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CENTRE for AEROSPACE & SECURITY STUDIES

Air and Space Technologies: Harnessing the Innovation Economy

Analysis Report

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INTRODUCTION

The aerospace industry has evolved into a pivotal element of both security and economic development, propelled by rapid technological advancements. Serving as a catalyst for growth beyond traditional industrial sectors, it offers nations unparalleled opportunities. CASS organised a seminar on 24 September 2024 titled ***'Air and Space Technologies: Harnessing the Innovation Economy.'***

The innovation economy is characterised by the commercialisation of new ideas and technologies, which is a critical enabler of this transformation. By fostering a culture of Research and Development (R&D), promoting Public-Private Partnerships (PPPs), and implementing supportive economic policies, nations can create fertile ground for aerospace advancements. The interplay between technological innovation and economic growth is particularly crucial for developing countries, where strategic investments in aerospace can yield significant returns in terms of national security, economic development, and global standing.

The distinguished subject matter experts who spoke at the seminar were:

- Air Marshal Zahid Mehmood (Retd), Former Vice Chief of the Air Staff, Pakistan Air Force
- Dr Najam Abbas Naqvi, Chairman, National Center of GIS and Space Applications, Institute of Space Technology
- Air Vice Marshal Dr Liaquat Ullah Iqbal, DG Public Relations & Publications, National Aerospace Science and Technology Park

The seminar was moderated by Air Vice Marshal Nasser Wyne (Retd), Director (Aerospace Warfare), Centre for Aerospace & Security Studies, Islamabad with Concluding Remarks by President CASS, Islamabad, Air Marshal Javaid Ahmed (Retd).

EXECUTIVE SUMMARY

In his brief *Opening Remarks*, ***Air Vice Marshal Nasser Wyne (Retd)*** highlighted that for decades, air power has been synonymous with military superiority, defined by speed, range, and flexibility. Today, aerospace power—an integration of air, space, and cyber capabilities, represents the next frontier. He informed the audience that developed nations are at the forefront of this transformation, leveraging advanced technologies to reshape defence technologies. What made this evolution ground breaking is its connection to the innovation economy. Moreover, countries that have mastered aerospace power have capitalised on these innovations, turning them into strategic advantages. He recommended that for nations like Pakistan, with limited resources, the challenge lies in balancing priorities.

In the Keynote Address, ***Air Marshal Zahid Mehmood (Retd)*** *discussed* aerospace's evolution from a primarily defence-focused sector to a key driver of economic growth and technological innovation. He highlighted that developing countries could leverage aerospace technologies by fostering innovation and technology transfer; developing human capital and skills; enhancing scientific and research capabilities; attracting investments and partnerships, and leveraging aerospace for tourism and culture. He identified several challenges in the industry which included high costs and financial risks; infrastructure limitations; environmental and sustainability issues and public perception and acceptance. He cited technological advancements, new business models and opportunities; global connectivity and economic growth as the major opportunities in aerospace. He elaborated on technological advancements in electric and hybrid aircraft; autonomous flight; urban air mobility; commercial space exploration; satellite constellations; and space tourism. He discussed the national security implications of aerospace development by referring to increased surveillance capabilities, air defence systems, space situational awareness, and space-based defence systems. He proposed that developing countries, including Pakistan must recognise and seize the opportunities the aerospace sector offers.

In his presentation, ***Dr Najam Abbas Naqvi*** explored the transformative potential of space technologies for national security, economic growth, and societal development. He highlighted the critical role of satellite-based applications in addressing some of the world's most pressing challenges; from disaster management to access to communication and education. He stressed that the space economy is no longer a niche market but is becoming a critical part of the global economy. In his view, development of new applications for satellite technologies, combined with advancements in AI and machine learning, would create unprecedented opportunities for economic growth and societal advancement. However, he stated that to capitalise on these opportunities, countries must invest in education, research, and innovation. He urged policymakers in Pakistan to incentivise private sector involvement through

funding and tax benefits while advocating for the establishment of aerospace innovation clusters to drive research and commercialisation. Lastly, he forecasted that with the right strategies in place, Pakistan could benefit from the growing global space economy, projected to be worth USD 1.8 trillion by 2035.

Air Vice Marshal Dr Liaquat Ullah Iqbal outlined the strategic vision behind PAF's flagship initiative 'National Aerospace Science and Technology Park' (NASTP) highlighting the interconnectivity of IT, computing, and aerospace industries. Dr Iqbal provided an overview of the various initiatives undertaken under NASTP's infrastructure which spans five cities, each focusing on distinct domains. He also touched upon the business strategies and future prospects of innovative technologies and their incubation within NASTP. Commending the collaborative efforts of multiple ministries, he emphasised the critical role played by thorough documentation and approvals at various levels in securing the Special Economic Zone (SEZ) status for NASTP. He affirmed that youth development, private sector engagement, diaspora outreach, and international collaborations are essential pillars for NASTP's sustained growth, positioning it as a key player in advancing Pakistan's aerospace sector.

In his *Concluding Remarks,* ***Air Marshal Javaid Ahmed (Retd)***, President CASS Islamabad, emphasised the need to evaluate both the positive and negative aspects of technology. He pointed out that the Ukraine conflict highlighted how unmanned systems are reshaping modern warfare, while the recent events in Beirut underscored the growing risk of consumer technology weaponisation. He stressed that technology was evolving rapidly; delivering solutions at an unprecedented pace but oversight and regulations remain far behind. President CASS also stressed the importance of acting fast, warning that if Pakistan did not take steps in the right direction, it was likely to fall behind. He commended efforts made by the Pakistan Air Force in the shape of NASTP, where technological advancements are being exploited to harness the innovation economy. He thanked the speakers for their insightful arguments and informed the house that CASS planned to hold a series of seminars on the importance of aerospace domain.

The seminar was followed by active participation from a diverse audience, including retired military officers, scholars, and students, who engaged in an interactive question and answer session, enriching the discourse on this critical subject.

