Pakistan's most authentic and foremost Aviation and Aerospace magazine

PAKISTAN AIR FORCE

JULY 2021

SECOND to NONE

QUARTERLY

EXCLUSIVE

THUNDER AROUND THE WORLD

ARTIFICIAL INTELLIGENCE
Leading to 4th Industrial Revolution

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Analysing the Potential of 3D Printing

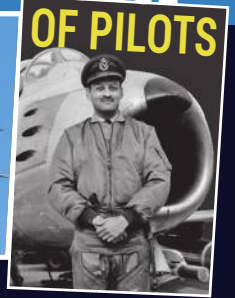
A TRIBUTE TO A WARRIOR
Story of an Unsung PAF Hero

FINEST HOUR
Tale of Defected AN-26

TRYING IT OUT
Story of F-20 Trials by PAF

Where ACES MEET

PRINCE OF PILOTS



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from the Editor-in-Chief

It appears that the menace of COVID-19 is finally losing its grasp and it is a beginning of a new dawn after a long, dark night. Things are finally looking up. Vaccines are being administered, hospitals are being relieved and the death toll has finally slowed down. However, the pandemic has not only changed the way we used to contemplate and tackle challenges but has also disturbed the dynamics of the contemporary world. Global economies have shattered, big businesses have collapsed and the nations are vying to make a fresh start. Fortunately, Pakistan was amongst those nations that handled the pandemic well, a fact which has also been acknowledged by international monitoring bodies. PAF took this spirit a step further, finding ways to keep the work going while taking all necessary precautions. One shining example is PAF's indigenous JF-17 Thunder program. Recently, Nigeria acquired this state-of-the-art aircraft for its air force, a testimony to its ever-increasing demand among the potential buyers. This feat was not achieved overnight. PAF's leadership carefully orchestrated a decade long promotional campaign for JF-17 Thunder across continents and this is what we have taken up in this edition as the lead story. Titled 'Thunder around the World', this special feature is as thrilling as the aerobatics display of 'Thunder' itself.

Another aircraft and its crew from the past that deserves recognition is the Bristol Freighter. With years of infallible service, the work horse and its resilient aircrew has done it all. From dropping supplies in war zones to ridding areas of locust swarms, the Freighter has made a name for itself. However, we know that any aircraft is only as good as the pilot. We have the perfect example for this in the form of legendary Air Cdre FS Hussain. Cheered on by Kings, Queens, premiers and head of states, FS Hussain's daredevil solo aerobatics left millions in awe all over the world. Another individual that deserves recognition but has been lost in the pages of history is Sqn Ldr Muhammad Ashfaq. A fearless airman who put his life on the edge during both the major wars with enemy.

While talking about PAF men and their professionalism, we bring out to you an untold tale never heard before. Narrated by the veteran himself, the story of ferrying the defected Afghan AN-26 aircraft during 1980's would surely enthral our readers. Feats like these cannot be achieved by a few, they require synergy. And while talking of that, the recently held 'ACES Meet' exercise comes to our mind. We give to our readers an in-depth account of the exercise that saw unprecedented collaboration between the participating allied air forces. Of course, any air force is only as good as the man at its helm. PAF has been fortunate in this regard, having a legacy of unsurpassed leadership. This heritage is currently upheld by Air Chief Marshal Zaheer Ahmed Baber Sidhu, who recently led a dazzling flypast on 25 March, initiating the Pakistan Day Parade in all its glory.

Another huge development in the field of emerging technologies which came under our radar, recently, was repair of a battle-damaged 'Saab Gripen' by using additive concepts. The technology has opened up a plethora of options never available before and this is what we have aptly covered in our 'technology watch' section. Another evolving concept which is taking the world by storm is Artificial Intelligence (AI). We shall take a gander at how AI has changed the ball game, where it's headed, how we can take advantage of this advancement and acquire it especially in aerospace industry. Adopting emerging technologies has always remained the top priority of PAF, since long. As always, this was also observed in 1984, when the Cold War was at its peak. We shall delve into the tale of how Pakistan almost acquired the famous F-20 'Tiger shark' from USA and how the decision changed after trials undertaken by AVM Abbas Mirza (Retd).

As we recover from the onslaught of COVID-19, we need to keep our hopes high and look towards a better future. Pakistan is famous for its resilience and resourcefulness. So, keeping that in mind, we have a line-up for you that you will find diverse, interesting and inspiring. If you are able to feel any of these emotions, we would have done our job effectively.

Happy Readings!

Muhammad Ali

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Page Photo: PAF Archives

PAKISTAN AIR FORCE
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AMBASSADOR OF CHINA MEETS AIR CHIEF

On 27 April, 2021, Ambassador of the People's Republic of China, H.E. Mr Nong Rong called on Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force in his office. On his arrival at the Air Headquarters, the distinguished guest was received by the Air Chief. Mr Nong Rong congratulated the Air Chief on assuming command of the PAF and said that Pakistan Air Force would achieve new heights and glory under his inspirational leadership.

The Air Chief expressed his satisfaction on the existing cooperation between PAF and PLAAF, and reiterated his resolve to take this cooperation to new heights. Various matters of mutual interests and bilateral cooperation were also discussed in the meeting.

AMBASSADOR OF UAE CALLS ON AIR CHIEF

On 3 May, 2021, Ambassador of the United Arab Emirates, H.E Hamad Obaid Ibrahim Al-Zaabi, called on Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force in his office.

The visiting dignitary congratulated the Air Chief on assuming command of the PAF. He assured of cooperation and support in all spheres of collaboration between the two countries. The Air Chief said that Pakistan and UAE have strong religious, cultural and historical bonds which are manifested through strong cooperation between UAE Air Force and Pakistan Air Force. Various matters of mutual interests and bilateral cooperation were also discussed in the meeting.

AMBASSADOR OF CZECH REPUBLIC VISITS AHQ

On 7 May, 2021, Ambassador of Czech Republic H.E. Mr. Tomas Smetanka called on Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force in his office. The honourable ambassador congratulated the Air Chief on assuming the command of the PAF.

The visiting dignitary lauded the professionalism of PAF personnel and the exceptional progress made by PAF over the years, especially through indigenization. Air Chief highlighted that both the countries enjoy cordial relations and reiterated his resolve to further enhance the existing bilateral cooperation between the two countries. Both the dignitaries agreed to further enhance and expand mutual cooperation between the two countries.

Various matters of mutual interest and professional cooperation came under discussion during the meeting.

AMBASSADOR OF TURKEY CALLS ON AIR CHIEF

On 7 May, 2021, Turkish Ambassador H.E. Ihsan Mustafa Yurdakul called on Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force in his office. The honourable ambassador congratulated the Air Chief on assuming the command of the PAF. During the meeting, both the dignitaries discussed matters of professional and mutual interests.

Ambassador H.E. Ihsan Mustafa Yurdakul commended the professionalism of PAF and said that people of both countries have long lasting bond of brotherhood which is augmented by common religion and culture.

Air Chief highlighted that both the countries have always stood alongside each other, no matter how crucial the situation was. He further said, "Turkey is one of the few countries that has unequivocally supported Pakistan". The Air Chief also assured that Air Forces of both the countries would continue mutual cooperation in every field.

NIGERIA INDUCTS 3 JF-17 AIRCRAFT

On 21 May, 2021, Pakistan Aeronautical Complex Kamra, formally handed over 03 JF-17 Thunder aircraft to Nigerian Air Force, during a graceful ceremony held at Nigerian Air Force Base, Makudri to mark the 57th anniversary of Nigerian Air Force. Minister of Defence of Nigeria Maj Gen (Rtd) Bashir Magashi was the Guest of Honour representing the President, at the occasion, whereas Air Marshal Syed Noman Ali, Vice Chief of the Air Staff, Pakistan Air Force was invited to attend the ceremony as special guest of Nigerian Air Force.

Expressing his views at the occasion, Air Marshal Syed Noman Ali said that today's event was not only a historical landmark for Pakistan's JF-17 program but was also a reflection of strong military cooperation and mutual trust between Nigeria and Pakistan. He further said that the JF-17 aircraft with its unique fighting capabilities would prove to be a potent platform in addressing the security requirements of Nigeria. He also assured that Pakistan Air Force and Pakistan Aeronautical Complex would continue to provide all out support to Nigerian Air Force in meeting all its requirements.

PAF PRESENTS CEREMONIAL AIR ESCORT TO THE PRESIDENT OF THE REPUBLIC OF TAJIKSTAN

On 2 June, 2021, as a gesture of hospitality and brotherhood, a contingent of JF-17 Thunder aircraft from No 18 Squadron of Pakistan Air Force presented ceremonial air escort to the President of the Republic of Tajikistan, H.E. Mr Emomali Rahmon as his VVIP aircraft entered the Pakistan Air Space. The JF-17 formation leader extended greetings to the dignitary. H.E. Mr Emomali Rahmon reciprocated the same and thanked the formation leader.

CHIEF OF THE NAVAL STAFF CALLS ON AIR CHIEF

On 11 June, 2021, Chief of the Naval Staff Admiral Muhammad Amjad Khan Niazi, called on Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force at Air Headquarters, Islamabad.

Both the Services Chiefs reiterated to further augment the existing synergy between the two services and take it to new heights.

The Air Chief lauded various indigenous projects being undertaken by Pakistan Navy in the recent years, which have transformed it into a potent force.

The Chief of the Naval Staff acknowledged PAF's support to Pakistan Navy in strengthening the maritime defence of the country. Various matters pertaining to regional security and mutual interest were also discussed during the meeting.

