circumstances.

Governments are reaching out to non-traditional A&D players for information technology (IT) solutions

Amidst the budget constraints, the governments are focusing on cost in their urge to identify affordable solutions. Their efforts include performing certain work internally rather than employing a contractor and reducing product development cycles. They also fragment large contracts into multiple smaller contracts, and give the smaller contracts to comparatively smaller companies primarily on the basis of price competitiveness. This leads to increase in competition among the large players who generally have little to fear from from smaller players in case of large contracts. Furthermore, non-traditional players outside of the A&D industry, particularly IT companies are challenging A&D players in the technology and cyber security solution markets. Some customers including the US Department of Defense (DOD) are turning to commercial contractors, rather than traditional defense contractors, for products and services in the IT and cyber security domain. IT players are also offering services and products related to avionics systems, manufacturing engineering, and service life cycle management, sourcing and engineering. For instance, the US DoD awarded a US$4.3 billion contract to IT players, Accenture, Leidos and Cerner for electronic health record solutions for the DOD's Military Health System in 2015. In 2016, the US Defense Information Systems Agency (DISA) awarded a US$320 million contract to IT major IBM to update the point-of-sale system at US military commissaries worldwide.

- Suraj Mishra
T.E. MECH A

MANAGING AND RETAILING TALENT

Companies can gain an edge in the marketplace with the help of highly engaged, talented workforce :

Companies are highly dependent on the continued services of key executive officers and engineering personnel, because of the specialized nature of the business. These companies also depend on the progress of supplementary management employees and the hiring of newly qualified engineering, marketing, manufacturing, sales and management personnel for operations. The products and services provided by A&D industries involve sophisticated technologies and engineering, along with complex manufacturing and system integration processes. Companies must hire and retain the qualified and skilled employees' essential to perform the business-critical processes due to the highly specialized nature of the business. Furthermore, certain employees may be required to receive security clearance and substantial training in order to work on certain programs or perform certain tasks.

Lacks of diversity, ineffective succession planning and limited options for talent mobility are the main trials faced by talent management in A&D :

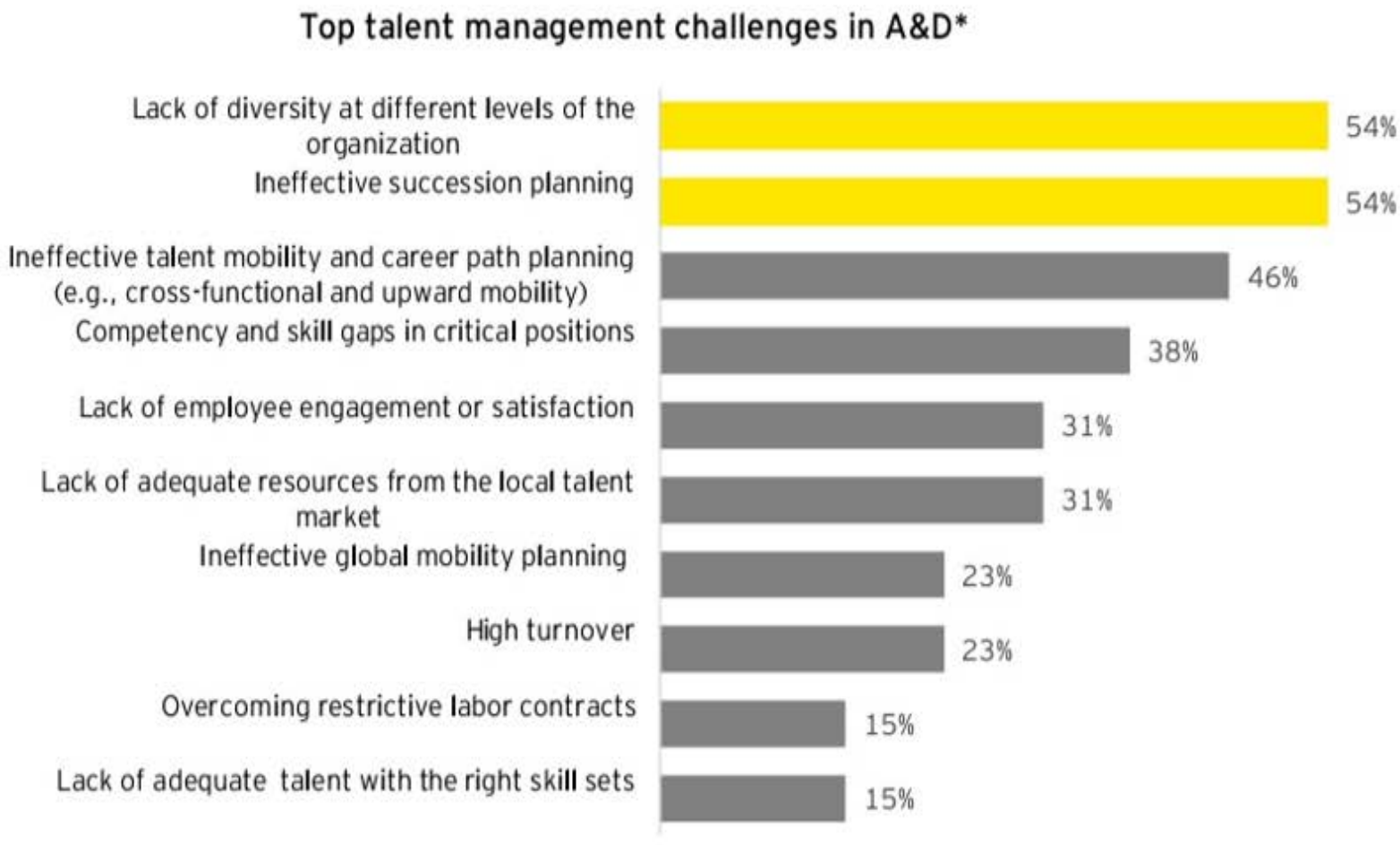
A survey to identify the major challenges faced by A&D companies around talent management was conducted. Leadership development and succession planning must be managed by companies throughout their business. Most of the companies have habitual practices for management transition and the transfer of knowledge. However, the loss of key personnel, together with a failure to sufficiently train other employees, hire new employees or transfer data, could significantly impact their ability to perform under their contracts. Having said that, as A&D develop their operations globally, it becomes extremely vital to hire and retain employees with pertinent experience in local traditions, laws, regulations and business practices.

Inability to attract and retain qualified personnel, and maintain a diversified workforce at different levels of the organization might lead to materially adverse effect on revenue and earnings. Moreover, the typical workforce demographic continues to move toward a greater proportion of employees approaching retirement; to the magnitude that companies lose skilled employees. It is critical that the companies improve other employees, hire new proficient employees and effectively manage the transfer of important data. Rivalry for proficient employees is extreme and companies are subjected to the threat of not being able to hire or retain employees with the essential skills or authorizations. For skilled cyber, technical and scientific spots, A&D companies have to compete with marketable technology companies outside of

the trade business, as the quantity of skilled engineers is declining and the number of cyber professionals is not keeping up with demand.

As commercial technology companies grow at a faster rate or face fewer cost and product pricing constraints, they may be able to offer more attractive compensation and other benefits to candidates. To the extent that the demand for skilled personnel exceeds supply, A&D companies could experience higher labour, recruiting or training costs in order to attract and retain skilled employees. If they are unable to hire or retain talent, they could experience difficulty in performing key contracts. Also, during tough times, activities to surge functioning efficiency through workforce reductions, and consolidating and relocating certain operations may challenge the companies' ability to retain talent.

- Mihir Gohil
T.E. MECH A



*Percentage of HR survey respondents

Source: "What are your top talent management challenges?," *Enabling talent to drive innovation in aerospace and defense*, June 2016, EY, 2016.

ABILITY TO PERFORM IN KEY CONTRACTS

Failed programs adversely affect the brand value and financial actions of A&D companies :

A&D companies are involved in major contracts and at times possess huge backlogs. New development programs involve complex design and new technologies which are unproven at times. This results in technological challenges and performance hindrances leading to delays, setbacks, cost overruns and failures. In some cases, product requirements or specifications may also be modified during the course of the program. The delays might result in termination of contract leading to financial losses for the OEM. For instance, an aircraft OEM had lost billions of dollars primarily because of cancellation of contracts due to delay in deliveries in a next generation aircraft program. The company will also likely face over $30 million loss for each of its first 50 deliveries of the aircraft.

A&D is witnessing rise in cost-reimbursable contracts, especially with the governments. The increasing commitment of companies to guarantee a certain level of performance is translating into higher risk exposure in case the performance level is not achieved. This becomes even more critical in a highly competitive environment where companies take over more challenging guarantees on performance and availability. Failure to bear major programs on time as well as binding to quality and technical standards within budget, in case of both fixed price and cost performance contracts, might lead to consequences such as termination of orders, penalty imposition and loss of orders. Owing to the additional costs related to design changes, supply chain issues, testing and manufacturing complexity, he estimated delivery timeline for Boeings KC-46 tanker program has already been postponed by 14 months than initially planned. Delivery delays and performance issues with key programs also lead to contract renegotiations with key customers. For example, a gulf-based airline company refused to take deliveries of Airbus A320neos since December 2015 due to performance issues with the engines of the aircraft. The company is renegotiating with Airbus to change its orders for A320neo to A321neos with a different engine option.