KEY TAKEAWAYS

- Evolution of the aerospace from a primarily defence-focused sector to a key driver of economic growth and technological innovation is a fascinating journey, spanning more than a century.
- In the next decade, both air and the space domains are expected to undergo substantial changes driven by technological innovation, shifting national security priorities, and evolving economic landscapes.
- The 21st Century has seen an unprecedented expansion of private sector involvement in aerospace. Companies like SpaceX, Blue Origin, and Virgin Galactic have emerged, driven by entrepreneurs with a vision to make space more accessible and commercially viable.
- The global aerospace industry is now a major player in the economy, contributing hundreds of billions of dollars annually. It has become a key driver of high-tech manufacturing, R&D, and skilled employment.
- Future of the aerospace industry is bright, characterised by the capacity to innovate and a commitment to meet the challenges of a rapidly changing world.
- Space technologies contribute significantly to national security by supporting non-military applications such as disaster management, forecasting, urban planning, and environmental monitoring.
- Integration of Earth observation, navigation, and communication satellites, along with AI and machine learning, is essential to developing new applications that benefit industries and drive economic growth.
- The number of active satellites, particularly in low Earth orbit, is rapidly increasing. As of June 2024, over 10,000 satellites are in orbit, with two-thirds of them part of SpaceX's Starlink constellation. Consequently, space debris presents a growing challenge that must be addressed.
- The global space economy is poised for significant growth, projected to reach USD1.8 trillion by 2035. The market for satellite-based applications will see rapid expansion, particularly in sectors like agriculture, disaster management, and telecommunications. Moreover, the reduction in launch costs and satellite manufacturing expenses has eased access to space.
- Nations that capitalise on space technologies today will secure their place in the future global economy and innovation landscape.
- Space education is severely lacking in Pakistan, with less than 24 pages of content related to space science in the entire curriculum from grades 1-12.

- Innovation in space technologies often originates in academic institutions, but collaboration between academia and industry is essential for translating research into practical applications. Successful partnerships, like those between MIT and Boeing or Stanford and SpaceX, provide models for how academia and industry can work together to drive advancements in space technologies.
- Establishment of the National Aerospace Science and Technology Park (NASTP) underscores the commitment to innovation, private sector development, and international partnerships, aiming to leverage technology for national progress and security.
- NASTP is not just a science and technology park. It focuses on creating 'islands of excellence' by establishing a Triple Helix Model - linkages between the government, academia and business community.
- Four key pillars are the backbone of NASTP's growth: youth, private sector, Pakistani diaspora and international collaborations.

PROPOSED WAY FORWARD

- Developing countries can leverage aerospace advancements to attract foreign investment and forge strategic partnerships by creating incentives for investments and forming international alliances.
- Countries not involved in aerospace Research and Development should acquire aerospace technologies from friendly countries through the Transfer of Technology (ToT).
- As space becomes increasingly congested with satellites and debris, enhancing space situational awareness (SSA) is critical for national security.
- In view of emerging threats in the air domain like stealth aircraft and hypersonic missiles, development of sophisticated interceptors and missile defence systems is critical in maintaining air superiority.
- Microchips, navigation devices, and propulsion systems are dual-use technologies that have both military and civilian applications. Pakistan's policymakers need to leverage these dual-use technologies.
- Emerging technologies like Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT) offer opportunities to enhance operational efficiency, optimise flight paths, and improve maintenance practices. The aerospace industry should timely incorporate these technologies to benefit from these advancements.
- Development of space technology must commence at the grassroots level, beginning with education in schools and universities, followed by investment in R&D at research institutions, and finally, large-scale production of these technologies by the industry.
- Space education needs to be integrated into school curricula to inspire future scientists and engineers.
- Nations like Pakistan can utilise the economic potential of space technologies by developing a specialised space workforce, fostering collaborative research initiatives, incentivising innovation, improving space education, establishing aerospace innovation clusters, and encouraging Public-Private Partnerships.
- The government ought to offer financial incentives, such as tax waivers and grants, to encourage start-ups and private companies to invest in space technologies. Incentivising private sector involvement is crucial, as government sectors face bureaucratic constraints that slow down technological progress.
- For Pakistan to flourish further in the aerospace sector, the country needs to follow the Triple Helix Model by bringing academia, government, and private

sector to one place. NASTP is a perfect platform where all three stakeholders can work together.

- While development of space technology is crucial, real economic growth will come from applications that use space-based data and satellite services. Pakistan should focus on leveraging these technologies for practical applications in fields such as agriculture, disaster management, and urban planning to generate revenue and foster societal development.

SUMMARY OF PROCEEDINGS

Air Vice Marshal Nasser Wyne (Retd)

Director (Aerospace Warfare),
Centre for Aerospace & Security Studies, Islamabad

Opening Remarks

Air Vice Marshal Nasser Wyne (Retd) set the stage for the seminar and said that the world stood at a crucial intersection where military, economic, and technological power were increasingly intertwined. The shift from air to aerospace power was not only a strategic necessity but also a pathway to economic progress through innovation. He argued that for decades, air power has been synonymous with military superiority, defined by speed, range, and flexibility. Today aerospace power - an integration of air, space, and cyber capabilities represents the next frontier. He stated that developed nations were at the forefront of this transformation, leveraging advanced technologies to reshape defence strategies. What made this evolution groundbreaking was its connection to the innovation economy.

Air Vice Marshal Wyne also argued that aerospace power extends beyond advanced aircraft or sophisticated defence systems. It involves harnessing innovations in space exploration, satellite technology, cyber warfare, and AI to redefine modern military capabilities. The innovation economy created a loop where technological advancements were driving aerospace progress, reinforcing both national security and economic resilience. He asserted that countries that had mastered aerospace power have capitalised on these innovations, turning them into strategic advantages. From space-based communications to stealth technologies, these advancements were reshaping military engagements and strategic deterrence. Lastly, Air Vice Marshal Wyne urged that for nations like Pakistan, with limited resources, the challenge lies in balancing priorities. However, aligning with the innovation economy offers significant opportunities, including enhancing military effectiveness and stimulating economic growth through high-tech industries.

Air Marshal Zahid Mehmood

Former Vice Chief of the Air Staff, Pakistan Air Force

Keynote Address

Air Marshal Zahid Mehmood (Retd) began his *Keynote Address* by highlighting that aerospace had evolved from a primarily defence-focused sector to a key driver of economic growth and technological innovation with profound implications for global industries and everyday life. He discussed the origins of aerospace, by referring to the Wright brothers' historical flight. With time, especially during World War I and II,

aviation technology advanced rapidly. Governments invested heavily in R&D to improve aircraft speed, range, and payload capacity. Furthermore, the Cold War witnessed a race between the United States and the erstwhile USSR in aerospace which led to significant breakthroughs such as Intercontinental Ballistic Missiles (ICBMs), advanced reconnaissance satellites, and investments in aerospace R&D. However, the post-World War II era marked a shift towards commercial aviation with commercial jetliners making air travel faster and more accessible. The Airline Deregulation Act of 1978, further catalysed this transformation, with increased competition, lower fares, and the growth of new airlines. These trends led to substantial economic growth and increased innovation in the industry.

Commenting on technological innovations, the speaker asserted that fuel-efficient engines, advanced materials, and aerodynamic designs helped to reduce operational costs and enhance performance. Likewise, advancements in satellites became crucial for communication, weather forecasting, navigation, and earth observation. The launch of commercial satellites and growth of satellite-based services opened new revenue streams and applications.