CHIEF OF AIR STAFF, PAKISTAN AIR FORCE VISITS COMMAND AND STAFF COLLEGE QUETTA

On 3 June, 2021, Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force visited Command and Staff College, Quetta. Addressing the course participants at the College, the Air Chief said that in contemporary warfare, air power had become the most effective element of military power. He added that a deeper and clear understanding of its application along with associated challenges and advantages was essential for joint operations planning and execution. Referring to the regional geo-political environment, the Air Chief said that the PAF was fully cognizant of the security challenges and was actively pursuing its operational development plans. He further added that PAF attaches utmost importance to operational preparedness and remains ready to respond to any challenge to the national security of Pakistan. In his concluding remarks, the Air Chief said that for all of us in uniform, to remain operationally ready at all times, is not a matter of choice; but a mandatory obligation to this country and its citizens.

PARTICIPANTS OF NATIONAL SECURITY WORKSHOP BALOCHISTAN VISIT AHQ

On 7 July, 2021, the participants of National Security Workshop, Balochistan visited Air Headquarters, Islamabad. The visiting members from the 7th chapter of this workshop included parliamentarians, tribal elders, religious scholars, political figures, notables, bureaucrats, educationists, lawyers and members of civil society. The visiting guests were given a briefing on "Organization of PAF and nature of its operations."

Interacting with the participants, the Air Chief said that the prosperity of Pakistan greatly depends upon the development of Balochistan. He further said that PAF along with other state institutions was taking all necessary measures to bring the Balochi youth in the mainstream for the progress of the country. The Air Chief also said that "PAF is evolving to cater for the technological intensity and innovation in future air warfare."

CHIEF OF THE AIR STAFF ADDRESSES AT PAKISTAN NAVY WAR COLLEGE

On 17 June, 2020, Chief of the Air Staff Air Chief Marshal Zaheer Ahmed Baber Sidhu addressed the course members and faculty of 50th PN Staff Course at Pakistan Navy War College (PNWC), Lahore.

While addressing the audience, Air Chief appreciated the quality academic stimulus and level of training imparted at Pakistan Navy War College.

Chief of the Air Staff also commended Pakistan Navy's valuable services to safeguard the maritime frontiers of the country. Speaking on prevailing security challenges and technological advancements, the Air Chief expressed his confidence in the combat potential of Pakistan Armed Forces. He emphasized that our Armed Forces remain poised to defend the territorial integrity and sovereignty of the nation. Chief of Air Staff appraised that Pakistan Air Force is a professional force having capacity to timely respond to any nefarious design against the country.

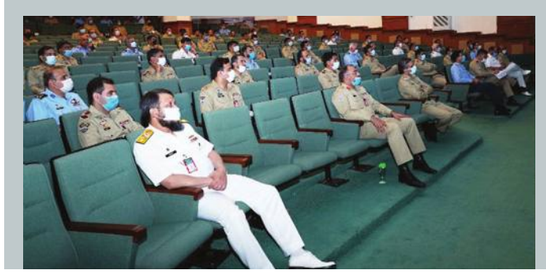
Earlier on his arrival at PNWC, Chief of the Air Staff was received by Commandant Pakistan Navy War College, Rear Admiral Muhammad Zubair Shafique.

AIR CHIEF VISITS NATIONAL DEFENCE UNIVERSITY

On 24 June, 2021, Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force visited National Defence University, Islamabad to address the course participants.

While addressing the audience, the Air Chief appreciated the quality academic stimulus and level of training imparted at National Defence University.

Speaking on prevailing security challenges and technological advancements, the Air Chief expressed his confidence in the combat potential of Pakistan Armed Forces. He emphasized that our Armed Forces always remained poised to defend the territorial integrity and sovereignty of the nation. "PAF is a professional force having capacity to timely respond to any nefarious design against the country," said the Air Chief.



Later on, Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force interacted with the course participants.

AIR CHIEF AWARDED WITH TURKISH LEGION OF MERIT

On 29 June, 2021, Air Chief Marshal Zaheer Ahmed Baber Sidhu, called on Commander Turkish Air Force, General Hasan KÜÇÜKAKYÜZ. Both the commanders held detailed discussion on enhancing collaboration and exchanging expertise between the air forces of the two countries to meet the challenges of the contemporary world. The discussion also included exchange & training of pilots between PAF and TuAF.

Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force and Chief of the Turkish General Staff General Yaşar GÜLER,

CAS, PAF addressing during the award ceremony.

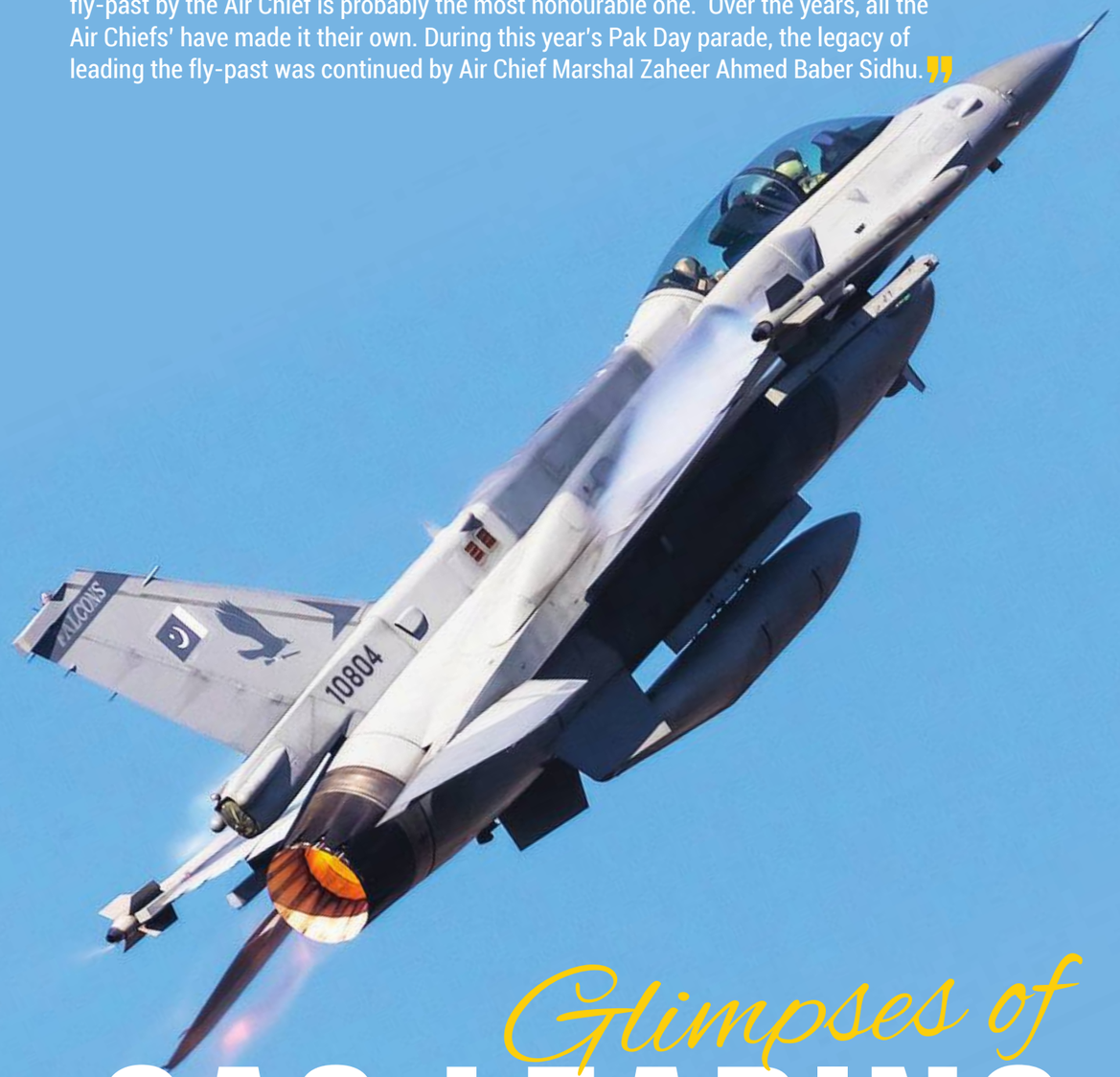
Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force was also awarded Legion of Merit of Turkish Armed Forces in recognition of his outstanding services for promotion of collaboration and ties between the two air forces. General Hasan KÜÇÜKAKYÜZ, Commander Turkish Air Force, presented the medal.

CAS, PAF WITNESSED EX "ANATOLIAN EAGLE-2021"

On 30 June, 2021, Air Chief Marshal Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, Pakistan Air Force visited the 3rd Main Jet Base in Konya, Turkey to review the multi-national air exercise Anatolian Eagle-2021.

The Air Chief was given a detailed briefing about the conduct of the Exercise. While interacting with the participants, the Air Chief praised the operational readiness and professionalism of the participating aircrew. He also underscored the significance of training in air operations for synergetic and effective employment of assets in a real scenario. He further said, "Such exercises contribute immensely in achieving greater synergy and cooperation amongst friendly forces." Pakistan Air Force is also participating in the exercise along with various other air forces.

"Like many prestigious traditions that PAF still carries to this day, leading of Pak Day fly-past by the Air Chief is probably the most honourable one. Over the years, all the Air Chiefs' have made it their own. During this year's Pak Day parade, the legacy of leading the fly-past was continued by Air Chief Marshal Zaheer Ahmed Baber Sidhu."