Ability to deliver the challenging production ramp up on new programs :

In both defense and civil businesses, the challenge of delivering the production is critical, at all value chain levels. For instance, Airbus and Boeing are focusing on ramping up production to keep up with heavy delivery commitments for their programs. Boeing plans to boost the production of 737 Max from 42 units in 2016 to 57 units monthly in 2019, while Airbus plans to boost a number of major programs including A350 XWB, A380 and A320 Neo.

- Nilesh Nag
T.E. MECH A

COMPLAINCE TO WIDE RANGE OF REGULATIONS AND RESTRICTIONS

A&D operates in a highly regulated environment across many jurisdictions :

Companies have to abide with the laws and regulations related to the administration and performance of contracts, especially for the government contracts. They face various rules and regulations related to the export of products and services as well as use of technology. Failure to comply with any of the regulations could result into severe consequences, such as imposition of fines and penalties, termination of the whole contract, suspension or debarment from bidding on or being awarded government contracts, and civil or criminal investigations or proceedings.

High exposure to bribery and corruption risk :

The A&D companies have to operate in a highly regulated environment as their customer base includes government and defense agencies. This subjects A&D companies to increased scrutiny around corruption and bribery. Furthermore, A&D companies mostly work in partnerships with a numerous small and non-consolidated entities. These entities have a lower level of control and oversight from their parent groups and present higher risk of fraud and corruption. The level of exposure to corruption and bribery litigations multiplies while operating in countries with high level of corruption. Involvement in bribery or corrupt practices may lead to severe consequences, such as order cancellations or even blacklisting. For instance, a leading European defense company was blacklisted by the Government of India for alleged corruption charges associated to a helicopter acquisition program.

A&D have to comply with a large set of laws and regulations :

In defense contracts, the contractors have to comply with several procurement regulations and several mandates around information security, contract pricing and project costs. Another key regulation for the defense contractors is the offset obligation. In certain countries foreign A&D must abide by specific offset terms and conditions to become eligible for supplying defense equipment to those countries. For instance, for large supply contracts to the Indian Government, a foreign company must invest back 30% of a contract value to the local industry. Similarly, Israel has an offset demand of 35% of the total value of an agreement. In commercial aerospace, there are regulations for aircraft design and maintenance, typical airline flights, obstruction lighting and marking, pilot training activities, lighter-than-air aircraft, man-made structure heights, model rocket launches, model aircraft operation and drone operations. In the US, the Federal Aviation Administration (FAA) has the authority to regulate all aspects of civil aviation in the country, including airports, air

traffic control, aviation safety and commercial space transportation. The design, production and maintenance of all the aircraft to be flown in US require FAA approval. While these regulations are critical for passenger and operator safety, they also make it imperative for OEMs and suppliers to maintain high-quality standards of their products and services. Furthermore, A&D are also subjected to risks related with changes in accounting and revenue recognition standards. Consequently, companies may see periodic and variable impacts on their revenue due from adjustments in contract estimates, particularly on large contracts with a longer performance period.

The A&D industry is subjected to intellectual property infringement risks as it is a technologically advanced market :

A&D companies possess intellectual property portfolios comprising of patents, unpatented trade secrets, data, software, trademarks and copyrights. They enter into different types of confidentiality agreements, such as intellectual property (IP) agreements and non-disclosure agreements, with their employees, suppliers and some customers to prevent disclosure of trade secrets and other proprietary information. However, in some cases these measures may not be sufficient to deter misappropriation confidential information. Furthermore, the IP laws vary from one country to another. The protection provided to the IP by the laws and courts of foreign nations may not be as adequate for A&D . As a result, operating in large number of foreign countries exposes the companies to risk of IP rights violations. For instance, sensitive IP owned by two US-based military aircraft manufacturers was stolen by hackers and was allegedly passed on to an emerging country manufacturer few years back.

Export control laws and regulations can significantly affect financial aspects of a company :

Export of some critical defense products is subject to licensing and export controls by the jurisdiction where those are produced. The export controls can become more restrictive driven by political factors or changing international circumstances and are highly dependent on the relation of the involved countries. Lower number of export markets where the defense contractors can export may have a significant adverse effect on the business. As the companies operate in a large number of markets, they are subjected to different regulatory mandates in different markets. Some of these regulations might be very much local in nature, meaning the regulation in one country might be in contradiction to that in another. Complying with such a wide range of regulations is a further challenge. Any failure to comply could result in suspension of the export privileges.

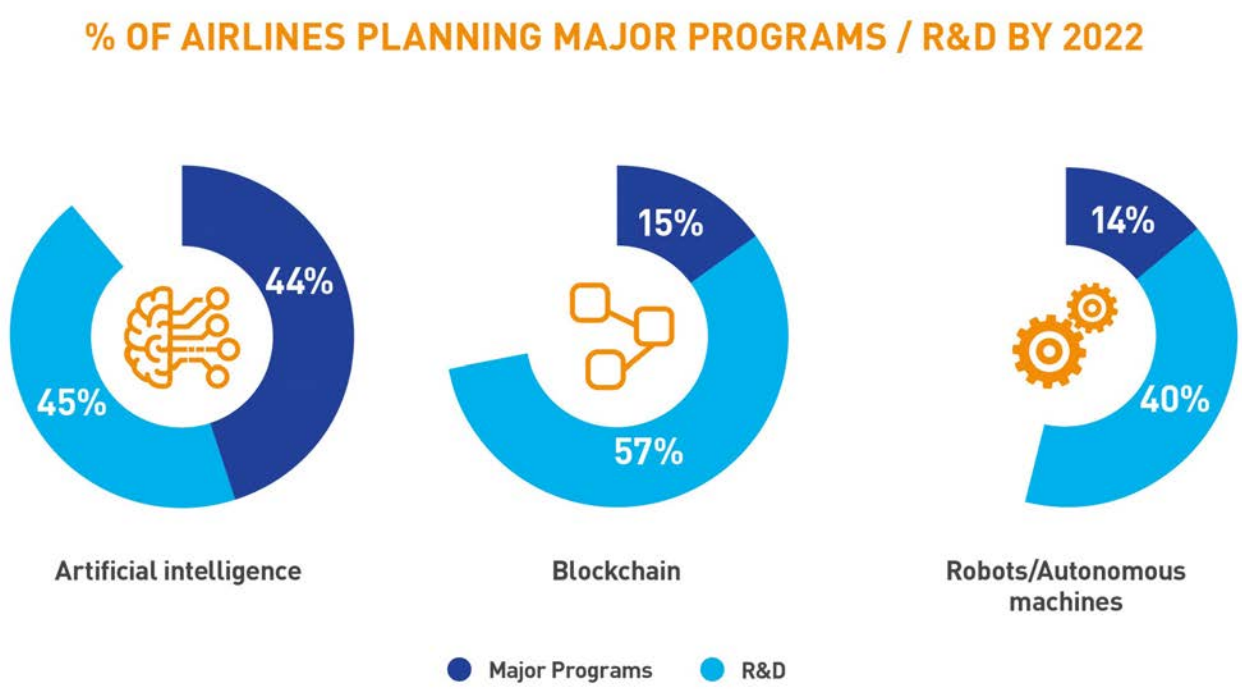
- Harsh Chaurasia
T.E. MECH A

CAPACITY TO INNOVATE

Innovation requires large upfront financial investments :

Along with high-end technologies and engineering, the A&D industry offers complex manufacturing and system integration processes. The end users change and evolve their demands regularly. A&D companies need to constantly focus on innovations on their product and services offerings to strive in the current era of rapidly evolving technologies across industries. A&D needs to create the right infrastructure to foster innovation through funding in-house R&D, collaboration with industry partners and partnerships with the academia. Some of the technologies that A&D practice in their manufacturing and other processes are decades old. They need to upgrade these technologies regularly as well as adopt new and advanced technologies to stay competitive. The advancements in internet of things and digital technologies makes it even more important for aircraft manufacturers and their suppliers to look for opportunities to offer new products and services in original equipment. While OEMs are using the digital technologies to improve the performance and efficiency of their aircraft and parts, aftermarket service providers are extensively using sensors to capture in-flight data to facilitate predictive maintenance and associated services. A&D are also increasingly adopting digital and advance manufacturing technologies in design and production of their products. Reduction of supply chain lead time, improvement of reliability and productivity, and simplification of designs is possible by using digital technologies.