Speaking on the private sector, the Air Marshal Mehmood remarked that the 21st Century witnessed an unprecedented expansion and involvement of companies like SpaceX, and Blue Origin, that made space more accessible and commercially viable. This new wave has been pivotal in reducing cost of space travel and fostering a competitive market for space exploration and satellite deployment. SpaceX's development of reusable rockets proved revolutionary, significantly lowering the cost of accessing space. The expansion of commercial launch services allowed a variety of new applications, from satellite internet constellations to interplanetary exploration. In addition to innovation, the private sector helped in creating an aerospace-related ecosystem.

Discussing the economic impact, Air Marshal Mehmood revealed that the sector had been supporting millions of jobs worldwide in manufacturing, engineering, maintenance, and operations. It also stimulated economic activity in tourism, telecommunications, and materials science. The global aerospace industry was now a major player in the economy, and a key driver of high-tech manufacturing, R&D, and skilled employment. The sector's focus on innovation had led to advancements in materials science, avionics, and automation, which had applications beyond aerospace, including in automotive, healthcare, and consumer electronics. By, 2023, the aerospace global market share was projected to be close to USD 1400 billion, with Asia-Pacific projected to hold around 20 percent of the global market value.

The speaker discussed that developing countries could leverage advancements in aerospace to boost their economic development and global standing through a strategic, scalable, and stepwise approach to benefit across diverse sectors. R&D investments could enable exploration of aerospace technologies and their applications

in different sectors, such as telecommunications, materials science, and AI. Likewise, facilitation of partnerships between aerospace companies and local industries to transfer technology and knowledge could lead to innovation. Establishment or enhancement of educational programmes and vocational training could build a skilled workforce.

Likewise, partnerships with established aerospace institutions and universities for knowledge exchange and joint research projects were equally important. Aerospace research often overlapped with other scientific fields and provided opportunities for joint research projects that apply aerospace technologies to solve problems in different fields. Moreover, development or upgradation of research facilities to support aerospace-related studies could also be used for interdisciplinary research and foster innovation across various fields.

Air Marshal Mehmood further added that tax incentives, grants, and subsidies could attract investment and forge strategic partnerships. Furthermore, international aerospace collaborations could enhance access to global markets, share risks, and benefit from global expertise. Countries could also use aerospace advancements to boost tourism and cultural exchange by exploring opportunities, attracting high-value tourists, and fostering a niche market. Likewise, promotion of aerospace-related cultural and educational events, such as exhibitions and workshops, could raise awareness and interest in aerospace and related fields.

The speaker pointed out several challenges in the field, including rigorous regulatory and safety standards which necessitate exhaustive testing and validation processes for innovations, substantial time, and financial investment. He also identified the capital-intensive nature of the sector, which required billions of dollars in development and infrastructure costs and presented hurdles for many companies, start-ups, and entrepreneurs. Additionally, the financial risks associated with developing unproven technologies could deter investment and slow the adoption. Furthermore, existing airport infrastructure and air traffic management systems were not equipped to cater to technologies such as electric and Vertical Take-off and Landing (VTOL) aircraft and the integration of autonomous aircraft. These shortcomings required coordinated efforts between governments, industry stakeholders, and other entities. The speaker also termed true environmental sustainability a major challenge, referring to the hurdles in the development of Sustainable Aviation Fuels (SAFs). Gaining public trust and acceptance via communication and education was crucial for the successful deployment of innovative technologies.

Discussing the potential opportunities in aerospace, Air Marshal Mehmood highlighted that AI, ML and IoT offered opportunities to enhance operational efficiency, optimise flight paths, improve maintenance practices, analyse vast amounts of data, and monitor aircraft systems. He also mentioned the emergence of new business models and market opportunities referring to urban air mobility (UAM) and VTOL aircraft. The

growth of low-cost carriers and digital platforms had already transformed the industry, and continued innovation promised to create new revenue streams and enhance passenger experiences. Increased innovation in aviation could expand global connectivity, open up new markets, and foster economic growth.

Discussing the role of airpower and space, he argued that the next decade promised transformative shifts, influenced heavily by advancements in technology, evolving national security concerns, and economic opportunities. He referred to Electric and Hybrid aircraft by companies like Airbus and Boeing to reduce carbon emissions, improve fuel efficiency, and potentially lower operational costs in the long run. Advancements in autonomous or semi-autonomous flight systems such as drones and unmanned aerial vehicles (UAVs) were expected to grow exponentially. Autonomous flight technologies could enhance safety, reduce human error, and optimise air traffic management. Likewise, the concept of Urban Air Mobility, with electric vertical take-off and landing (eVTOL) aircraft, was being tested for use in urban environments to transform city transportation. Deployment of satellite mega constellations, such as SpaceX's Starlink and Amazon's Project Kuiper, aimed to provide global high-speed internet coverage, enabling more robust connectivity in remote areas. Space tourism was also moving from science fiction to reality, with companies like Virgin Galactic and Blue Origin offering suborbital spaceflights.

Towards the end, Air Marshal Mehmood stressed the importance of enhanced air surveillance technologies, such as advanced radar systems and high-altitude drones, vis-a-vis national security. The ability to monitor and respond to threats more effectively would be essential as geopolitical tensions evolved. He added that nations were investing in advanced air defence systems to protect against emerging threats, including hypersonic missiles and advanced stealth aircraft. Consequently, the development of sophisticated interceptors and missile defence systems would be critical in maintaining air superiority. He also stressed on enhancing space situational awareness (SSA) given congested satellites and debris. Moreover, the development of space-based defence systems, including missile warning satellites and space-based sensors, would be crucial for the early detection of potential threats. Nations might also explore space-based platforms for defensive capabilities and strategic deterrence.

Concluding his talk, Air Marshal Mehmood stated that air and space domains were expected to undergo substantial changes driven by technological innovation, shifting national security priorities, and evolving economic landscapes. Resultantly, he urged developing countries, including Pakistan to recognise and seize the opportunities that the aerospace sector had to offer. He was optimistic about the future of the aerospace industry, characterised by the capacity to innovate and a commitment to meet challenges of a rapidly changing world.

Dr Najam Abbas Naqvi

Chairman, National Center of GIS and Space Applications, Institute of Space Technology

Dr Naqvi began by redefining national security as something broader than just military might and border protection. He argued that national security encompasses various dimensions, including economic stability, disaster preparedness, as well as individual safety and knowledge security. His assertion set the tone for his presentation by emphasising the importance of space technology in modern security frameworks, extending far beyond the confines of traditional military applications.