Glimpses of CAS LEADING THE FLY-PAST 2021

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1: Air Chief Marshal (ACM) Zaheer Ahmed Baber Sidhu, Chief of the Air Staff, PAF in the cockpit of F-16 D Block-52 aircraft.

2: Air Chief gearing up for the mission.

3: Air Chief carrying out the preflight inspection.

4: Air Chief arrived at the base a night earlier to lead the fly-past on 25 March, 2021. During his visit he met the ground crew at a PAF operational air base.

Title Photo: Air Chief's F-16 D Block-52 over the parade venue during Pak Day Fly-Past, 2021. (Photo: Snappers Crew).

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1: Another view of Air Chief's aircraft over the parade venue. (Photo: Awais Lali).

2: ACM Zaheer Ahmed Baber Sidhu salutes back the PAF personnel while taxiing out for the mission.

3: Air Chief leading the prayers for a safe and prosperous future of the nation.

4: Air Chief performing last minutes checks before taxiing out for the mission.

5: ACM Zaheer Ahmed Baber Sidhu along with AVM Zafar Aslam, AOC CAC, arriving at No 9 Sqn.

6: Air Chief takes-off and heads towards the parade venue.

(All Photos PAF Archives unless specified).

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Around the World

For over a decade, 'Pride of the Nation' JF-17 Thunder has stunned the world with its 'Thundery' aerobatic displays at major international air shows. Seen in the title illustration is a PAF JF-17 Thunder in its standard green livery performing at Radom Air Show, 2018. (Photo: Andrzej Rejter).

"Aptly named the 'Pride of the Nation', JF-17 Thunder has proven its mettle not only in Pakistan, but all over the world. With its thunderous performances in air shows all over the world, JF-17 has mesmerized thousands. This is the tale of this amazing aircraft and its equally enthralling pilots who proudly carry the 'Green' across continents."

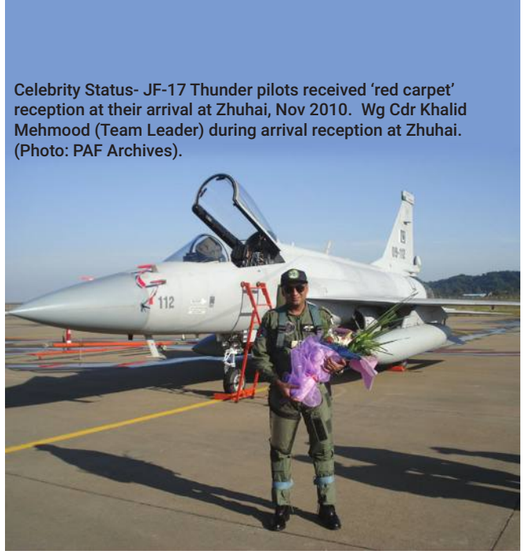
by Air Cdre Muhammad Ali, SI (M) (Retd)

Cleared for take-off, Wg Cdr Khalid Mehmood (OC No 26 MR Sqn) lights all the stages of the afterburner and his JF-17 Thunder screamed down the runway. Its power like you've never felt before. No one had seen the JF-17 performance in an aerial display in an International Air Show and many did not know what to expect. The Thunder's reputation and most importantly Pakistan's Pride was at stake. Wg Cdr Khalid Mehmood felt the pressure of not just his Air Chief would be watching anxiously but of the keen eyes of air chiefs' from around the world who had come to the Zhuhai Air Show 2010. The JF-17 aircraft had come a long way in a short period since it was inducted into service in 2007. The PAF had put everything into it. It was time to show the world what Pakistan's next generation fighter looked like.

Cleared for Take-Off

Fraction of a second after getting airborne and without cleaning up the landing gears, he pulled back on the control stick and banked left sharply, sending the jet into a turn just after liftoff, followed by the climb. With thousands of pounds of deafening thrust, Wg Cdr Khalid Mehmood leapt into the air, in a heart-in-throat manoeuvre where it looked as if the pilot had lost control and the aircraft wing had hit the runway. Everyone in the audience was on edge, they had not witnessed such a feat in their lives before. What they didn't know that this was Thunder's signature manoeuvre, well-crafted to leave the audience spell bound at the very beginning of the demo. Since then, it has become the Thunder's signature manoeuvre at most air shows around the world. With the sensational take-off, Wg Cdr Khalid Mehmood had guaranteed one thing to the audience. They were in for one wild ride at breakneck speeds. What followed were sharp 90 degrees banks, brutal 180 turns, aileron rolls, snapping 6Gs to 8Gs in seconds, his heart fighting to keep the blood flow upstairs, the inverted fly past, barrel rolls and Cuban 8s, with a finale the vertical roll. The Thunder was in one of its natural habitats. At Zhuhai

Wg Cdr Khalid Mehmood waves to the cheering crowd after JF-17's maiden performance at Zhuhai International Air Show, Nov 2010. (Photo: PAF Archives).



Celebrity Status- JF-17 Thunder pilots received 'red carpet' reception at their arrival at Zhuhai, Nov 2010. Wg Cdr Khalid Mehmood (Team Leader) during arrival reception at Zhuhai. (Photo: PAF Archives).

Air Show-2010 it was a flying start, the performance of JF-17 surpassed all expectations and Chinese media dubbed Wg Cdr Khalid Mehmood as 'Asian Thunder'. It was show stealer and then on, there was no turning back.

Behind the Scenes

With its fleet now aging, the JF-17 was the PAF's answer for the next in line for the throne. Flying into the future, the Thunder had been on the forefront of PAF operations. With its debut performance at Pakistan Day Parade in 2007, JF-17 Thunder righteously claimed the 'Pride of the Nation' status among the Pakistani nation. In year 2010, PAF decided to showcase the aircraft at an International Forum and that's how JF-17 appeared in Farnborough Air Show at England as 'Thunder from the East'. In this air show, the challenge was the marathon ferry flight of under qualification 'Thunder' to England while flying over two continents. Handling logistics for such a long flight and in different countries was not an easy task. Soon a group of passionate pilots, engineers, technicians was detailed under Wg Cdr Khalid Mehmood to plan the entire ferry route in its minutest of details. Seldom PAF has conducted such an epic flight of fighter aircraft that included flying over deserts of Middle East, scenic views of Turkey / Europe and crossing the English Channel in last leg from Italy to UK. Aircraft tail No 10-113 piloted by Wg Cdr Khalid Mehmood was first to land at Farnborough at 1430 hrs on 16 July' 2010 followed by aircraft tail No 10-114 flown by Sqn Ldr Azkaar ul Hasnain. For the disappointment of many aviation enthusiasts, Thunder remained on static display (as planned) for the entire show displaying its lethal arsenal and sleek design. Although the news was dominated by big beasts, the international media also especially focused on the debutant, Made in Pakistan JF-17 Thunder, as the 'New Kid on the Block'. From then on, the Thunder was going places, becoming centre of attraction in shows in China, Turkey, Middle East, Europe, etc. In November 2010, PAF decided to feature the Thunder in static as well as aerial displays in Zhuhai Air Show in China.

> Technologically a leap above legacy aircraft, the JF-17 Thunder, is not just any fighter jet. It is a judgment day weapon that has already proved its worth in recent conflict with the adversary.

The task of entering the JF-17 Thunder for aerobatics demonstration

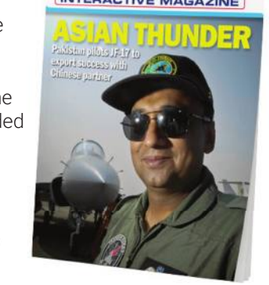
Taking a Break- JF-17 Thunders making a refuelling stop at a Chinese airport during their marathon ferry flight to Zhuhai, Nov 2010. Seen in cockpits are Wg Cdr Khalid Mehmood and Sqn Ldr Azkar ul Hasnain. (Photo: PAF Archives).

Top: 'Turning and Burning'- Wg Cdr Khalid Mehmood takes-off for his maiden performance at Zhuhai Air Show, Nov 2010. (Photo: PAF Archives).

Right: Where it All Started- JF-17 participating in the static display category (only) at the Farnborough air show, June 2010. It was JF-17's first appearance at any international event. (Photo: PAF Archives).

at the international air show was enormous. Before leaving for Zhuhai, the PAF high ups had left everything to Wg Cdr Khalid Mehmood and his team to decide, to put together an aerial demo of a dozen or so manoeuvres that showed off the Thunder's incredible handling. "Air Staff showed full confidence in me and my team which not only boosted our morale but also motivated us to deliver our best. I started by asking myself a question, how the first aerial display of JF-17 Thunder should look like. Being a visitor to air show in the past, I exactly knew the expectations of aviation enthusiasts and general public," Khalid Mehmood remembers. Being among the pioneering JF-17 pilots, he knew well the strengths and weaknesses of the platform.

Moreover, he was also aware of the toll these manoeuvres could have on the human body during an aerial display. His team had to plan immaculately and there was no room for a mistake or error. "From F-16s to Grippen and Russian to European aircraft, I started watching dozens of videos of these famous display aircraft. Soon it dawned upon me that we needed to have a signature manoeuvre for Thunder, and this is how we came up with



Team Leader, Wg Cdr Khalid Mehmood remained in the spot light of international media during Zhuhai Air Show, Nov 2010. (Photo: Chinese Media).

A bird eye view of JF-17s parked at Farnborough, June 2010. (Photo: PAF Archives).

Wg Cdr Usman Ali and Sqn Ldr Yaser Mudasser were the two display pilots at the Paris Air Show-2015. (Photo: PAF Archives).