Advanced manufacturing techniques like 3D printing are gaining limelight. For instance, GE Aviation is using 3D printing for manufacturing of fuel nozzles, which has drastically reduced the number of parts required per nozzle from 18 to 1. GE announced the acquisitions of Europe-based Arcam AB and Concept Lasers



and is establishing a "GE Additive Customer Experience Center" in Germany to enhance its manufacturing capabilities. Boeing has about 50,000 3D printed parts flying on its commercial, military and space products. Airbus, on the other hand, is focusing on using additive manufacturing for not only prototyping and parts manufacturing for a wide range of aircraft, but also for spare parts solutions.

A&D needs to improve engineering processes for improved marketing, improved quality, product reuse and significantly cut costs. Simplifying engineering would also simplify supply chain complexity. The future performance of A&D companies would largely depend on a number of factors related to innovation, such as :

- Ability to recognize the upcoming trends in technology in the current and future markets
- Identify additional applications for existing technology to cater to customer needs
- Capacity to develop new technologically advanced offerings and enhance them by adding innovative features
- Ability to develop, design, manufacture and provide innovative offerings to market at cost-effective prices
- Enhance product designs for export that are in accordance with all the compliances and regulations of the export destinations

A&D companies need to make an effort to streamline their operations while they undergo a significant growth in their business. They also need to focus on a number of transformational activities including consolidation, lean initiatives and system integration. To support the growth in business, companies need to adapt to innovative ways to manage their internal operations and business transformation processes. It is also extremely important to anticipate the market's future direction and to understand the needs of the customers with foresight and clarity. Companies can create early product or service concepts that help them remain ahead of competition by innovating. Inability to innovate new products and services can significantly hamper the future businesses of A&D .

Innovation requires large R&D investments and need to continuously invest financial resources to develop new offerings. These expenditures could divert attention and resources from other projects, and might result in delay in those projects.

Airbus and Boeing, are concentrating on establishing new technology and innovation centres to speed up their capacity to innovate. For instance, Airbus has opened an innovation centre at San Jose in the US with a fully independent VC fund, while Boeing has opened its new research and technology centre at St. Louis in the US. Companies are also focusing on new appointments for improving innovations. For example, Airbus had named Paul Eremenko the new chief technology officer (CTO) and Marc Fontaine as the digital transformation officer (DTO) in 2016.

- Hardik Padia
T.E. MECH A

FAILURE TO REALIZE THE BENEFITS OF M&AS AND PARTNERSHIPS

Improper due diligence can lead to undesired results from M&As and partnerships :

Through mergers and acquisitions (M&As), A&D identify opportunities that will complement their existing products, technologies, services or customer base. M&As also help them to expand their offerings to new markets. The anticipated benefits from acquisitions, JVs, partnerships and related activities broadly depend on the following factors:

- Ability of the acquirer to integrate its existing operations with the operations of the acquired business
- Performance of the fundamental product and service portfolio of the acquired company
- Performance of the management team and other personnel of the acquired company

The A&D industry witnessed a surge in the deal values in 2015, where the total deal values were more than US$56 billion compared with US$15.6 billion in 2014. The surge included a record US$31 billion acquisition of Precision Castparts by Berkshire Hathaway. In 2016, approximately 187 M&A deals were completed or announced in the A&D industry, with a total deal value of over US$17 billion. In 75 of these deals, the acquirer companies were based in the US, while in 25 of these deals the acquirer companies were based in China. In 2017, 38 A&D deals were completed or announced till 31 March 2017, with a total deal value of over US$10 billion. The largest deal announced during the first quarter of 2017 was the acquisition of Zodiac Aerospace by Safran Group for over US$9 billion.

During evaluation of new M&A transactions, companies are required to make decisions regarding the value of business opportunities, technologies, other assets and potential liabilities. Overvaluation of the acquired business, failure in achieving synergies, inability to retain talent and financial challenges are resultants of poor M&A decisions.

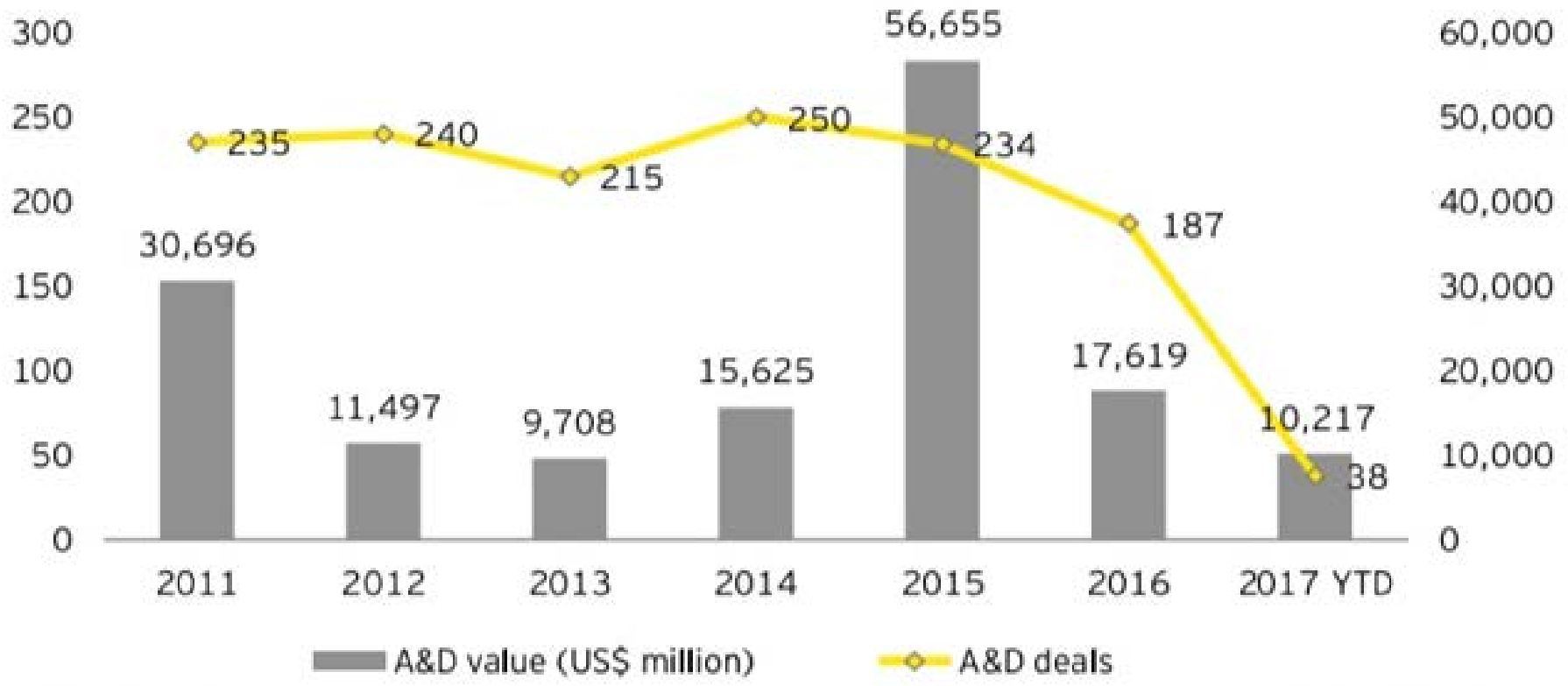
Faced with decreasing growth in core OE production, the OEMs are actively pursuing aftermarket opportunities, looking for distribution and service models. This is creating tension with MRO (maintenance, repair, and operating supply providers), historically a key customer group, particularly within the engine segment where the OEMs are moving toward through life support models underpinned by ownership of operational data. Data capture caters to new revenue models and increased prognostic maintenance, which drives airline availability. Formation of JVs in international markets by the A&D is also a way to increase their global presence as well as to bring services closer to their customer base. Moreover, defense companies need to form JVs in developing

countries as part of their offset obligations. In some of the offset arrangements, the global need to transfer some technology know-how to their local partners in these. The technology transfer related to the JVs carries the risks of IP violations and copyright infringements.

Large A&D parties also make strategic divestitures on a regular basis to focus on their core business or dispose of underperforming businesses. For instance, while Lockheed Martin has stripped off its Information Systems and Global Solutions (IG&S) businesses to focus on its core businesses, on the other hand, Leonardo-Finmeccanica has already sold off its transportation business. These disinvestments at times result in continued financial involvement in the disinvested businesses through guarantees or some similar financial arrangements. The lack of expected performance by these divested businesses could affect the future financial results through additional payment obligations, higher costs or asset write-downs.

- Balaji Murthy
T.E. MECH A

Year-wise M&A deals completed and announced in A&D, 2011–17 year to date (YTD)



*Number of deals includes deals with undisclosed values; 2017 YTD: 1 January 2017–31 March 2017

Source: Thomson One, EY Analysis.