He pointed out that while military applications of space technologies are well-known, space technologies can also be leveraged to support national security in non-military ways. Earth observation satellites, for example, can be used for agriculture monitoring, environmental assessments, and urban planning - all of which directly affect a nation's resilience and sustainability. This broader, more nuanced understanding of national security provided a foundation for his subsequent discussion of economic opportunities in the space sector.

Dr Naqvi highlighted the rapid growth of satellite technology, noting that as of June 2024, there were over 10,000 active satellites in orbit, two-thirds of which belonged to SpaceX's Starlink constellation. These satellites primarily operate in low Earth orbit (LEO), at altitudes between 400 and 1,200 kilometres. However, he pointed out that with this rapid growth has come a surge in space debris. As of mid-2024, there were approximately 13,326 pieces of debris in orbit, posing a significant threat to the sustainability of space operations. He underscored the need to address this challenge.

Dr Naqvi then went on to categorise satellites into three main types: Earth Observation Satellites, Navigation Satellites, and Communication Satellites. He provided the technical details of these satellite systems, explaining how different altitudes affect speed and functionality of satellites. He noted that these systems are indispensable for everything from logistics and transportation to telecommunications and even everyday activities like food delivery and ride-hailing. Further, he underlined the significance of precise position which is provided by global satellite navigation systems. Navigation is needed in aviation, spacecraft, rocketry, drones, search and rescue, maritime, fisheries, and electrical networks.

Dr Naqvi also highlighted the economic potential of space technologies. He cited the World Economic Forum's April 2024 report, which projects that the global space economy will grow to USD 1.8 trillion by 2035, up from USD 630 billion in 2023 driven by both the technological backbone - such as satellite manufacturing and launch services - and the reach of satellite applications, which are becoming increasingly ubiquitous across industries.

Dr Naqvi noted that the market for satellite applications is expected to grow significantly, with reach portion of the market outpacing the backbone in terms of revenue generation. By 2035, reach is projected to generate USD 756 billion, while the backbone will account for USD 525 billion. He thus stressed that countries like Pakistan should focus on developing applications for satellite technologies, as the cost of launching and manufacturing satellites has decreased, making the sector more accessible than ever before.

The speaker again underscored the crucial role that satellite-based applications can play in boosting national security. He discussed three key pillars that define the intersection of national security and space technology:

1. Disaster Forecasting and Mitigation
2. Humanitarian Response
3. Access to Prosperity

Dr Naqvi argued that space technologies can help bridge the digital divide by providing internet and communication services to underserved communities.

Discussing Pakistan's National Center of GIS and Space Applications (NCGSA) as a case study of academia-industry collaboration, he shared that the Center was established by the Higher Education Commission (HEC) in 2018. It consists of seven labs located across Pakistan, each focused on solving region-specific problems through the use of space-based data. These labs work on a variety of issues, from forest management and geological hazard mitigation to agriculture monitoring and small satellite technology development. He underscored that the success of the Center which produced over 3,000 outputs in four years, demonstrating the potential of academic collaboration to drive innovation in the space sector. Dr Naqvi called for more such initiatives to foster a culture of R&D that can support the growth of space technologies.

Additionally, he pointed to successful international examples, such as MIT's collaboration with Boeing and Stanford's partnership with SpaceX, as models for how universities and private companies can work together to advance space technologies. In Pakistan, he acknowledged that there was still a significant gap between academia and industry but noted that efforts were being made to bridge this divide through initiatives like the NCGSA. Relatedly, Dr Naqvi emphasised that innovation in space technologies often originates in academic institutions, and that it is essential for universities to work closely with industry to translate research into practical applications. He also highlighted the importance of providing financial incentives for research, as funding is often a major barrier to innovation.

Dr Naqvi outlined a set of recommendations for how nations like Pakistan can harness the economic potential of space technologies:

1. **Developing a Specialised Space Workforce**: He stressed the importance of interdisciplinary education, noting that space technologies require expertise in a wide range of fields, from aerospace engineering to computer science. He called for more universities to offer specialised programmes in space science and technology and for greater collaboration between different academic disciplines.
2. **Fostering Collaborative Research Initiatives**: Dr Naqvi recommended that governments and private companies invest in collaborative research initiatives that bring together academia, industry, and research centres. He argued that such collaborations are essential for driving innovation and ensuring that research is translated into practical applications.
3. **Enhancing Space Awareness and Education**: He noted that space science education is severely lacking in Pakistan, with less than 24 pages of content related to space science in the entire K-12 curriculum. He called for more efforts to raise awareness of the importance of space technologies, both in schools and in the general public, to inspire the next generation of scientists and engineers.
4. **Incentivising Innovation**: Dr Naqvi called for the government to provide financial incentives for innovation in the space sector, such as tax benefits for startups and grants for research initiatives. He stressed that without proper funding, it is difficult to encourage innovation and entrepreneurship in space technology. He thus noted that incentivising private sector involvement was crucial, as government sectors often faced bureaucratic hurdles that slow down technological progress.
5. **Establishing Aerospace Innovation Clusters**: The speaker suggested the creation of aerospace innovation clusters to foster collaboration and innovation among different stakeholders in the space technology ecosystem. He cited the National Aerospace Science and Technology Park (NASTP) in Pakistan as a model example, where academia, industry, and government entities come together to drive advancements in aerospace technologies.
6. **Public-Private Partnerships (PPPs)**: Dr Najam strongly advocated for public-private partnerships in the space sector, stating that private companies often have faster decision-making processes than government institutions. By collaborating with the private sector, governments can expedite development and deployment of space technologies, ensuring that these technologies contribute to economic growth and national security.

A critical point that Dr Naqvi made was the need for patience in the development of space technologies. He acknowledged that many stakeholders, particularly those in government, often expect immediate results. However, technological advancements take time, especially when building expertise from the ground up. He emphasised that the development of space technology must start at the grassroots level, beginning

with education in schools and universities, followed by investment in R&D at research institutions, and finally, implementation of these technologies by the industry. He mentioned significant investments in space technology by other countries like India, Saudi Arabia, Peru, and Thailand demonstrating that space technology is a priority for nations beyond the traditional space powers.

Concluding, Dr Naqvi referred to the economic potential of space technologies. He pointed out to the findings of the World Economic Forum's report, which estimates that the space economy will grow to USD 1.8 trillion by 2035. He urged Pakistan to position itself as a key player in this rapidly growing market by focusing on the applications of space technology, particularly in areas like agriculture, disaster management, and telecommunications.