'History in the Making'

The first JF-17 prototype aircraft (called FC-1) was rolled out in May 2003. It made its first flight in August 2003. Later on, two more prototype aircraft were added for basic structure, flight qualities, performance and engine flight testing while two prototype aircraft were involved in comprehensive avionics flight testing. The basic flight testing was completed in 2007 which also marked the arrival of JF-17 Thunder aircraft in Pakistan where it was formally presented to the nation as a Pakistan Day gift on 23 March 2007. Wg Cdr Ahsan Rafique (now AVM) had the honour of being the first PAF pilot to perform on this historic day. Beautifully painted in the colours of Pakistan and China, the JF-17 Thunder (Tail No 101) stole the show and left the audience spell bound with its maiden 'Thundery' performance at the national level. Soon, the country's first-ever indigenous aircraft claimed the title of 'Pride of the Nation'.

Painted in the colours of Pak-China flags, JF-17 prepares for its maiden flight for display at Pakistan Day Parade-2007. (Photo: PAF Archives).

the idea of manoeuvres like 'Thunder Take-off' and in that lift-off to 10 feet, sharp turn followed by pull up just after take-off with gears still down," recollects Khalid Mehmood. Slowly and gradually the team finalised the display routine on papers. Next thing was going up in the air. The manoeuvres were first flown at 10,000 feet, then at 5,000 feet and then going down in the intervals of 1000 feet before finally practicing them at 500 feet. For that a team of two pilots, Wg Cdr Khalid Mehmood and Sqn Azkaar were selected and both practiced the aerobatic sequence. After numerous trials, final display sequence was locked and was approved by the Air Headquarters.

Next up was the preparation of ferry flight to Zhuhai China. This time it was not that big a challenge as the team had the experience of ferrying the JF-17 to UK. However, PAF has not conducted such classic flight that included crossing over the majestic Karakoram and the Himalayas, some of the toughest terrain on earth and halfway across into south China, with layovers at various Chinese airfields to rest and refuel. It was an uphill task that needed not only extraordinary efforts but also a sound and meticulous planning.

In the backdrop of World's tallest sky scrappers, JF-17 Thunder getting ready to stun the aviation enthusiasts at Dubai Air Show, Nov 2013. (Photo: PAF Archives).

Wg Cdr Khalid Mehmood takes off for a Thundery performance during Turkish Air Force's centenary celebration held at Izmir, June, 2011. (Photo: Carl Brent)

Two C-130 Hercules aircraft of No 6 Sqn were tasked to carry the engineers, technicians and logistics support equipment to escort the three-ship Thunder formation to Zhuhai, China. It was a high stakes adventure but with higher rewards. The tiring journey was soon forgotten when the pilots landed and stepped into the limelight. The red carpet reception and the vibe was incredible as the Thunder pilots were treated as celebrities.

Five days at Zhuhai saw JF-17 Thunder reputation sky-rocket to unimaginable levels. Wg Cdr Khalid Mehmood and Sqn Ldr Azkar ul Hasnain flew in tandem every day during the show. Chinese national and international media exploded with the news of JF-17s 'Thundery' performances, the demo pilots became the talk of the town and major newspapers covered the stories on their front pages. Potential buyers also showed keen interest as they all knew that this promising aerial platform was here to stay and would compete with its rivals in a big way. Thunder's maiden performance at an international forum was not only a great success but also gave confidence to PAF leadership to send it around the world in future.

Resultantly, June 2011 saw a team of JF-17 Thunder including Wg Cdr Khalid Mehmood and Wg Cdr Ronald Afzal to participate in centenary celebrations of Turkish Air Force held at Izmir. The hosts had especially requested the PAF Leadership to send Thunder to be part of these historical celebrations. Thunder and its demo pilots lived up to their enviable reputation and captured the limelight especially among the European media. Flying in tandem with the aerial display of famous

Piercing the Skies- JF-17 performance left the spectators mesmerized during Zhuhai, show, Nov 2016.. (Photo: Snappers Crew).

'Turk Solo', Thunder's display was a treat to watch.

Carrying the Flag Around

By now, the Thunder had developed a enviable reputation as a state-of-the-art modern aircraft, supremely agile, robust, and able to tolerate admirable level of stress. Internationally, it emerged as a most lucrative aerial platform for air forces in need of upgrading their ageing 3rd generation fleet of fighter aircraft. Back at home, the first batch of 50 aircraft was ready to be delivered to PAF which also emerged as the headline news among the international media. At the same time, aerial displays at China and Turkey had greatly enhanced its reputation around the world and the organisers of major air shows were keen to invite Thunder for its aerial performances. This led to Thunders first ever participation in one of the world's largest air shows, the Dubai Air Show. Wg Cdr Ronald Afzal along with Sqn Ldr Yaser Mudasser were selected to perform at Dubai Air Show that was held in November 2013. "Whatever is done is done. If you did well in past, it is history. Every day is a new day and you have to start it all over again, it is as simple as that. The pressure was enormous as we were performing for the first time in Middle-east, in a completely new set of climate and environment, however, all went as planned," reminisces Sqn Ldr Yaser Mudasser. Flying side by side with world's best,

Top: JF-17, piloted by Wg Cdr Khalid Mehmood, arriving at Farnborough, June 2010. (Photo: Global Aviation Resource).

Left: Wg Cdr Usman Ali thrilled the European audience with his signature 'thunder turn' manoeuvre during Paris Air Show, June 2015. (Photo: PAF Archives).

Bottom: The Team-PAF's contingent during Paris Air Show, June 2015. (Photo: PAF Archives).

Top: 'Because I was Inverted'- Wg Cdr Usman Ali takes a good look at the city suburbs while he prepares to align his Thunder for the next manoeuvre. (Photo: PAF Archives).

Right Bottom: Like a Rocket-JF-17 Thunder takes off during Zhuhai Air Show, Nov 2016. (Photo: Lihutao).

Thunder proved equal to the task and made a mark during the entire show. Once again, its performance remained under the radar of many potential buyers and aviation enthusiasts alike.

Thunder over Paris

Proving its mettle across Asia, it was time for the Thunder to move on to European skies. In 2015, the organisers of the renowned Paris Air Show sent a special invitation to PAF leadership to send JF-17 to participate in static as well as aerobatic displays.

That year's Paris Air Show was unique. Unlike previous years, this year there were only two fighter jets participating in the category of solo aerobatics display: France's Dassault Rafale and 'Pride of Pakistan' JF-17 Thunder.

Although, the format of the air shows is in no way meant to declare a winner or loser, however, this year's air show focused all its attention on these two key players. Dassault Rafale had been participating and displaying its strength in various previous air shows. However, it was JF-17s maiden performance in the European skies, taking the stakes for PAF pilots to new heights. "It was a great honour for me and my team to perform for the first time in European skies. PAF leadership had showed full confidence in me and my team, now it was time for us to deliver, that too, in the most befitting manner," reminisces Air Cdre Usman Ali (then Wg Cdr), who was leading the JF-17 demo team at the show.

On the first day, Rafale went about its climbs, loops and dives in a routine manner having performed the same manoeuvres at previous Paris and other shows in the Middle-East and Asia. As for the Thunder, it was a proud moment for the circuit's youngest racer. "Thunder -1, you are cleared for take-off," the words Wg Cdr Usman Ali had been waiting to hear from the control tower. He pushed the JF-17 to the max, diving into the famous 'Thunder Turn'. He's hit with a crushing force of eight times his body weight but it's his favourite manoeuvre, one that is indicative of the jet's full potential. Max turns, half Cuban 8s, solid pull-ups without the Gs easing off, Usman pushed the aircraft to its limit and the jet didn't even break a sweat.

Thunder has made the history and made it in style. As the demo finished and the aircraft touched down on Paris Le Bourget runway, it was already a star. It had stolen not only the hearts of the aviation enthusiasts but also the lime light of the international media. Instantaneously, Thunder's maiden demo performance made to the headlines of major newspapers, TV channels and famous social media sites. Interestingly, JF-17 Thunder was not the only one which stole the limelight, Sqn Ldr Yaser Mudasser earned rockstar status for his uncanny resemblance with the Top Gun film hero, Tom Cruise. Earlier during the ferry flight from Pakistan, his picture with PAF JF-17 Thunder had gone viral on the social media, making him a celebrity over night.

"It was our show. We were done. Another season in the books," said Wg Cdr Usman Ali with a grin.

Another scintillating performance at Zhuhai, Nov 2010. (Photo: PAF Archives).

PAF contingent arriving to participate in Paris Air Show 2019. (Photo: PAF Archives).

All About Team Work- 'Ground Crew' play an important role in keeping the Thunder perform at its best. PAF ground crew enjoying lighter moments after a long day's work at Paris Air Show-2019. (Photo: PAF Archives).

Back to Zhuhai

For next couple of years, duo of Wg Cdr Yaser Mudasser and Wg Cdr Zeeshan Baryar was selected to take Thunder around the world, especially at Zhuhai in 2016 and Dubai in 2017. For Yaser Mudasser, it was his first appearance at Zhuhai. However, more than the Paris air show he enjoyed demo flying at Zhuhai. "In Paris there are altitude restrictions, cannot do vertical rolls and busting the crowd line means immediate disqualification. At Zhuhai, pilots can go big on manoeuvres, you have more liberty to exhibit the aircraft's true potential," he added. Xiaolong (Chinese name for JF-17 Thunder meaning fierce dragon) was coming back to its natural habitat after six long years. The Chinese spectators were desperately waiting for their beloved 'Fierce Dragon' to perform over the coastal city, a few hour drive from bustling Hong Kong. "Solo aerobatic flying is all about pilot's skills, razor-sharp intelligence and swift reflexes. It takes high degree of professional skills required to operate those fighter planes in that limited six and a half minutes flight demo packed with display of all-available tricks of the trade," said Wg Cdr Yaser Mudasser. Therefore saying that the selection criteria in the PAF for demo flying is strict, is an understatement.