EXPOSURE TO CYBERSECURITY EVENTS

Increased digitalization increases the threat of cyber-attacks on the A&D :

A&D transfers large volume of data including flight operations quality assurance, flight data monitoring and load management between end users, manufacturer and service provider. The confidential data on specifications, technology and performance of equipment or services are exchanged routinely by the involved companies with the objective of enhancing collaboration on design, development and support. All such data is valuable for cyber terrorists with unethical clients in the industry, who use this stolen data to copy products and undercut prices to outperform competition.

In commercial aerospace, key aircraft functions, such as flight navigation and control, propulsion, landing and braking, and information systems, are managed by embedded electronic systems and safety-critical software. The critical data generated during the time of the flight is analysed for better flight safety and optimization. In the defense sector, upgradation of existing weapons as well as increased focus on intelligence, surveillance, and reconnaissance (ISR) systems have increased the information flow within the supply chain. Furthermore, the confidential and sensitive nature of the information around program specifications and technologies involved necessitates the usage of reliable and enhanced cyber security solutions.

With increasing dependency on internet network by military organizations, cyber-attacks are on the rise. Furthermore, the traditional methods of defenses against cyber threats become ineffective against new types of cyber-attacks and advanced malwares. Companies need to invest in next generation cyber security solutions to be able to prevent themselves against advanced cyber-attacks.

The total losses incurred by companies across different industries because of cybercrimes are estimated to be approximately US$400 billion per year. A&D have to constantly defend themselves against large cyber-attacks by hackers backed by enemy countries as well as against attacks from less sophisticated and unorganized hackers. For instance, press reports state that companies such as BAE Systems annually resist hundreds of cyber-attacks by foreign government-backed hackers.

The US DOD and the defense agencies of other countries are making significant investments in cyber security. Realizing the opportunity in the cyber security market, leading A&D including Lockheed Martin, Raytheon, Northrop Grumman, as well as a number of smaller A&D companies are investing in developing cyber security solutions with both offensive and defensive capabilities.

Cyber-attacks leading to compromising of confidential data of suppliers, customers or the government can lead to legal trouble.

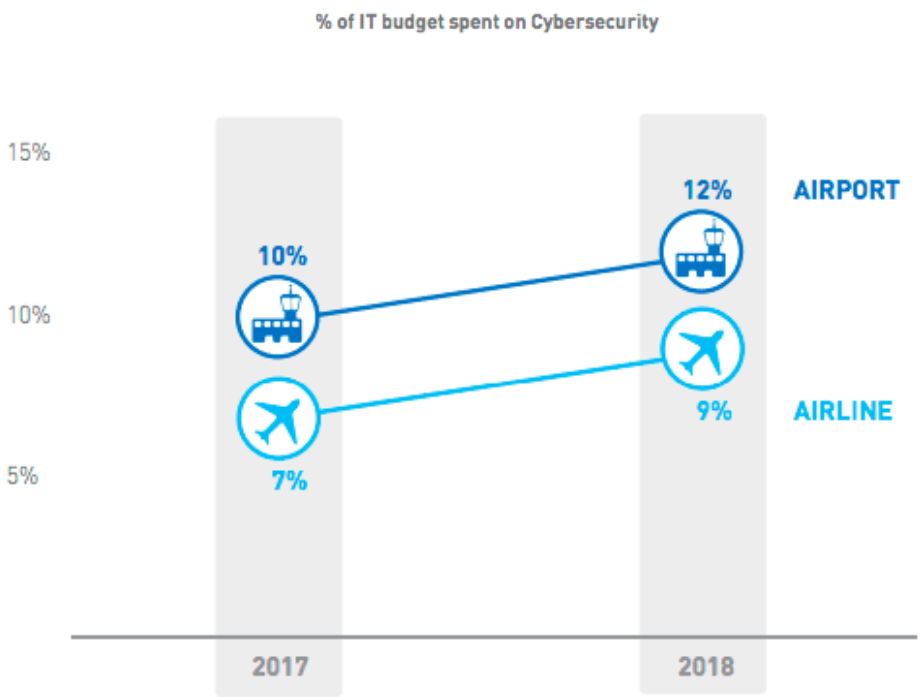
Major A&D companies are implementing integrated supply chain management (ISCM) platforms to facilitate uninterrupted information exchange between the different supply chain participants, from suppliers to customers. This involves continuous to and fro flow of vulnerable data through the ISCM platform, a part of which might also be confidential in nature. Any data theft or cyber-attack on any part of the ISCM platform would potentially lead to a threat to the entire supply chain network, creating a multiplier effect on the risk of cyber security events.

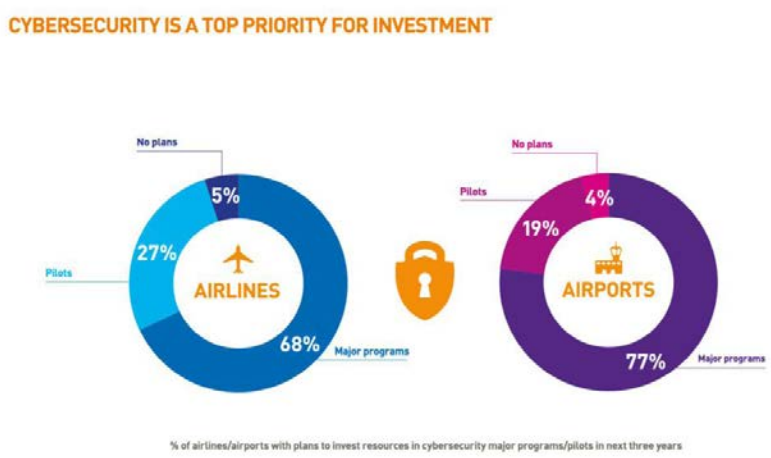
In addition, most of the contracts in the A&D industry have strict rules on loss of confidential and critical information and can attract contractual penalties for data loss. Loss of confidential data also exposes companies to legal claims from upstream and downstream companies in the supply chain.

A&D must have a significant focus on designing or procuring enhanced cloud computing solutions, operating systems and virtual machine technologies to defend their cyber space against cyber-attacks from hostile states cyber-terrorists in the near future. Companies can also turn to insurance as a financial protection against the threat of cyber-attacks.

Bill Colbert, partner and advisory of Ernst and Young LLP, said that 'A&D firms possess valuable IP that is also valuable to cyber criminals. Whether a firm builds weapons, ships, aircraft or spacecraft, their cyber data contains sensitive information about capabilities,limitations, and weaknesses of their products, which could be exploited and monetized by cyber criminals. CYber attacks can result in loss of competitive advantage through intellectual property theft, potential degradation of national security if stolen data is used by foreign militaries.'

- Amarjeet Pandit
T.E. MECH A



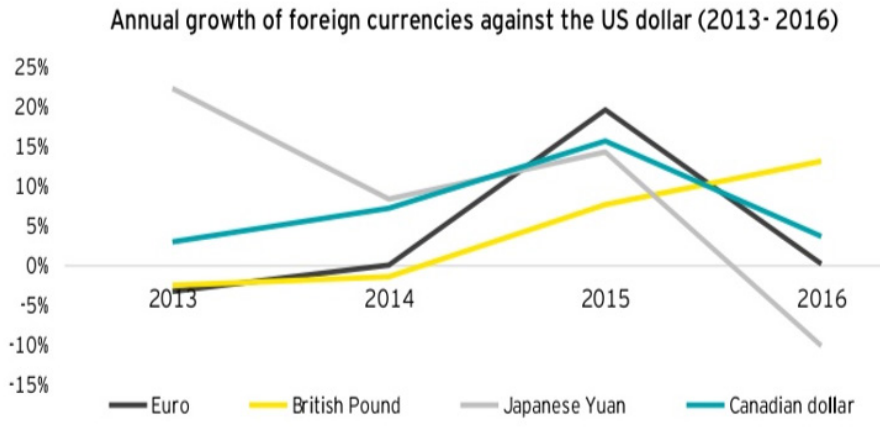


FOREIGN CURRENCY AND COMMODITY PRICE FLUCTUATIONS.

Revenues from international operations are impacted by fluctuations in foreign currencies :

Operating in a number of countries around the globe, A&D companies have to face the fluctuations in foreign currency exchange rates. The following chart highlights the fluctuations in the yearly growth rate of the average value of major currencies against the US dollar over the last five year.

Given that most of the A&D companies have a global footprint, they earn significant portion of their revenues in currencies other than the currency of their home market. With currency fluctuations, value of the revenues earned in foreign currencies changes. The impact of currency rate fluctuations on the company is even more magnified when a significant portion of its revenue comes in foreign currencies. In addition to its effect on the revenues earned, currency fluctuations also affect the receivables, payables and return on assets denominated in foreign currencies. Furthermore, production in various countries adds to the risks associated with fluctuations in foreign exchange rate as compared with the home currency. In the first half of 2016, General Dynamics reported negative foreign exchange impacts of US$100 million and in the second quarter of 2016, Northrop Grumman reported a US$30 million decrement in its cash balances because of the fortifying of the US dollar. On the other hand, Leonardo recorded approximately €200 million negative impact on revenue in the first nine months of 2016, primarily due to strengthening of euro against the British Pound.