Air Vice Marshal Dr Liaquat Ullah Iqbal

DG Public Relations & Publications,
National Aerospace Science and Technology Park

Air Vice Marshal Dr Liaquat Ullah Iqbal began his presentation by emphasising the intrinsic linkage between aerospace development and national security. He highlighted the evolution of industrialisation, from Industry 1.0 to 5.0, noting that while Pakistan hovered around Industry 3.0, global efforts were already focused on Industry 6.0. This gap raised important questions about how Pakistan could catch up, particularly in the aerospace sector, to make progress in human-centric development.

One of the key points in Dr Iqbal's presentation was the dual-use nature of aerospace technologies. He noted that microchips, navigation devices, and propulsion systems had both military and civilian applications, and it was essential for Pakistan's policymakers to leverage these dual-use technologies. He also stressed that while aerospace was often grouped with defence (A&D), the commercial side of aerospace was vastly more significant, accounting for the bulk of the industry's economic impact. He urged national leaders to shift their focus away from defence-only applications and prioritise commercial aerospace opportunities.

Tracing Pakistan's industrial history, Dr Iqbal discussed how the country had moved through phases of nationalisation, privatisation, and PPPs. He credited early national initiatives like the Pakistan Industrial Development Corporation (PIDC) and the Pakistan Atomic Energy Commission (PAEC) for laying the groundwork for industrial progress but acknowledged the setbacks that came with nationalisation. He maintained that despite these challenges, there had been a resurgence in PPPs, and stressed the importance of continuing to leverage such partnerships to drive growth in the aerospace sector.

Air Vice Marshal Dr Iqbal gave a detailed account of Pakistan's achievements in aerospace, particularly through the efforts of the Pakistan Air Force (PAF). He highlighted establishment of key institutions such as the Pakistan Aeronautical

Complex (PAC) and the Air Weapon Complex, which had made noteworthy contributions to Pakistan's defence capabilities. He further emphasised creation of the PAF Space Force and Cyber Force, which paved the way for PAF's transition into a high-tech air force.

Dr Iqbal reaffirmed that national security was deeply interconnected with the aerospace industry and that Pakistan's progress in this area held vast potential for economic and technological growth. In this regard, he called for continued collaboration between academia, industry, and government to ensure Pakistan's competitiveness in the global aerospace market. He maintained that PAF was working on the mandate accorded by the Founder of Pakistan when he visited the Royal PAF School in 1948. PAF also derived its inspiration from US General Henry Arnold, who stressed the need for innovation and technological integration in air forces. He also paid tribute to M. M. Alam whose legacy continued to inspire generations of PAF officers. In light of these inspirations, establishment of NASTP marked a pivotal moment in the PAF's journey towards self-reliance in aerospace technology.

Air Vice Marshal Dr Iqbal outlined NASTP's role as a central hub for aerospace development in Pakistan, its objectives, including design, research, development, and innovation, along with its aim to connect various stakeholders within the aerospace ecosystem. NASTP's focus on creating 'islands of excellence' and its efforts to establish a Triple Helix Model were highlighted. He also detailed NASTP's infrastructure, including design organisations, certification centres, incubation centres, and training centres. He also discussed the establishment of science and technology parks at different levels, aiming to cover the breadth and depth of Pakistan in four cities: Rawalpindi, Karachi, Lahore and Kharian. NASTP Rawalpindi was the largest in terms of more than 100 technology companies that were being housed there.

Air Vice Marshal Dr Iqbal showcased the significant progress made by NASTP in a short period. He mentioned the establishment of the National Space Cluster at Kamra, the Aerospace Village, and the Air University Aviation Aerospace Campus. He also highlighted the development of industrial parks, design centres, and residential complexes. The address emphasised the collaborations with international partners and the establishment of various regional centres. Notably, an international expo was held successfully with 14 aerospace companies of Türkiye. He went on to deem the President of Azerbaijan's visit as the culmination of our international collaborations.

NASTP also provided a conducive innovation ecosystem for youth to conduct R&D and make headways in the aerospace sector. There was a growing number of institutes in this technology park, which were certified by the European Union Aviation Safety Agency (EASA). He particularly alluded to PPPs in driving NASTP's growth while stating that all forms of PPP were being practised in this technology park.

Dr Iqbal identified four key pillars supporting NASTP's growth: national youth, the private sector, experts in the diaspora, and international collaborations. He discussed the initiatives undertaken to engage with youth, one of them being a young cohort that was graduating from the Incubation Centre. The fostering of private sector participation drove the innovation and financial stimulus needed for R&D. Additionally, he argued that by leveraging the expertise of overseas Pakistanis, NASTP had the potential to grow further in terms of international standards.

Lastly, Air Vice Marshal Dr Iqbal acknowledged the challenges ahead, such as operationalisation, integration, and capacity enhancement. He outlined NASTP's future plans, including the expansion of existing facilities, establishment of new initiatives, and pursuit of international collaborations. He expressed NASTP's commitment to playing a pivotal role in the technological, socioeconomic growth of Pakistan.

Air Marshal Javaid Ahmed (Retd)

President, Centre for Aerospace & Security *Studies, Islamabad*

Concluding Remarks & Vote of Thanks

In his Concluding Remarks and Vote of Thanks, Air Marshal Javaid Ahmed (Retd), President CASS Islamabad, emphasised on the need to evaluate both the positive and negative aspects of technology. He remarked that the Ukraine conflict highlighted how unmanned systems are reshaping modern warfare, while the recent events in Beirut underscored the growing risk of consumer technology weaponisation. He stressed that technology was evolving rapidly; delivering solutions at an unprecedented pace but oversight and regulations remain far behind. President CASS also warned that if the global technological divide between East and West deepens, Pakistan might be forced to make a critical choice. He acknowledged the importance of pockets of excellence in academia and among individuals, advocating for the continued harnessing of these capabilities. In the end, he reflected on the enduring spirit of indigenisation and innovation in the country, which, he asserted, remains key to future progress. He commended the efforts made by PAF for establishing NASTP, which is providing opportunities to the private sector for research and investment in a host of technology domains. In the end, President CASS thanked the speakers for the enriching discussion.

ANNEXURES

1. Profile of Speakers

Air Marshal Zahid Mehmood (Retd)
Former Vice Chief of the Air Staff, Pakistan Air Force

A graduate of National Defence University and Air War College, Air Marshal Zahid Mehmood (Retd) has 36 years' experience of military aviation as a fighter pilot in the Pakistan Air Force. During his service with the PAF, he has held various Command and Staff appointments including Assistant Chief of Air Staff (Plans), Director General C4I, Deputy Chief of Air Staff Personnel, and Vice Chief of Air Staff. He holds Master's Degrees in Strategic Studies and Defence & Strategic Studies. An alumnus of the Harvard Kennedy School for National and International Security (USA), his areas of expertise include National Security with emphasis on traditional security threats and response options; Doctrine, and Policy. He lectures regularly at Pakistan's National Defence University and Air War College on related subjects. He is a recipient of Hilal-i-Imtiaz (Military) for his services to the PAF.