Wg Cdr Yaser Mudasser, who has been part of the Thunder demo team for quite some time, explained that aerobatic flying demanded the best of both the aircraft and the pilot. While the aircraft must be highly manoeuvrable, tolerant of G loads, the pilot must also possess matching skills and enduring physiological/ physical stamina. That's why it's mandatory for the pilots to follow a strict physical exercise routine, prescribed sleep cycle and selective diet schedule.

May this Crescent and Star always fly higher and higher- JF-17 performs at Paris Air Show, June 2019. (Photo: Awais Lali).

As envisaged, Xiaolong once again came up to the expectation of general public, not to mention the keenness which the potential buyers showed during their visits to various forums including presentations, static display areas and flight simulator.

Radom 2018

Cordial and friendly relations between Pakistan and Poland has always been matter of pride for the two nations, especially the two air forces. The history of these enviable relations dates back to 1947, when a handful of polish aviators led by legendary Air Cdre Turowicz helped the then nascent RPAF stand on its own feet. The Pakistani nation has not forgotten it and has always reciprocated the same whenever the need arose. What can be a better opportunity for the Thunder then to participate in 100 years celebrations of Polish Air Force held at Radom in 2018? Receiving a special invitation from the Polish comrades, the PAF contingent under Sqn Ldr Zeeshan Baryar left for Radom in August. Sqn Ldr Sibtain Akhtar was the other pilot selected for the demo team. Realising the importance of the event, military forces of eight countries dispatched their demo teams to Radom. Throughout the event, the skies over Radom remained coloured with the smokes of world's best aerobatic teams, Frecce Tricolori, Patrouille Suisse, Midnight Hawks and Turkish Stars, just to name a few. JF-17 thunder participated alongside some of the big names including Su-27, Gripen, F-16, and F-18s. However, painted in all green with Pakistan crescent and star as its livery, JF-17 Thunder remained the star of the show and gave aircraft spotters a great chance to run for their money.

Getting ready for piercing the skies over Dubai, Nov 2017. (Photo: PAF Archives).

"It has been a real matter of pride to fly the all green Pakistani flag painted Thunder in foreign skies, you can't ask for a better chance, that's what I believe," reminisces Sqn Ldr Zeeshan Baryar, who buzzed the Radom air space with his spectacular aerial display. Another thing that gave an extra edge to JF-17 was its performance in European skies after a break of three years. It was worth a wait for the aviation enthusiasts as they enjoyed every bit of Thunder's thundery performance.

Besides racing low level knife-edge high G manoeuvres on the turns and pull ups, Baryar's favourite was the high alpha pass, when a pilot slowed the jet to almost its stall speed. "There is no margin for error and it's a manoeuvre that's dramatic with the white puffy smoke trailing and no chance of recovery if something goes wrong at 300 feet," he said, explaining the romance of combining risk and awareness to do something spectacular.

"JF-17 is an incredible jet, much more forgiving and easy to operate than its predecessors, thanks to its state-of-the-art avionics and aerodynamic design. You can have a bad day and the plane will still do well," recalls Sqn Ldr Sibtain Akhtar.

"It's modern, sleek, and agile. It attracts the attention of the air forces, potential buyers from around the world. To them it is surprising that Pakistan can develop such a high quality

Top: Zhuhai, 2016-JF-17 sits at the tarmac after arrival from Pakistan. J-10s of 'Ba Yi' Chinese Aerobatics Team seen in the background. (Photo: PAF Archives).

Centre: JF-17 Thunder from 'Black Panthers' rests in the tarmac as Italian aerobatic team colour the Dubai skyline during Dubai Air Show, 2013. (Photo: WO Iftikhar Muhammad).

Bottom: Thunder at its Best- Sqn Ldr Yaser Mudasser performs during Dubai Air Show, 2017. (Photo: PAF Archives).

Right Page 1: Marshaller direct the JF-17 Thunder towards a parking spot after landing at Radom, Poland. (Photo: PAF Archives).

Right Page 2: June 2018-Sqn Ldr Zeeshan Baryar and Sqn Ldr Sibtain Akhtar pose for the camera after arrival at Radom, Poland. (Photo: PAF Archives).

weapon system that too, in a short span," Sibtain added describing the jet as the cutting edge of technology.

Paris Again

Three-shipped Thunder formation fitted with three drop tanks each, landed amidst moderate showers with low clouds loitering around Le Bourget, Paris in the afternoon of July 2019. The demo pilots, Wg Cdr Zeeshan Baryar and Sqn Ldr Sibtain Akhtar switched-off the roaring engines of Thunders as the ground's man indicated to do so. Opening the canopy of his green painted Thunder, Zeeshan thanked Almighty for the safe flight and stepped out of the aircraft. Nothing was new for him, he had been there four years ago. However, the only difference was that he was leading the demo team this time. With pleasantries exchanged, the team quickly moved to hotel to take rest as a hectic next day awaits.

"Paris air show is always exciting, no matter how many times you have already participated. It's the mega event where the variety of aerial platforms are vying to steal the lime light, that's why

> Thunder demo pilots have been Pakistan's ambassadors in green at international air shows. PAF leadership has opted to underline its huge success in recent years by bringing the JF-17 aircraft to air shows. It is an opportunity to market our own indigenously manufactured cutting edge aircraft to such a global audience.

JF-17 Thunder International Appearances

Month/ Year	Occasion	Display Pilots	Static/ Aerial
Jul 2010	Farnborough Air Show, UK	Wg Cdr Khalid Mehmood Sqn Ldr Azkaar ul Husnain	Static only
Nov 2010	Zhuhai Air Show, China	Wg Cdr Khalid Mehmood Sqn Ldr Azkaar ul Husnain	Both
Jun 2011	Centenary Celebrations of TuAF Izmir, Turkey	Wg Cdr Khalid Mehmood Wg Cdr Ronald Afzal	Both
Nov 2011	Dubai Air Show, UAE	Wg Cdr Rashid Habib Wg Cdr Ronald Afzal	Both
Nov 2013	Dubai Air Show, UAE	Wg Cdr Ronald Afzal Sqn Ldr Yaser Mudasser	Both
Jul 2015	Paris Air Show, France	Wg Cdr Usman Ali Sqn Ldr Yaser Mudasser	Both
Nov 2016	Zhuhai Air Show, China	Wg Cdr Yaser Mudasser Sqn Ldr Zeeshan Baryar	Both
Nov 2017	Dubai Air Show, UAE	Sqn Ldr Yaser Mudasser Sqn Ldr Zeeshan Baryar	Both
Aug 2018	Centenary Celebrations of Polish Air Force, Random Poland	Wg Cdr Zeeshan Baryar Sqn Ldr Sibtain Akhtar	Aerial
Oct 2018	Zhuhai Air Show, China	Wg Cdr Zeeshan Baryar Sqn Ldr Sibtain Akhtar	Both
Jun 2019	Paris Air Show, France	Wg Cdr Zeeshan Baryar Sqn Ldr Sibtain Akhtar	Both

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it's not easy. You have to remain focussed and forget that you are running into a competition. This is what we are told time and again by our leadership," adds Zeeshan Baryar. Demo pilots live for the rush of the show, the roar of the crowd, the chance to feel alive. They enjoy the attention not just from pilots of air forces of the world but especially from the Pakistani diaspora settled abroad. These Pakistanis come from all across Europe to see PAF perform at Paris. For them it is a morale booster, moment of pride to see their own indigenously manufactured aircraft compete with the best of the best in the game.

"It's about giving them a bit of a show. Lay down some impressive performances, talk to them while showing around the aircraft, have photographs with them and sign few autographs," said Sqn Ldr Sibtain Akhtar.

No one can doubt the potential of the West's armour and weaponry. But the Thunder is the state-of-the-art rival. It is fast, innovative and efficient and so much more. PAF designers and engineers took everything they knew about aerodynamics and packaged it into the JF-17. Commendably, unlike some of the world's other most super sophisticated 5th generation aircraft, the Thunder did not see a decade of controversy about its technical abilities or get plagued by costly overruns. It possesses a huge performance over match against many late generation aircraft. In many ways it is PAF's insurance policy. With designers and engineers pouring over every detail of this machine, the Thunder was developed exclusively for defeating the highest end threats. As the Thunder community describes it, "It seems to have been built by a pilot, easiest aircraft to fly, it's a pilot's aircraft, so easy that we did not need a dual seater for more than 15 years," adds Air Cdre (now AVM) Khalid Mehmood with a smile.

JF-17 Thunder's incredible aerial performances across the world for the last decade or so has already started to bear fruit. Nigerian air force, which had earlier contracted with PAC Kamra, has received three JF-17 aircraft during a graceful ceremony held in June 2021. Large number of air forces have shown keen interest as the future of JF-17 Thunder sales looks promising. With the rollout of much awaited and eagerly anticipated Block-III version of JF-17 Thunder, chances of many more air forces putting their money on this state-of-the-art, modern and 'Made in Pakistan' fighter jet would be ever growing.

1: Inverted flying remained one of the sought after manoeuvre for the spectators at Dubai Air Show, 2017. (Photo: WO Iftikhar Muhammad).