* Source: Thomson One, EY Analysis.

Commodity price increase puts pressure on the profitability of A&D companies :

Financial performance of A&D companies is also impacted by the fluctuations in the prices of key commodities or raw materials such as aluminium, titanium and composites. The following chart shows the monthly average price for aluminium in the global market since January 2016.

Prices of these raw materials directly reflect in the manufacturing costs of the A&D products. They also impact the costs associated at all stages of the A&D supply chain and have a cascading effect on the final product. Given the immense level of pressure companies have for apt pricing, due to high negotiating power of the customers as well as the competitive nature of the industry, increased costs of production directly affects the company's profits.

- Kairav Nanavaty
T.E. MECH A

COMPETITIONS

ISNEE QUAD - TORC 2019

Quad is an all terrain vehicle (a four wheeler bike), which was initially developed as a farm-to-town vehicle in isolated and mountainous areas.

“Indian Society of New Era Engineers” is an organization focusing on the technical and managerial development of future engineers. The organising committee gives opportunity to the undergraduate and diploma engineers to research and develop innovative projects. Design challenges organised by ISNEE provide students a panorama to work as a team and allows them to commit and dedicate to demonstrate and prove their creativity to resolve real life problems.

Quad-Torc is a four day competition which involves many events which are planned each day. The competition embarks with drop test event which is mandatory for all the teams to surpass, where the vehicle is dropped from a height of 7 feet. Many other events such as the DisAsm, Suspension test, Manoeuvrability, Kill the Hill and other documentation events such as the Design Validation, Evaluation and Business plan presentation are planned accordingly.

Team Technocrats is the particular team from Thakur College of Engineering & Technology to participate in ISNEE QUAD-TORC national level competition. The Quad-Torc 2019 was held at Bijnor, Uttar Pradesh from 6th-10th September 2019. The team participated and showcased their skills in 2019 with a total of 42 team members.

Reasons to participate in this competition :

- To showcase our skills at a national level.
- To build a bridge between imagination and the real engineering through designing and manufacturing.
- To create a change in the society with our knowledge of engineering.

Our experience while :

1. **Deciding the material, budget, design :** The most significant and challenging part as a team is to build a vehicle with high quality components and also to maintain the budget. The work initiated with hundreds of iterations for suspension and steering mechanism to choose the best design and reliability for our vehicle. While participating for the first time the team was a bit confused about the material to be used and finalised on Carbon Steel (AISI 1018) but participating for the third time the team is more focused on weight reduction and is willing to choose Alloy Steel (AISI 4130) as it gives twice more strength as compared to its weight.

2. **Planning and manufacturing the vehicle :** As we finalised our material and design, it was the time to have an efficient schedule for manufacturing. As we were new to this competition and also due to lack of knowledge we decided to attend the workshop which was organised by ISNEE committee. It was a 2 day workshop at Pune which gave a brief insight to different plans of approach and manufacturing techniques. The engine was a 250cc LIFAN engine provided by SD Motors. So we decided to get our hands dirty at Malad west Bombay talkies for manufacturing where we had a place to work and a massive ground to test dynamically the vehicle at each stage.

Experience of the competition :

Forty-Nine teams from all over the nation participated in this competition. Every team and their vehicle were unique in its own way and surprised everyone with their skills. The technical inspectors helped and guided each team throughout the competition. The competition was well organised and the members from other teams also helped each other with any spares or fabrication if needed hence showcased sportsman spirit. Being the first team from our college we managed to gain some good numbers in terms of ranking and achievements.

ACHIEVEMENTS

- Won **First prize** in **Cost Plan.**
- Secured **First place** in **DisAsm** event **(49.16min)**
- Judgers choice Award (Best female participant: **Ms. Ruchi Pourana**)
- Secured **Second place** in **Business Plan** presentation.
- Secured **Third place** in **Traction Test.**
- Secured **Third place** in **Fuel Economy Test.**
- Finished **sixth** in the **endurance race.**
- **AIR position 5th** among **50** registered teams.

Team Captain	Team Mentor
Pradeep Kapri	**Prof. Sachin Oak**

E - FEST ASME : HPVC 2020

About E-FEST :

E-FEST, organised by American Society of Mechanical Engineers (ASME), is a technical festival that takes place all across the globe in continents like North America, South America, Europe and Asia, of which Team Photon participates in the Asia-Pacific level. The E-FEST houses various competitions like Human Powered Vehicle Challenge (HPVC), Student Design Competition (SDC), Innovative Additive Manufacturing 3D Challenge (IAM3D™), New Elevator Pitch Competition, Oral Competition. Out of the aforementioned, HPVC is the highlight of the technical fest and invites majority of the footfalls. In these competition students from different colleges engineer human powered vehicles like bike, trike and quad-bike. The motto is to encourage the ideas, innovations and skills of the students and inspire them to co-create eco-friendly technologies. This year the E-FEST was held at Marwardi University, Rajkot (Gujarat) from 27th February to 1st March. Many teams that took part in the enthralling competition included IIT – Roorke, VIT – Vellore, IIT – Patna, Delhi Technical University, NMIMS (Shirpur) and many more.

About Team Photon

Team Photon, by representing TCET, has been actively participating in E-FEST: HPVC since 2017 and has always aimed at ameliorating itself. Each year the team has showcased a better version of itself taking into account the experience and knowledge gained. This year we fabricated Phoenix, a vehicle catering to the urban settings and changing lifestyles. In doing so, comfort was the key criteria and thereby a detailed research was undertaken on the subject of biomechanics to deduce and derive the optimum lengths of various components of our vehicle. We aspired to develop a proficient vehicle that would pose as a preferential choice in upcoming era of green vehicles.

Experience :

The preparations for the competition commenced in the month of June 2019. As the members of a team are the cornerstone for subsequent success we started by recruiting new members. The new members were trained in handling some of the basic power tools and were made aware of some terminologies and practices that would be implemented upon for the days to come. Design reports, an eminent part of the competition, were closely scrutinized so as to look for the scopes of improvements. Soon after the team had a fair idea about the type of vehicle that was to be developed, that is a semi-recumbent front wheel driven bike, the process of designing followed. The team continued to improvise as and when faced with hurdles during designing process. Simultaneously the process of sourcing was under way so as to ease out the manufacturing phase.

After completing a fair 3D model, the manufacturing of the vehicle begun. Various raw materials and components were procured from various places spread across Mumbai. The team simultaneously worked on the fabrication of the vehicle and formulation of the design report. This year, as planned, we were able to spend more time on the riders practice for the Sprint Race and Endurance Race. As any vehicle is as good as its driver, similarly the physical fitness of the riders played a very crucial role. The days spent in the competition gave the team members the first-hand experience of the competitive nature of the world outside the bounds of the classroom. Just like every other team, Team Photon competed with vigour and the rest is history.

3-Days of the competition :

After an overnight journey in Saurashtra Mail we reached Rajkot in morning around 10. Due to then immediate threat of Covid-19; we were provided with basic precautionary sanitation needs. As we reached our pit area, we started unpacking our prudent packing. Till afternoon, we had almost assembled whole vehicle. After having lunch we completed whole assembly. We

wanted to complete static testing on the very same day itself but due to time constraints we were sent back from inspection areas. Our aim for the next day was to successfully complete static inspection in the first-go. After again going through whole vehicle we successfully completed inspection by lunch. After having lunch, we went to look over other teams' vehicle and learn from the same. Some team members went for design presentation. A power-point presentation needs to be presented to panel of judges. Aaron Weinerman (ASME Global Representative and Manager of Public Affairs) along with many other delegates was on round to study every vehicle in the competition. He was in awe with our vehicle and even rode it. Probably Phoenix was the only vehicle he rode out of all the 50 vehicles present in the competition.

Coming on to next day, we had Men's sprint and Female's sprint scheduled for the day. A 100 metres track was set-up with sufficient run-up track. Sprint time was to be recorded and displayed on the screen present. After various checks by our team on vehicle regarding transmission, safety, ease of riding, etc. we moved for racing in our allotted timing slots. All the rigorous riding practice done by our riders yielded in successful results. We stood at 3th position in Women's sprint and 17th in Men's sprint. Third day was one of most challenging part of the competition. Endurance race was to be conducted on that day. In Endurance Race, the team has to collectively ride the vehicle for 2.5 hours passing various obstacles and completing a few tasks simultaneously. The track was of 1.25 km, and every rider was required to complete 5 complete laps as per rule-book. Almost all the qualities of rider and team were tested. There were many teeth biting moments when and where the integrity of team was checked.

After having our lunch we proceeded to awards ceremony. After long wait, when finally the judges started announcing HPVC awards we were on edge of our seats. We were stunned, astonished and pleased when we heard, 'The overall first prize of HPVC 2019 goes to Team No.: 12', we still become emotionally dehydrated when we recall that wonderful moment. Many memories were made; lessons were learnt for such a magnifying and amazing experience. As it is rightly said, "A dream doesn't become reality through magic; it takes sweat, determination and hard work."