Air Vice Marshal Dr Liaquat Ullah Iqbal
DG Public Relations & Publications, National Aerospace Science and Technology Park

Air Vice Marshal Dr Liaquat Ullah Iqbal is serving as DG Public Relations & Publications National Aerospace Science and Technology Park. As founding CPD and CEO of the project, he had led NASTP from January 2018 to July 2024.He hails from GD (P) Branch of the Pakistan Air Force and was commissioned on 26 June 1994. Prior to commissioning, he attended the US Air Force Academy (USAFA), in Colorado. His research work has been focused on aircraft design, including F-22, UAVs and airships. His academic career includes teaching at the Institute of Avionics and Aeronautics, Air University and as faculty and department head at College of Aeronautical Engineering, National University of Sciences and Technology. Dr Iqbal completed Masters and PhD degrees from School of Aeronautics and Astronautics, Purdue University, USA. He was awarded Sitara-i-Imtiaz (Military) for meritorious services to the country.

Dr Najam Abbas Naqvi

Dr Najam Abbas Naqvi, Chairman, National Center of GIS and Space Applications (NCGSA), Institute of Space Technology

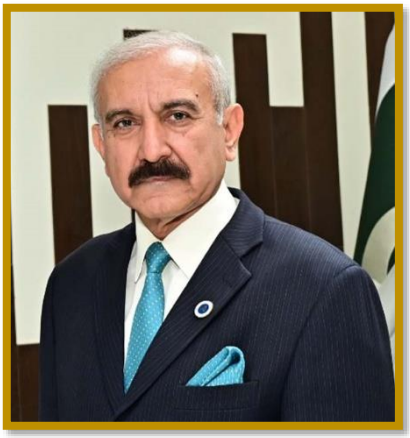
Dr Najam Abbas Naqvi has nearly 25 years of extensive experience in the fields of space science, technology, and education. He completed Bachelor's degree in Electrical Engineering from the University of Engineering and Technology, Lahore, followed by an MS in Electrical Engineering from the National University of Sciences and Technology (NUST), Islamabad. He also obtained a specialised MS in Navigation and Related Applications from Politecnico di Torino, Italy. Dr Naqvi later earned his Doctor of Engineering in Guidance, Navigation & Control from Northwestern Polytechnical University, China. Currently, Dr Naqvi serves as a Deputy Chief Manager at SUPARCO and Professor in the Department of Space Science at the Institute of Space Technology, Islamabad. He also holds the key position of Chairman and Central Project Director at the NCGSA, a project of the Higher Education Commission of Pakistan.

Air Vice Marshal Nasser Wyne (Retd)

Director (Aerospace Warfare), Centre for Aerospace & Security Studies, Islamabad

Air Vice Marshal Nasser Wyne (Retd) joined the Centre for Aerospace & Security Studies, Islamabad as Director in May 2023. Air Vice Marshal Wyne served in the Pakistan Air Force from 1988 to 2021. During his career, he commanded a fighter squadron, Wing, and a Base. He remained on the faculty of Flying Instructors' School (FIS), Combat Commanders' School (CCS), and PAF Air War College (AWC) and has also served as an instructor pilot with the Sri Lankan Air Force. He did National Security and War Course (NSWC) from the National Defence University (NDU) and has also served as Air Attaché at the Pakistan embassy in Beijing, China. His staff appointments include Secretary to Chief of Air Staff, Inspector General Air force (IGAF), and Director General Joint Cantt Gwadar. He is a recipient of Sitara-i-Imtiaz (Military) for his services to the PAF.

Air Marshal Javaid Ahmed (Retd)
President, Centre for Aerospace & Security Studies, Islamabad



Air Marshal Javaid Ahmed (Retd) was appointed President of the Centre for Aerospace & Security Studies, Islamabad on 29 April 2024. Previously, he served as Vice Chancellor of Air University. With a distinguished career spanning approximately 40 years in the Pakistan Air Force (PAF), he has held several critical positions. His roles have included Chairman of the Pakistan Aeronautical Complex (PAC) Kamra, Officer Commanding of the Combat Commanders School, and Chief Project Director of the JF-17 Fighter Aircraft Production Program. He is recognised for his expertise in aerospace development policies, as well as doctrine formulation and implementation strategies. Air Marshal Ahmed is an alumnus of the Air War College, where he graduated in Defense & Strategic Studies. He also holds Master's degree in War Studies from the National Defence University. His skills in command and management are complemented by his advanced knowledge in emerging academic fields. Previously, he also served as Director of Policy and Doctrine at CASS, Islamabad. In recognition of his significant contributions to the Pakistan Air Force, he awarded Tamgha-i-Imtiaz, Sitara-i-Imtiaz, and Hilal-i-Imtiaz (Military).

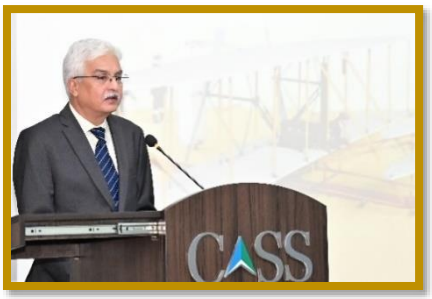
2. Press Release

Experts Urge Strategic Investments in Aerospace Innovations for National Security and Economic Growth at CASS Seminar

24 September 2024

The Centre for Aerospace & Security Studies (CASS), Islamabad, successfully concluded a seminar on the *'Air and Space Technologies: Harnessing the Innovation Economy.'* This event convened distinguished experts from the defence, technology, and academic sectors to discuss strategies for leveraging space and technological advancements to prosper in an innovation-driven economic landscape in Pakistan.

Air Vice Marshal Nasser Wyne (Retd), Director (Aerospace Warfare) at CASS, set the stage for the seminar sharing how the rise of air power in the Twentieth Century transitioned into aerospace power, incorporating space exploration, satellite technology, and autonomous systems. This shift, he stressed, presents strategic opportunities for nations to bypass traditional developmental barriers and capitalise on cutting-edge innovations for both defence and economic growth. Air Vice Marshal Wyne further asserted that the innovation economy, fuelled by the commercialisation of new technologies, was playing a crucial role in this transformation.