2: Wg Cdr Ronald Afzal takes off for another Thundery performance at Dubai Air Show, 2013. (Photo: WO Iftikhar Muhammad).

3: Attracting large crowds, the aircraft remained the 'Star of the Show' at Paris, June 2019. (Photo: PAF Archives)

4: 'Xialong' (Fierce Dragon) attracted attention of prominent media outlets during its maiden appearance at Zhuhai Air Show, 2010. (Photo: PAF Archives).

5: Relation of Trust and Honour- A PAF ground crew salutes as Sqn Ldr Yaser Mudasser gets ready for aerial display at Dubai, 2017. (Photo: PAF Archives).

Sqn Ldr Zeeshan Baryar lands after a breathtaking performance at Radom International Show, June 2018. (Photo: Airteam Images).

A Tribute to a Work Horse

VENERABLE VETERAN

> "The story of Bristol Freighter service in RPAF is nothing short of spectacular. For decades, this 'Work Horse' remained the backbone of all RPAF air transport operations, gradually fading away in obscurity, paving the way for its more versatile predecessor, the 'C-130 Hercules'."

by Franciszek Grabowski

Freighter 31M of No 12 Sqn taxiing along the line up of other Freighters. The aircraft are devoid of code letters, suggesting the photo was taken soon after the delivery in mid 1950s. (Photo: PAF Archives).

Among the aircraft operated by the Royal Pakistan Air Force, the story of Bristol Freighter is probably the most exciting one. The aircraft was thought of as a development of Bristol Bombay transport aircraft, albeit with a fuselage large enough to accommodate large sized cargo, and capable of operations from improvised airstrips. The study that became Bristol Type 170 attracted interest of the Air Ministry of UK, which required some changes but otherwise found the aircraft most promising. RAF wanted to use it in the World War II against Japan. Unfortunately, the aircraft arrived too late for the war, being first flown in December 1945. This ultimately sealed the fate of the aircraft. Post-war cuts in the RAF structure rendered the aircraft unnecessary. Realising that, Bristol immediately began studies on modifying the aircraft for civilian operators.

The aircraft was ultimately manufactured in a total of 214 pieces. A marginal number to WWII standards, it was still a big success, especially in the commercial market, where previously demobbed Dakotas dominated. The last Freighter was withdrawn from use in 2004.

Above: 'The Office'- Cockpit of a Bristol Freighter. (Photo: flight-manuals-online.com).

Title Photo: Freighter 21P G788 Q, enroute to Gilgit via Indus Valley, photo taken somewhere in the early 1950s. As seen, the aircraft is in immaculate condition in a standard silver finish of the type. Noticeably, the panels behind the engines and gondolas are painted in black, in order to make the aircraft look neat, making oil spills and exhaust settlements invisible. (Photo: PAF Archives).

At the time of its establishment, Royal Pakistan Air Force had almost no transport aircraft. One or two venerable Dakotas, the only transport type used were facing numerous maintenance issues. They belonged to a stock of ex-RAF aircraft which were handed over to RIAF to be shared between India and Pakistan. Those Dakotas were already worn and most of them had to be returned to the air. Worse, a number of them belonged to C-47A/Dakota III variant, which performed poorly in higher altitudes and was not suitable to fly in mountainous areas of north Pakistan. To make things even more complicated, the only workshop specialised in overhaul of Dakotas was Hindustan Aircraft Ltd in Bangalore. Nonetheless, there was little choice, and the available aircraft were gradually overhauled locally, with some more coming from India according to partition agreements or acquired from abroad.

Chittagong (East Pakistan), the crew of No 12 Sqn posing in front of Freighter 31M S403 B of No 12 Sqn. Photo taken in July 1964 during flood relief operations. From L to R: Flg Off Umeed Ali Khan GD(N), Flg Off William Desmond Harney GD(N), Flg Off Muhammad Ahmad GD(P), Flg Off S S Naz Mansur GD(P), Sqn Ldr Abdul Waheed Khan GD(P), Flt Lt Farooq Ahmed Ansari aka 'Spud' GD(P), Flg Off Muhammad Abdus Samad Khandker GD(N), Flg Off Javed Hayat Malik GD(P), 'unknown', crouching extreme left Flt Sgt Sher Ali GD(S). (Photo: PAF Archives).

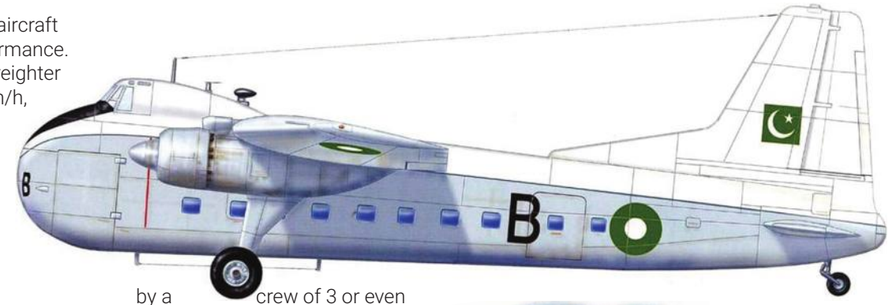
At the time of independence RPAF has only two transport units. No 6 Squadron, formerly No 6 RIAF Sqn, a dedicated transport unit inherited from the RIAF which was based at RPAF Peshawar, and Air Headquarter Communication Squadron established at RPAF Mauripur to perform VIP transport duties. Governor General's Communication Flight was also subordinated to the latter unit. Since their arrival, Dakotas provided critical transport service, especially in Kashmir war in 1948, which became the first conflict involving the two infant nations. Notorious technical problems with the worn-out Dakotas led to a decision to seek replacements. But it was easier said than done. The market offered little in ways of substitutes. There was just one aircraft that could have been considered an alternative, Fairchild C-82 Packet, but it was not available for Pakistan, USAF being the sole operator. Fairchild C-119 Flying Boxcar and French Nord Noratlas arrived too late. Thus, the only real alternative left for RPAF to replace the ageing Dakota was Bristol Freighter.

In front of Chittagong control tower, during flood relief operations, July 1964. From L to R: Flg Off Muhammad Javed Aslam GD(N), Flg Off Umeed Ali Khan GD(N), Flg Off Muhammad Ahmad GD(P), Flg Off William Desmond Harney GD(N). (Photo: PAF Archives).

Freighter 21P coded N, serial unknown. In the background Short Sealands of Indian Navy are also visible. The photo was possibly taken during Commonwealth Naval Exercises in Mid 50s at Triconmalee, Ceylon involving Royal Navy, Royal Pakistan Navy and Indian Navy. (Photo: PAF Archives).

Dakota and Freighter aircraft had very similar performance. Maximum speed of Freighter was 225 mph (362 km/h, 196 kn) at 3,000 ft (910 m) vs 224 mph (360 km/h, 195 kn) at 10,000 ft (3,000 m) of Dakota. Time to altitude of 10,000 ft (3,000 m) was 10 minutes for Freighter while the Dakota took 9 minutes 30 seconds. Service ceiling of Freighter at 23,000 ft (7,000 m) was slightly worse than that of Dakota - 26,400 ft (8,000 m). Dakota definitely outclassed Freighter in range. Freighter could fly 820 mi (1,320 km, 710 nm) while Dakota doubled that figure - 1,600 mi (2,600 km, 1,400 nm), with ferry range as much as 3,600 mi (5,800 km, 3,100 nm).

A few factors gave Freighter a clear advantage. The payload difference between the two made a vital difference. Dakota could typically carry 5,000 pounds (2,300 kg). In extreme situations, this limit could be stretched to 6,000 pounds (2,700 kg) or even 7,000 pounds (3,200 kg). On the other hand, the Freighter could carry a maximum of 10,870 lbs (5,000 kg), which meant double the payload of the standard Dakota. It was also equipped with much larger cargo compartment. Another factor that gave Freighter an edge over Dakota was the size of the crew. Dakota required a crew of 4, while Freighter could be flown by a crew of 3 or even just a pilot and co-pilot. Given the chronic personnel shortages at the time of partition, this provided an undeniable advantage. There was another factor that came into play. The only workshop capable of repairing Dakotas, No 102 Maintenance Unit, RPAF Drigh Road was overloaded with work of fixing other aircraft. The newly established Forward Repair Unit, RPAF Chaklala was just starting operations, and it needed time to take over work. Shortage of technicians was also critical, thus any major overhauls would have to be handled abroad. This was not viable for economic and strategic reasons. The younger Freighters offered the luxury of not being in need of major overhaul for at least a few years. Another factor which supremely surpasses Dakota, was freighter's clamshell nose doors. These doors could open up sideways allowing large-sized cargo like 3-ton trucks, large military vehicles to be loaded/offloaded with ease and efficiency. This facility proved to be a huge benefit during 1948 Kashmir war.

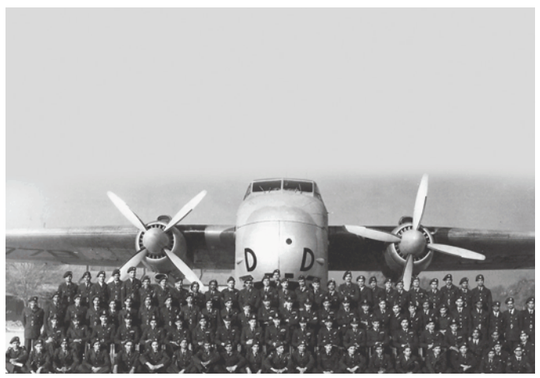


> "In July 1964 floods hit the Rangpur area in East Pakistan causing heavy damage and leaving about a million people homeless. Freighters from No 12 Squadron were detached to Chittagong to participate in relief operation"

All of these variables made Freighter the only suitable replacement of Dakotas. The

Bottom Left: Crew of No 6 Sqn pose in front of Freighter 21P G778 D. (Photo: Daud Shah).