Learning Outcomes :

Apart from the tangible trophies there were a lot of takeaways from this competition. Students involved as members of the team enhanced their skills of Time Management, Resource Management, negotiations, planning and procurement. Some of the technical skills that were picked up are Designing, Technical Writing, Manufacturing and Fabrication processes. While experiencing a few moments of despair, we were compelled to learn the skills of problem solving and team spirit.

Way Forward :

In spite of the conditions that have risen due the COVID-19 pandemic, lockdown being enforced; the challenges that are faced arising from the same, the Team has geared up to compete in HPVC 2021 in Chandigarh University. With online recruitment under way and support of our professors and mentors we are hopeful of achieving new heights.

ACHIEVEMENTS

- 1st Prize in Overall Competition
- 3rd Prize in Endurance Event
- 3rd Prize in Women's Speed Event
- 4th Place in Design Event
- 17th Place in Men's Speed Event

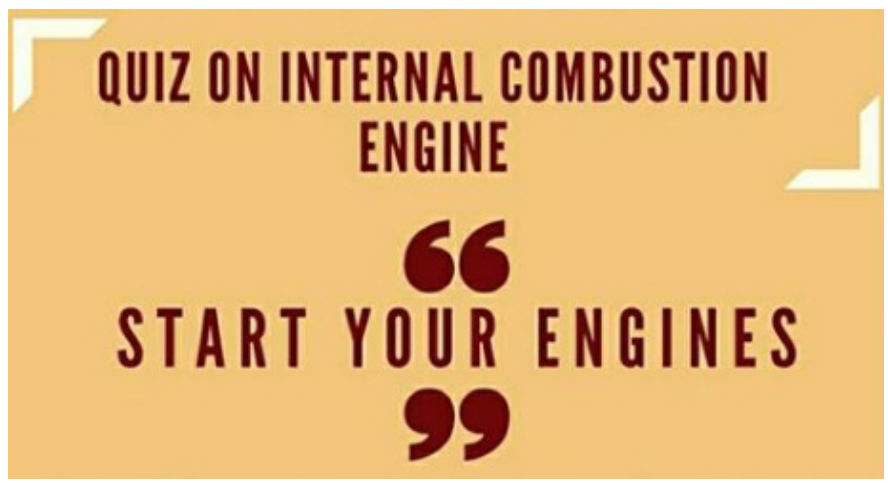
Team Captain	Team Mentor
Vaibhav Rane	**Prof. Mahendra Shelar**

ACTIVITIES

ASME-TCET conducted two challenging yet fun contests during the COVID-19 pandemic. The two contests were: Quiz on Internal Combustion Engine and The Innovator's Competition.

1. **Quiz on Internal Combustion Engine :** This quiz was conducted on 10th June 2020. This quiz tested the participants knowledge on I.C. Engine, it's components, it's working, it's application, etc. It was conducted in two rounds. Around 65 students from various engineering colleges took part in this contest, out of which top 20 students advanced to the second round. The students who bagged the top three positions were Pradeep Kapri, Paresh Choudhary and Anushka Moharir.
2. **The Innovator's Competition :** For this contest, the participants were required to come up with solutions to the problems that the present world faces, and write articles based on the solutions. The winners of this competition were announced on 13th June 2020. They were; Balaji Murthy Bokka, Kunal Khadke and Asu Mohammed Sajid who wrote articles on Automated Prosthetic Manufacturing, Refrigeration Using Exhaust Gas Recirculation ad Design & Development Of Reloadable Tracker For Efficient Hernia Mesh Fixation, respectively.

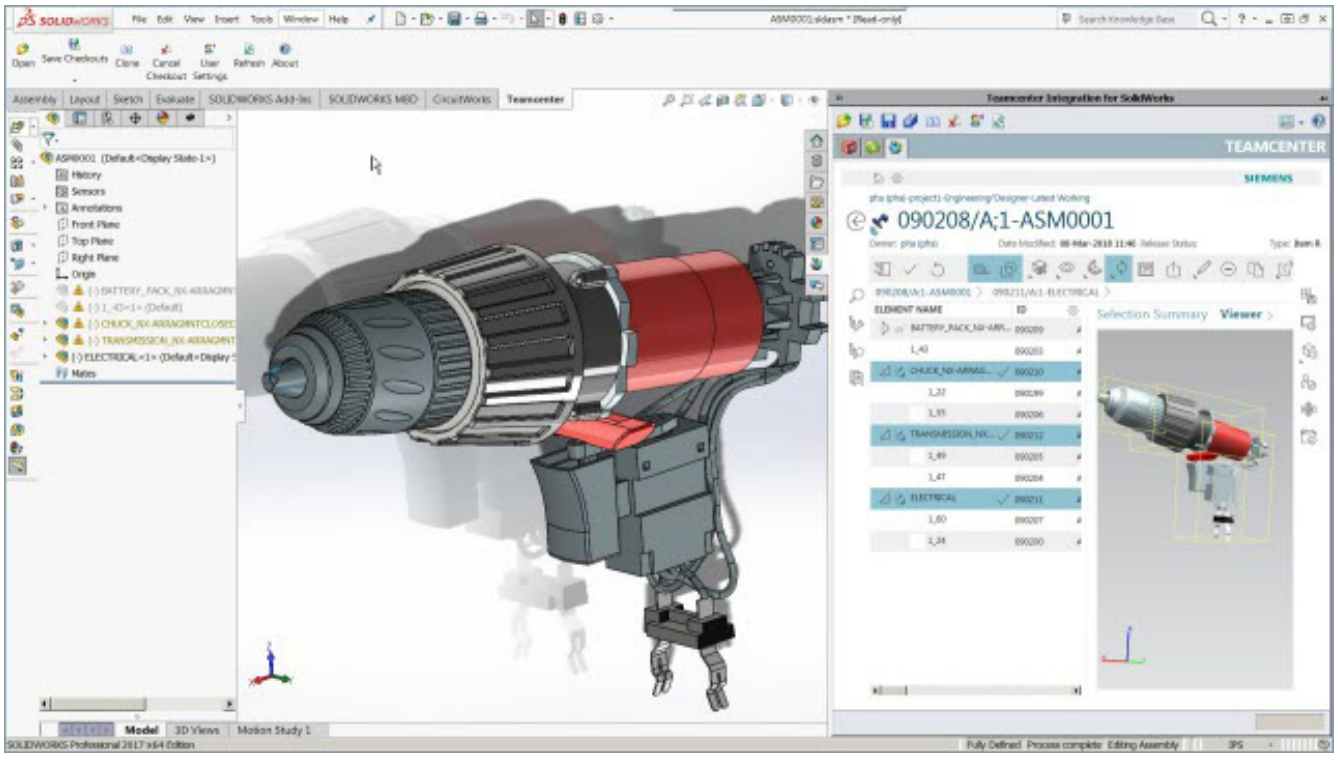
All the participants were awarded with e-certificates and the winners were given cash prizes. The feedback of all the participants for both the contests was good.



SOLIDWORKS WORKSHOP

Solid Works workshop was organized by TCET- ASME on 18th and 19th September 2019. This workshop was conducted by Cadd Centre in the premises of the college itself. Students from various engineering colleges participated in this workshop.

Solid Works is computer-aided designing software, which is primarily used for designing an entire mechatronics system. It is necessary for every mechanical engineering student to inculcate some knowledge of this software. The participants of this workshop were introduced to the various features of Solid Works software and they were also taught how to create 3D models using this software.



QUADCOPTER WORKSHOP

The Quadcopter workshop was organized by TCET- ASME on 18th and 19th September 2019. This workshop was conducted by Robokart in association with Innovation - Cell UMIC, IIT Bombay in the premises of the college itself. Students from various engineering colleges participated in this workshop.

A quadcopter is a multirotor helicopter that is lifted and propelled by four rotors. This workshop focussed on teaching about the designing and assembly of a RC drone. Participants were enlightened about the working principle of quadcopter, its construction, connection considerations for various configurations, stability criteria for quadcopter, etc. All the aspects of electronics, mechanics, programming and communication were well explained by the trained professionals. An important highlight of this event was flying the drone assembled by students in the college campus which proved to be a head turner during Zepyhr.