In his Keynote Address on *'Future of Air and Space in National Defence and the Global Innovation Economy'*, ***Air Marshal Zahid Mehmood (Retd),*** Former Vice Chief of the Air Staff, Pakistan Air Force, highlighted the evolution of aerospace from a defence-centric industry to a key driver of economic growth and technological innovation. He pointed out that while the sector originated in military needs, it has since expanded to foster commercial aviation, space exploration, and private sector involvement. He asserted that technological advancements in areas like satellite deployment, AI, and space exploration are creating new markets and opportunities globally. To capitalise on these, he emphasised the need for strategic investments and the development of skilled human capital, warning that countries that fail to adapt may fall behind. The Air Marshal also stressed the need for developing countries, like Pakistan, to harness aerospace innovations through strategic investments, technology transfer, and human capital development. He urged policymakers to foster public-private partnerships (PPPs) and invest in building capacity to secure their position in the rapidly evolving aerospace landscape.

In his presentation on *'Space and Technology Nexus: Boosting National Security & Economic Prosperity,'* ***Dr Najam Abbas Naqvi,*** Chairman National Center of GIS and Space Applications, outlined how advancements in satellite technology, earth observation, and global navigation systems are providing innovative solutions for sectors like agriculture, urban planning, and disaster management. Dr Naqvi acknowledged the importance of building a skilled workforce and fostering collaborative research between academia and industry to further leverage these technologies. He urged policymakers to incentivise private sector involvement through funding and tax benefits while advocating for the establishment of aerospace innovation clusters to drive research and commercialisation. Dr Naqvi stressed that leveraging PPPs would be essential in sharing risks and advancing large-scale space projects. He forecasted that with the right strategies in place, Pakistan could position itself to benefit from the growing global space economy, projected to be worth USD 1.8 trillion by 2035.

In his address on *'Aerospace Evolution in Pakistan: Initiatives and Impacts,'* ***Air Vice Marshal Dr Liaquat Ullah Iqbal,*** Director General Public Relations & Publications at the National Aerospace Science and Technology Park (NASTP), outlined the strategic vision behind PAF's flagship initiative. He articulated the critical role of NASTP as the driving force for the Triple Helix Model, highlighting the interconnectedness of the IT, computing, and aerospace industries. Dr Iqbal provided an overview of the various initiatives undertaken under NASTP's infrastructure, which spans five cities, each focusing on distinct domains. He also briefly touched upon the business strategies and future prospects of innovative technologies and their incubation within NASTP. Commending the collaborative efforts of multiple ministries, he emphasised the critical role played by thorough documentation and approvals at various levels in securing the Special Economic Zone (SEZ) status for NASTP. He affirmed that youth development, private sector engagement, diaspora outreach, and international collaborations are essential pillars for NASTP's sustained growth, positioning it as a key player in advancing Pakistan's aerospace sector.

In his *Concluding Remarks* and *Vote of Thanks*, ***Air Marshal Javaid Ahmed (Retd),*** President CASS Islamabad, articulated the need to evaluate both the positive and negative aspects of technology. He remarked that the Ukraine conflict highlighted how unmanned systems are reshaping modern warfare, while the recent events in Beirut underscored the growing risk of consumer technology weaponisation. He stressed that technology was evolving rapidly; delivering solutions at an unprecedented pace but oversight and regulations remain far behind. President CASS also warned that if the global technological divide between East and West deepens, Pakistan might be forced to make a critical choice. He acknowledged Pakistan's pockets of excellence in academia and among individuals, advocating for the continued harnessing of these capabilities. In the end, he reflected on the enduring spirit of indigenisation and innovation in the country, which, he asserted, remains key to future progress.

The seminar was followed by active participation from a diverse audience, including retired military officers, scholars, journalists, and students, who engaged in an interactive question and answer session, enriching the discourse on this critical subject.

3. Social Media Engagement

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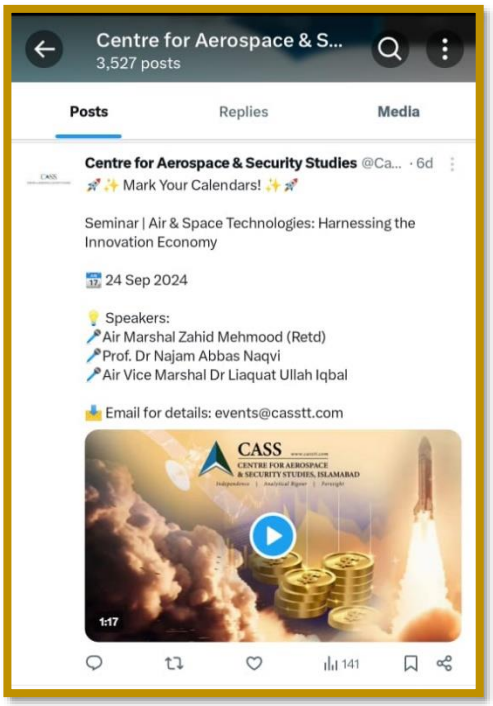