Bottom Right: No 6 Sqn crew pose against their aircraft, Freighter 21P, L to R: 'Unknown', Flg Off Mirza Abdul Majeed Baig GD(N), Flt Lt Syed Mahmood Ahmad GD(P), Flg Off Sardar Ali Taherkheli GD(P), 'Unknown', 'Unknown'. (Photo: PAF Archives).



aircraft was first shown in Pakistan in mid 1948. A Mk 21E C/N 12780 did a promotional tour around Asia. On 22 July 1948, it landed at Chaklala where a demonstration of loading and unloading was given to RPAF officials. The aircraft received provisional serial G775 and thus became the first ever aircraft to be flown on 29 July, the same year.

The impressions must have been positive as two aircraft were ordered and delivered in October 1948 for operational testing. One of them was Mk 21 transport with the serial G776 and the other Mk 21E convertible, capable of both transport and passenger duties – G775. The latter was the very aircraft demonstrated a few months' earlier. They were delivered in silver finish, just with RPAF insignia and black serial numbers on the tail and wing under-surfaces in typical RAF pattern.

Both aircraft were attached to operational units. G775 went to Comm Sqn while G776 flew missions to Kashmir with No 6 Sqn. Here the new type had a chance to shine truly. Carrying a Jeep in Dakota required a bit of effort to both load and unload the vehicle through the side cargo door. It was much easier in the Freighter, and more so, the latter was capable of carrying larger vehicles.

There was one instance that really left an expression. CWT Lorries were the go-to military troop transport at the time. Sturdy and dependable, it was a tough giant with an intimidating weight and size. Owing to this, the staff was left impressed when Freighter G776 was able to easily load up a 3-tonne CWT Lorry in its spacious cargo compartment and deliver it to Gilgit. This ease of transport in cargo this big in size would've been unthinkable in the Dakotas. The massive cargo compartment entrance also gave the Freighter a huge advantage in loading and unloading cargo, making it much faster and convenient. During one of the flights where the weather was exceptionally bad, the Freighter struck a tree with its wing. It was, fortunately, able to return to its base safely and was temporarily patched up. The aircraft was later flown to UK in 1948 for an overhaul. The pilot of the aircraft, Flg Off Syed Mansoor Ahmad Shah complained extensively about the servicing at Bristol, especially about its air conditioning systems, but was

Top: Freighter 21P G788 Q of No 6 Sqn during a flight to Gilgit amidst snow covered mountains of Karakoram range. (Photo: PAF Archives).

Right: Pak Army supplies being off-loaded at Chittangong airport. (Photo: PAF Archives).

1. From L to R: Flg Off Muhammad Ahmad GD(P) and Flg Off William Desmond Harney GD(N) followed by Army Engineer's Supply Air Dropping Crew at Chittagong, 1964. Freighter 31M N of No 12 Sqn in the background. William Desmond Harney rose to fame during 1965 war with India, when he was awarded with Sitar-e-Jurat (gallantry award) for rendering valuable services in defence of country. (Photo: PAF Archives)

2. From L to R: Flg Off Muhammad Abdus Samad Khandker GD(N), Flg Off Muhammad Ahmad GD(P), 'unknown', Flt Lt Farooq Ahmed Ansari 'Spud' GD(P) at Chittagong during flood relief operations in 1964. (Photo: PAF Archives)

3: From L to R: PSO to C-in-C (unknown), AVM Mohammad Asghar Khan, C-in-C, PAF and a receiving crew member Flg Off Amir aka 'Jinn' Shah GD(N). The aircraft is S4407 J of No 12 Sqn. (Photo: PAF Archives).

4: No 12 Sqn's Freighter ready to be offloaded at Chittagong during relief flood operation in July 1964. The advantage of clamshell door is clearly visible, allowing to move the freight directly onto a lorry. (Photo: PAF Archives).

A forlorn engineless Freighter 31M S4407 J of No 6 Sqn, seen parked somewhere in New Zealand after retirement from PAF. A factory passenger scheme is already protruding from behind the worn camouflage. (Photo: PAF Archives)

impressed by the reliability of the airframe and engines. In any way, despite the snags, during the course of operational evaluation of both aircraft it was found that the type fulfils demands of the RPAF. G776 returned to No 6 Sqn, where it was sought after by the pilots, but later in 1949 it joined G755 in the Comm Sqn. The eventual fate of G775 is unknown, but Freighter G776 crashed on 7 January 1955 at RPAF Lahore while on strength of No 6 Sqn.

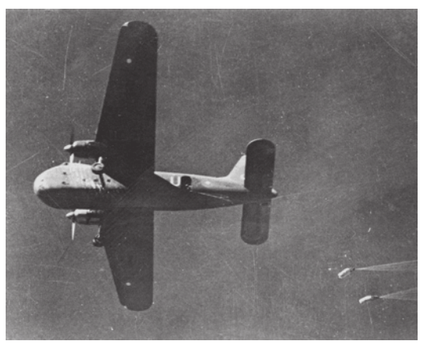
Above: 'Show of Power'- The aircraft display at Mauripur, late 1950s. 50 F-86 Sabres in the front row and about 31 in the second, mixed with about 12 T-33s, 10 Freighter 31Ms in the third row. (Photo: PAF Archives).

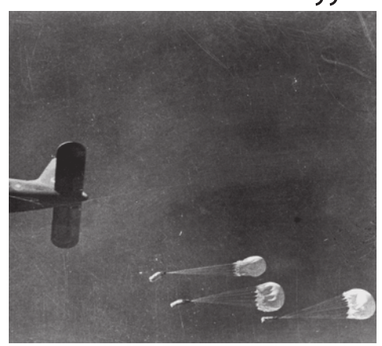
Below: Freighter 31M S4413 N of No 12 Sqn in the 1960s. Fin fillet distinguishing it from Mk 21P is clearly visible. (Photo: PAF Archives).

Later on, a change of Commander-in-Chief coincided with a cease-fire in Kashmir. AVM R. L. R. Atcherley decided for one transport squadron, ie. No 6 Sqn with 8 Freighters under establishment plus 4 in immediate reserve. According to the plan, AHQ Communication Sqn and Governor General Communication Flt were to be merged into one unit, Communications Squadron with one Viking, one Wayfarer, two Freighters plus two Freighters in immediate reserve. The total demand called for 17 aircraft, with 100% reserve making the requirement of 34 aircraft. So, a further 32 aircraft, 30 new built Mk 21P and two second hand Mk 21 converted to Mk 21P standard were ordered. The first aircraft, G777 arrived in November 1949, and others followed until G787 was flown in February 1950.

A Scottish company, Air Service Training was contracted to train

> Freighters flew twice a week between Lahore, Chaklala, Peshawar, Kohat, Sargodha, and Drigh Road or alternately Mauripur, delivering aircraft engines, spares, and supplies from maintenance units. They also flew mail runs to East Pakistan every Tuesday and Friday

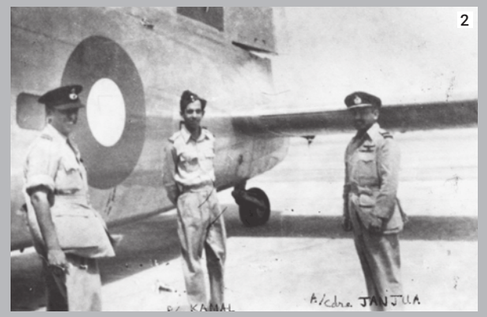




Top: Freighter 31M S4403 B of No 12 Sqn at Kohat. (Photo: PAF Archives).

Centre: A visit to Gligit in November 1958. Political Agent with his wife, Lt Gen Axel Georg Ljungdahl, Chief of the Royal Swedish Air Force, accompanied by his wife Ruth, AM Asghar Khan and Begum Amina Asghar Khan, unk Lt Col of the Northern Scouts. In the background a personal mount of Asghar Khan, Freighter 31M S4407 J of No 12 Sqn. (Photo: PAF Archives).

Left: Freighter 31M U during an aerial drop of supplies in flooded areas. (Photo: PAF Archives).



personnel for Freighter units. This training unit was established at Mauripur and started operations in 1950. Meanwhile, the aircraft immediately joined transport duties in West Pakistan, and between the West and East wings of the country. Freighters flew twice a week between Lahore, Chaklala, Peshawar, later also Kohat and Sargodha, and Drigh Road or alternately Mauripur, delivering aircraft engines, aircraft assemblies or spares, and supplies from and to stores or maintenance units. No 6 Sqn also flew mail runs to East Pakistan every Tuesday and Friday. Supply routes were established to Dacca with an extension to Chittagong. Freighters were also used to transport Shaheen Scouts for their annual camps. Another important aspect was dropping supplies to Army units in Kashmir and for those operations a detachment was maintained at RPAF Chaklala from April to October each year. Flood season had Freighters on the front lines of relief operations.

A fatal accident involving a Freighter occurred on 6 April 1950. It was a tragedy that claimed several precious lives. A Freighter belonging to No 6 Sqn flew from Gilgit with pilots Flg Off Ashfaq and Plt Off S U Khan on board. When it approached Sazin in the Indus valley, the plane crashed into a mountain due to severe weather. The pilots were martyred along with 14 other passengers.