The major highlights of the event were:

- Interaction with trained professionals
- Make your own drone in 2 days
- Lives Demos, Interactive Questions, PPTs, Question and answer sessions, Comprehensive material
- Group wise flying sessions

INDUSTRIAL VISIT

SHIV PARVATI PLYWOOD

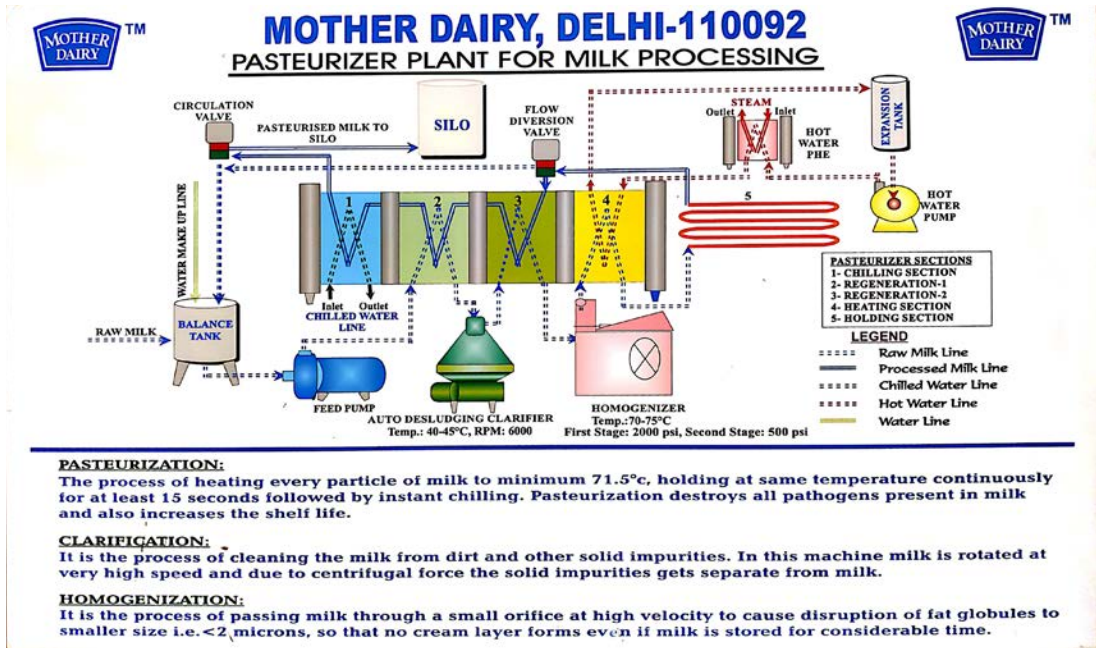
The students of Mechanical Department of Thakur College Of Engineering And Technology visited Shiv Parvati Plywood in Jim Corbett, on 7th January 2020. This industrial visit was organized by ASME-TCET Student's Chapter. Shiv Parvati Plywood. This industry produces plywood. Plywood is a durable alternative for solid wood. Its multiple designs give it a rustic appearance. Plywood can be used for creating cabinets, flooring, panelling, modular kitchen, desk, table, beds and other furniture.

Students learned about the various steps involved in manufacturing and production of plywood; which are as follows: Sourcing raw logs from legal and sustainable forest concessions, transporting these logs to the mills for processing, de-barking the logs, cutting and peeling them, sizing and grading, drying the veneers, repairing defects, application of glue and lay-up, cold pressing, hot pressing, trimming, sanding and finishing, quality control, packaging and finally delivery.

MOTHER DAIRY

Mother Dairy, an exclusively possessed subsidiary of the National Dairy Development Board (NDDB), was commissioned in 1974. Mother Dairy, an enterprise under Operation Flood, the realm's biggest diary development program launched to make India a milk sufficient nation. In the present day, this industry produces and manufactures markets and retails milk and milk products comprising of cultured products, ice creams, paneer and ghee under the Mother Dairy brand. The Company also has broadened its horizons with products in edible oils, fruits & vegetables, frozen vegetables, pulses, processed food like fruit juices, jams, etc. to meet the daily requirements of every household.

The official visit to this industry in Delhi was organized by ASME Student's Chapter on 08 January, 2020. Here the students got an opportunity to learn about internal operation of the machines, working of companies and they also developed an understanding of the practical aspects in the work space. Students got a closer insight about work ethics and communication skills.



GUIDE FOR HIGHER STUDIES

USA

WHY USA?

- Most preferred destination.
- Wide variety of programs to choose from.
- Courses can be a mix of various branches.
- A student-friendly system.
- A respectable pay scale.
- Many public and private universities to choose from.
- Better job and research opportunities.

WHAT USA HAS TO OFFER YOU AS A STUDENT?

- A diversified community of students.
- One of the best research facilities around the globe.
- Great funding opportunities.
- Great internships.
- CPT and OPT for STEM courses.

SOME COMMON JOBS IN USA AND THEIR PAY :

(Data acquired from official sources for 2019)

- Computer Science and IT $1,22,800
- Mechanical Engineer $88,400 to $1,38,000
- Industrial Engineer $88,000 to $1,34,000
- Civil Engineer $87,000 to $1,44,000
- Electronics Engineer $98,000 to $1,55,000
- Chemical Engineer $1,08,000 to $1,76,000
- Material Engineer $93,000 to $1,48,000

INTAKES IN THE USA :

Fall intake:

- Begins in August.
- Most preferred Intake.
- All the courses are available.
- More job opportunities once you graduate.

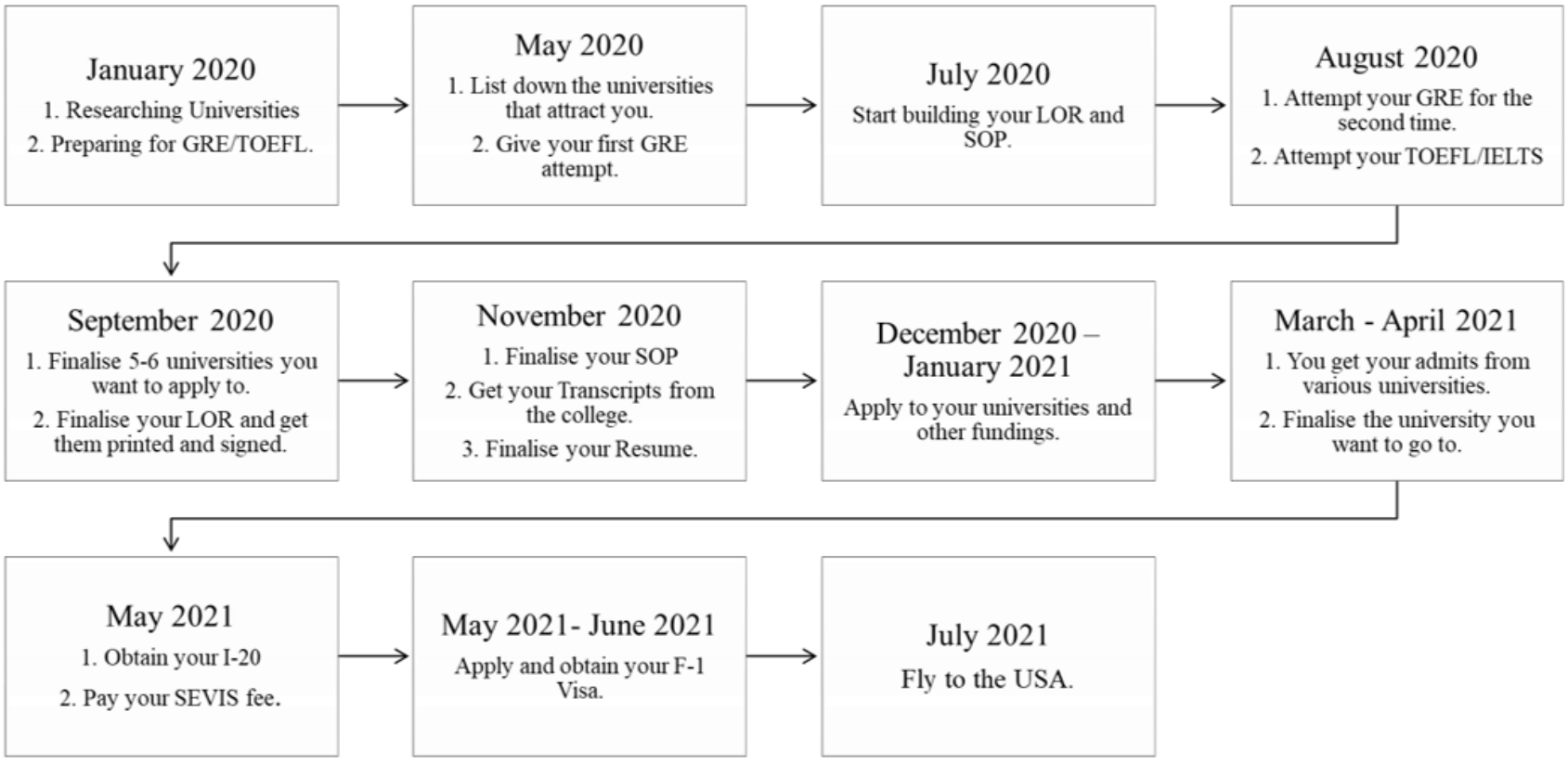
Spring intake:

- Begins in January.
- The number of courses offered are limited.
- Job opportunities are comparatively less.