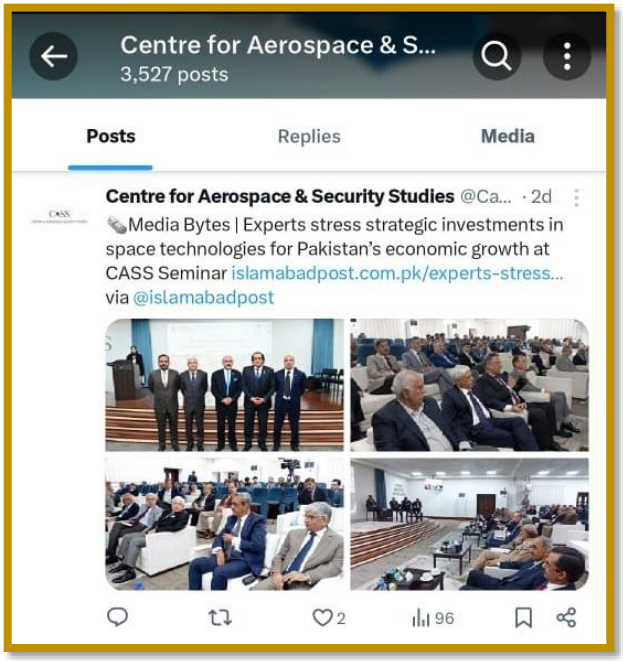

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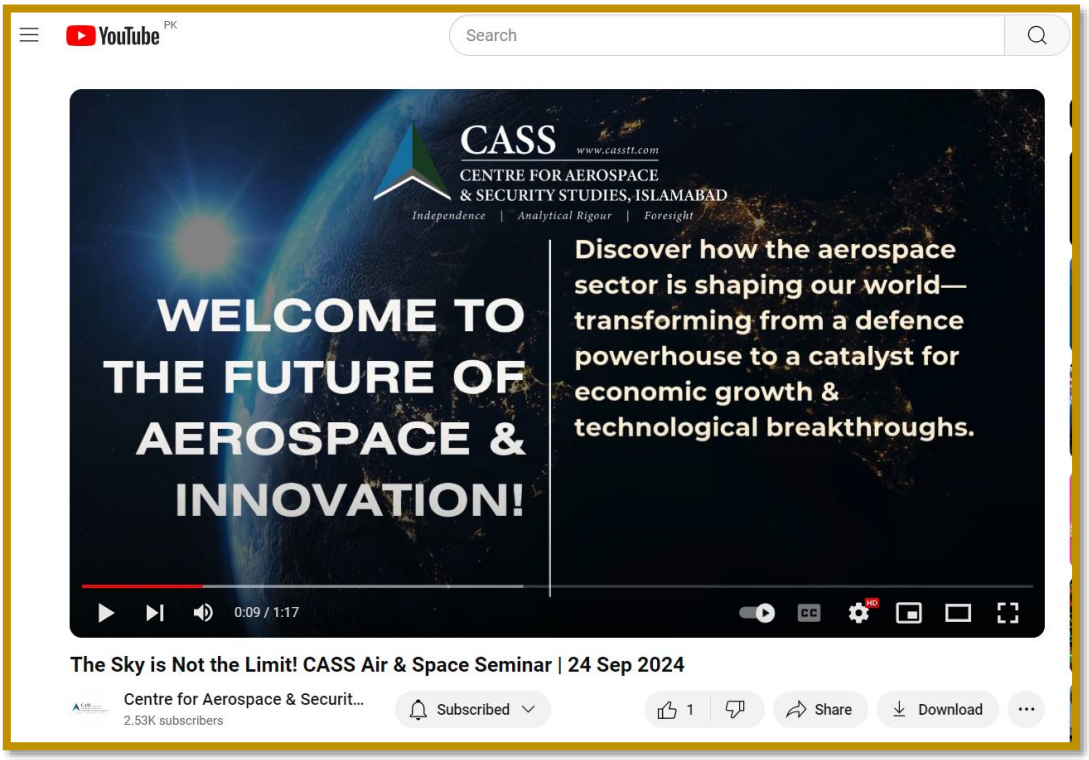
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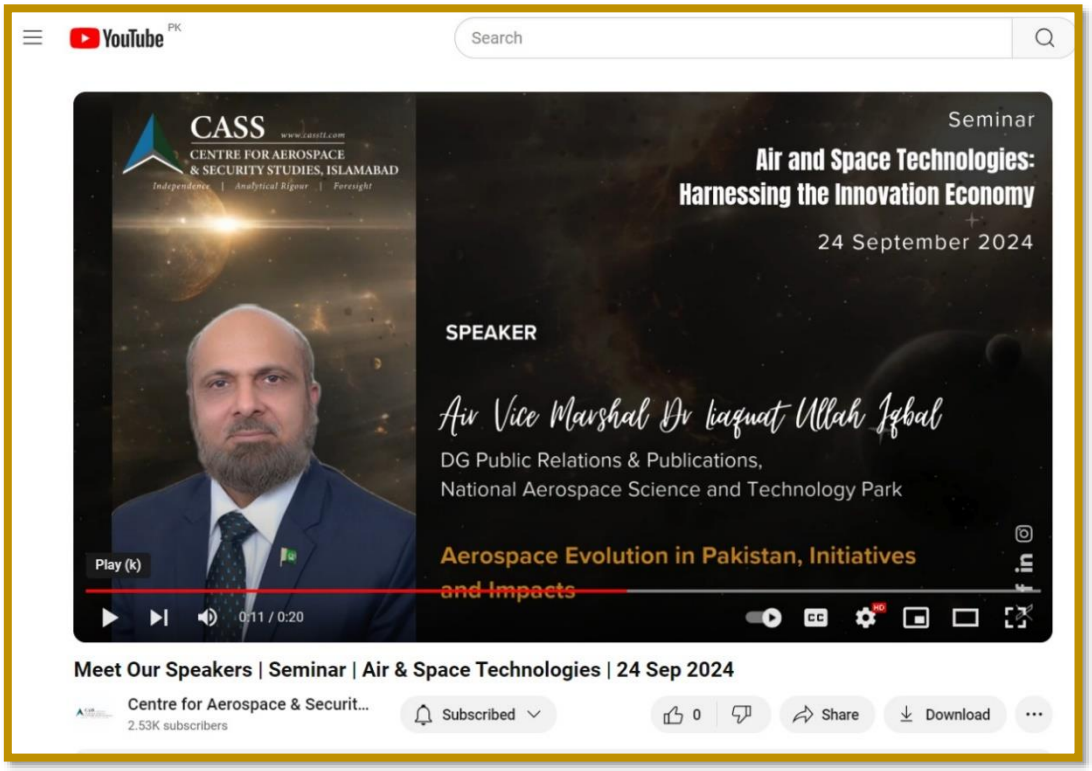
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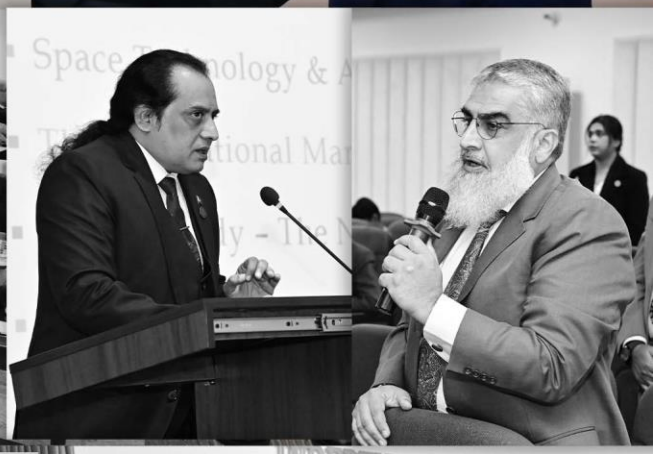
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ABOUT CASS

Established in 2018, the Centre for Aerospace & Security Studies (CASS) in Islamabad is a non-partisan think tank offering future-centric analysis on aerospace and security issues. CASS engages with thought leaders and informs the public through evidence-based research, aiming to influence discussions and policies at the national, regional, and global level, especially concerning airpower, emerging technologies, traditional and non-traditional security.

VISION

To serve as a thought leader in the aerospace and security domains globally, providing thinkers and policymakers with independent, comprehensive and multifaceted insight on aerospace and security issues.

MISSION

To provide independent insight and analysis on aerospace and international security issues, of both an immediate and long-term concern; and to inform the discourse of policymakers, academics, and practitioners through a diverse range of detailed research outputs disseminated through both direct and indirect engagement on a regular basis.

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