BASIC REQUIREMENTS :

- A Bachelors' Degree in the related field or an equivalent study of 16years.
- Test Scores (GRE and TOEFL/IELTS)
- Letters of Recommendations
- Statement of Purpose
- Resume
- Proof of Funds.
- F-1 visa.

APPLICATION TIMELINE FOR FALL 2021 :



COSTS RELATED TO PREPARING FOR USA:

Preparations	Charge	For 6 applications
GRE and TOEFL preparation Class	25k – 30k ($400)	
GRE exam	$205	
TOEFL exam	$180	
Counselling	25k to 50k ($500)	
Sending GRE scores	$27 each after 4 universities	$54
Sending TOEFL scores	$20 each after 4 universities	$40
Test prep reference material	$40 - $50 (Usually Free)	
Applications	$100	$600
I-20 delivery Fee	$60	
SEVIS Fee	$350	
Visa Fee	$160	
Tickets	$800 to $1000	
Shopping	$500	
TOTAL		$3900

COSTS RELATED TO THE UNIVERSITY :

- University fees
- Living expenses
- Medical Insurance
- Food and other

CANADA

WHY CANADA?

- Most preferred destination.
- Wide variety of programs to choose from.
- Easy Legalization process (Permanent Residence PR)
- Courses can be a mix of various branches.
- Better job opportunities
- A student-friendly system.
- A respectable pay scale.
- Many public and private universities to choose from.
- Better research opportunities.

WHAT CANADA HAS TO OFFER YOU AS A STUDENT?

- A diversified community of students.
- One of the best research facilities around the globe.
- Great funding and Scholarship opportunities.
- Great internships.
- Comparatively Less Expensive than USA.
- Can extend your Student Visa.
- Minimum time for Permanent Residence (PR) than other countries.

SOME COMMON JOBS IN CANADA AND THEIR PAY

(Data acquired from official sources for 2019)

- Computer Science and IT CAD 65,000- CAD 1,10,000
- Mechanical Engineer CAD 55,000 to CAD1,02,000
- Industrial Engineer CAD 49,000 to CAD 85,000
- Civil Engineer CAD 47,000 to CAD 95,000
- Electronics Engineer CAD 40,000 to CAD1,08,000
- Chemical Engineer CAD 53,000 to CAD 1,30,000
- Material Engineer CAD 35,000 to CAD 1,10,000

Note- These are minimum to maximum salaries in Canada as per the data. However, average Engineer salary is around CAD 75,000-80,000, and maximum salary can vary from the given data.

INTAKES IN CANADA:

Fall intake:

- Starts in September
- Primary intake
- Universities offer all the courses to international students

Winter intake:

- Starts in January
- Secondary intake
- Large number of courses available for students who missed fall intake

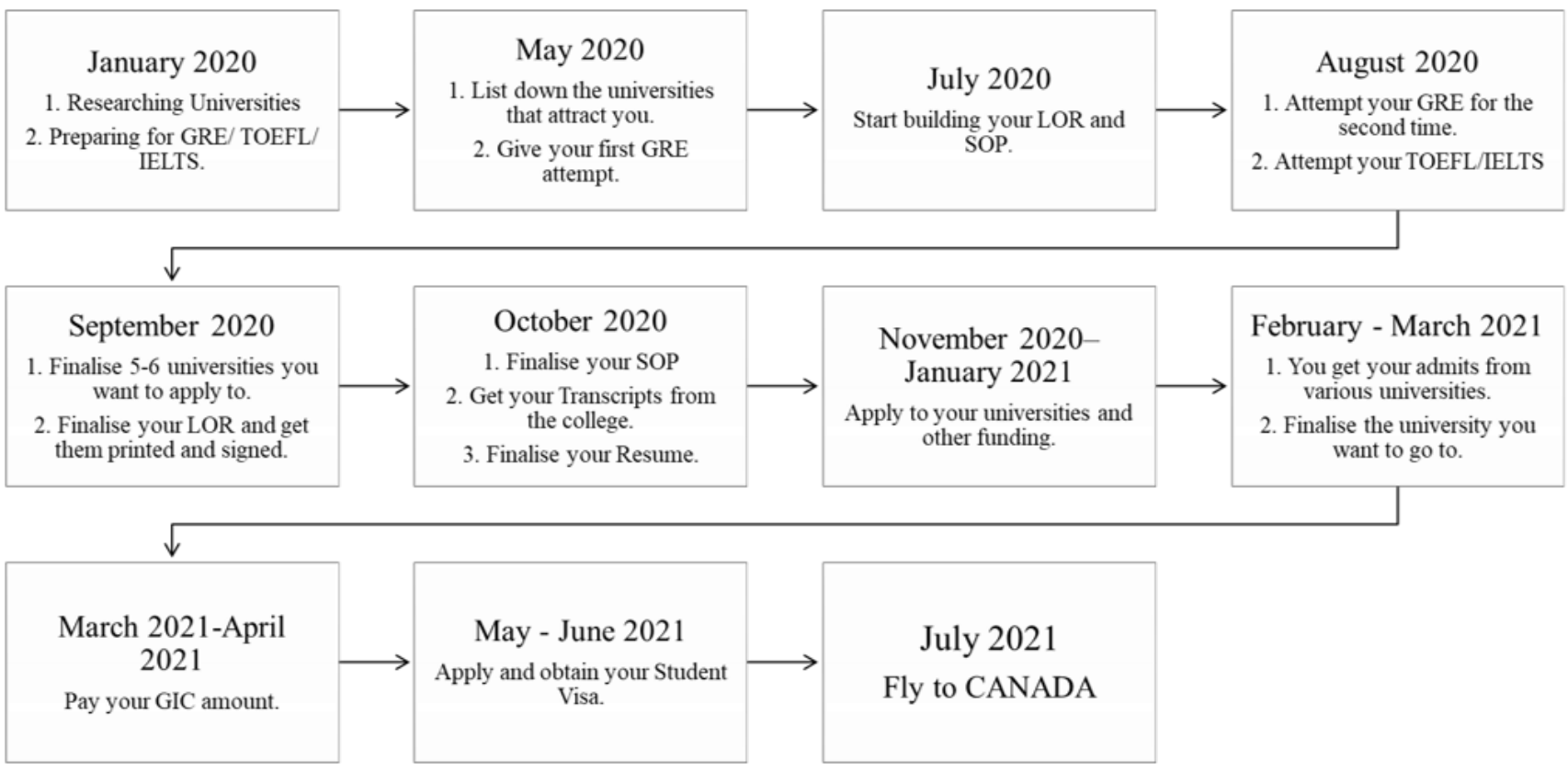
Spring intake:

- Starts in May
- Only a few courses available
- Not all universities offer courses in Spring intake

BASIC REQUIREMENTS :

- A Bachelors' Degree in the related field or an equivalent study of 16years.
- Test Scores (GRE and TOEFL/IELTS)
- Letters of Recommendations
- Statement of Purpose
- Resume
- Proof of Funds.
- F-1 visa.

APPLICATION TIMELINE FOR FALL 2021 :



GERMANY

WHY GERMANY?

- Germany provides a very unique program where a student can avail the benefits of free education in top 30 universities and apply for free admission
- Student can get part time internship assurance
- Low tuition fees and state funded universities
- Students are allowed to stay for 1.5 years after the completion of the study program
- Well known brands are from Germany like Mercedes Benz, BMW, Volkswagen, Adidas, Audi, Lufthansa, etc.

INTAKES IN GERMANY :

Winter intake:

- Starts in September/ October
- All universities offer large number of courses

Summer intake:

- Starts in April
- Less number of courses offered

BASIC REQUIREMENTS :

- 13 years education is accepted for Bachelors and 16 years for Masters programs
- IELTS is mandatory for admissions – 5.5 bands for Bachelors and 6 bands for Masters
- IELTS is not mandatory if the student has 60 to 65% in previous education
- The student has to pay the initial fees for admission after issuance of offer letter and rest of the fees before visa
- Show money has to be 8040 euros or 13 to 14 lakhs
- Visa processing time is for 1 and a half to 2 months
- A student can get 1.5 years of stay back period
- Dependents can fly only after 2 months by showing additional funds of 8000 euros

DOCUMENTS REQUIRED FOR MASTERS :

- 10th and 12th mark sheet and passing certificate (Apostle)
- Bachelors marks sheets and Degree certificate
- CV
- SOP/ Motivation Letter
- Copy of Passport
- Passport size photo
- Work experience (if any)

APPLICATION PROCEDURE :

- Find your program
- Apply
- Send all educational documents 10th onwards all originally scanned
- Valid passport
- Copy of IELTS
- GMAT scores if available
- Experience Certificate (for masters if any)
- Application fees
- Apostil documents required (highest degree)
- Wait to receive notification of acceptance
- Fly to Germany

Credits to: Mr. Pradeep Kapri, Mr. Saif Samnani and Mr. Paresh Choudhary

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