Additionally, a number of aircraft were lost or damaged in non-fatal accidents, but there is no exact record of those incidents. Those aircraft were either repaired, or reduced to spares and replaced by new Freighters.

1: 22 September 1955. A visit of Egypt's Deputy PM to Pakistan. Lt Gen Azam Khan and Wg Cdr Aziz along with dignitaries at Lahore airport. Seen in the background is Freighter 31M S4406 H. (Photo: PAF Archives).

2: History in the Making- The arrival of ever Freighter of the RPAF, G755 along with its pioneering crew: Sqn Ldr Abdullah Baig GD(P), Plt Off Kamal Ahmad GD(N) being received by Air Cdre Mohammad Khan Janjua. (Photo: PAF Archives).

3: Lahore 28 December 1956- Zhou Enlai (Chou En-Lai), Premier of the People's Republic of China, inspecting Guard of Honour. A line of Freighter seen in background. (Photo: PAF Archives).

4: Arrival of Air Marshal Omar Dhani, commander of the Indonesian Air Force, and Madam Dhani at PAF Base Lahore on 26 August 1963. (Photo: PAF Archives).

A meeting at Delhi, 26 March 1962. Freighter 31M T with a RNZAF Bristol Freighter NZ5909 behind. (Photo: CFL Jenks).

1: Freighter of No 6 Sqn parked at PAF Mauripur. (Photo: PAF Archives).

2: AVM R. L. R Atcherley climbs down from a Freighter for an inspection at Lahore on 26 December 1950. (Photo: PAF Archives).

3: Lahore 30 September 1950, Freighter G785 of No 6 Sqn and Tiger Moth D529. (Photo: PAF Archives).

4: Freighter 31 M, believed to be of No 12 Sqn, delivering a load from Skardu to Karachi. (Photo: PAF Archives).

5: G793 V during 1956 New Zealand Karakorum expedition. (Photo: PAF Archives).

Deliveries continued with G-788 - G793 arriving in July 1950, G794 - G800 during June to September 1951, and G801 and G802 in February and March 1952 respectively.

In 1951-52, No 6 Sqn came up with an original and ingenious idea to train cadets from RPAF Risalpur. Titled 'The Flying Class', the cadets were flown from Lahore in a Freighter specially modified for this purpose. Instructors included navigation instructor Flg Off Abdul Majid and airborne map reading instructor Plt Off Sultan Muhammad, adepts at the task assigned to them. The cadets accumulated real-time practical navigation and map-reading skills aboard the Freighter.

Final aircraft G804-G806 were delivered in the period December 1952-January 1953, while the last three, G807-G809 were delivered in April-May 1953. An aircrew training unit was formed as Transport Conversion Flight of Conversion School at RPAF Mauripur. Wg Cdr Mohammad Kyber Khan was appointed as its first chief instructor who personally selected the remaining faculty members.

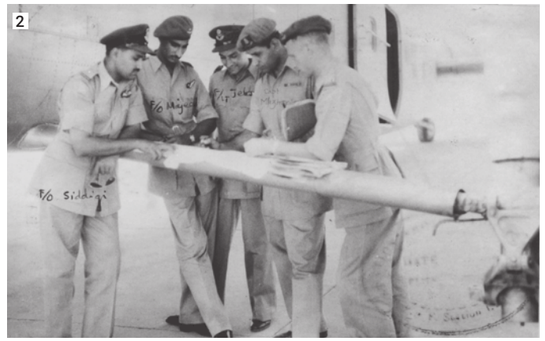
1: 1800 kg bombs being hanged onto Freighter under a watchful eye of C-in-C. Lahore, 3 December 1955. (Photo: Daud Shah).

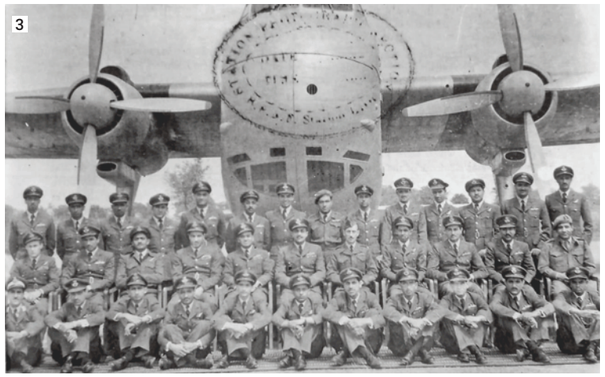
2: Lahore, 30 September 1950, debriefing after a mission. Flg Off Abdul Rashid Siddiqui GD(P), Flg Off Abdul Majeed Khan GD(P), Flt Lt Robin Lovis James Jebb GD(P) and Capt Mazhar, Army. (Photo: Daud Shah).

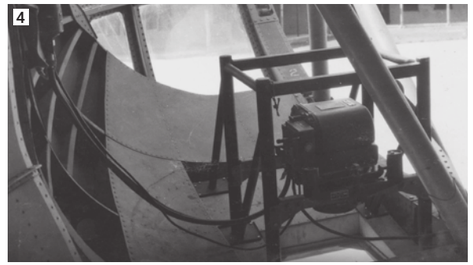
3: Personnel of No 6 Sqn pose in front of a Freighter, early 1950s. (Photo: PAF Archives).

4: Soon after induction, some of the Freighter were modified by the RPAF talented technicians and engineers to carry a reconnaissance camera inside its bulky nose. Photograph shows details of a recce camera installation in a Freighter 21P during C-in-C's visit on 21 March 1950. (Photo: PAF Archives).

5: Freighter 21P G781 taxiing at Drigh Road (Karachi) in 1951. (Photo: PAF Archives).







> One factor which supremely surpasses Dakota, was freighter's clamshell nose doors. These doors could open up sideways allowing large-sized cargo like 3-ton trucks, large military vehicles to be loaded/offloaded with ease and efficiency. This facility proved to be a huge benefit during 1948 Kashmir war.

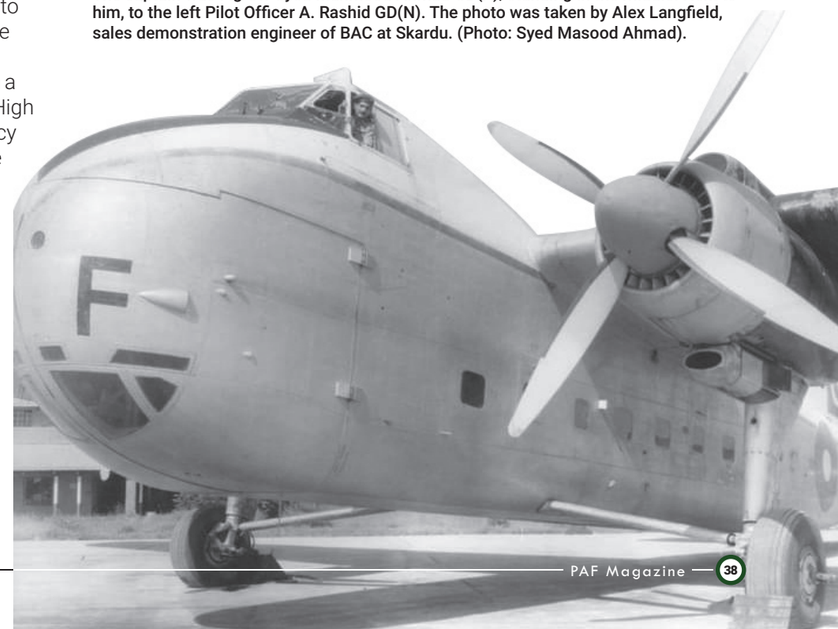
Camouflaged Freighter S4420 V of No 6 Sqn during a visit to RAF Changi, Singapore. (Photo: CFL Jenks Jenks).

During 1952 floods, No 6 Sqn was employed in large-scale food supply drops, for which the squadron received an award, presented on 17 August 1952 by the Governor of the West Pakistan. Another large operation of No 6 Sqn was Snow Drop which began on 15 November 1953 and involved dropping supplies in Pakistan's Northern Areas from RPAF Chaklala. The operation concluded on 30 November with 363,000 kg of supplies being freighted by Freighters to Gilgit and Skardu.

The next aircraft ordered were 38 improved Mk 31Ms which received new range of serials between S4401 and S4438. They were delivered from December 1953 to June 1955, usually in batches of three or four aircraft. The last one, S4438 was handed over on 29 June 1955 in a ceremony attended by the Pakistan High Commission in London, His Excellency Mohammed Ikramullah. With this the number of Bristol Freighter in the inventory of RPAF inflated to 81.

It seems that some of those aircraft were delivered in a distinctive Bristol style pattern, with white upper fuselage with thin green trim, and green spinners, while the rest were camouflaged, with a disruptive pattern of Dark Green and Dark Sea Grey on upper surfaces and PRU Blue on the bottom.

On 14 December 1949 Freighter G781 was flown from Lahore via Chaklala to Gilgit, and on the next day to Skardu and back to Lahore via Chaklala. On board was Ronald C.W. Ellison (extreme right) Assistant Chief Test Pilot Bristol Aircraft Company, who visited Pakistan to examine Freighter operations in World's toughest routes/ valleys. The captain was Flg Off Syed Mahmood Ahmad GD(P), standing in the middle. Next to him, to the left Pilot Officer A. Rashid GD(N). The photo was taken by Alex Langfield, sales demonstration engineer of BAC at Skardu. (Photo: Syed Masood Ahmad).



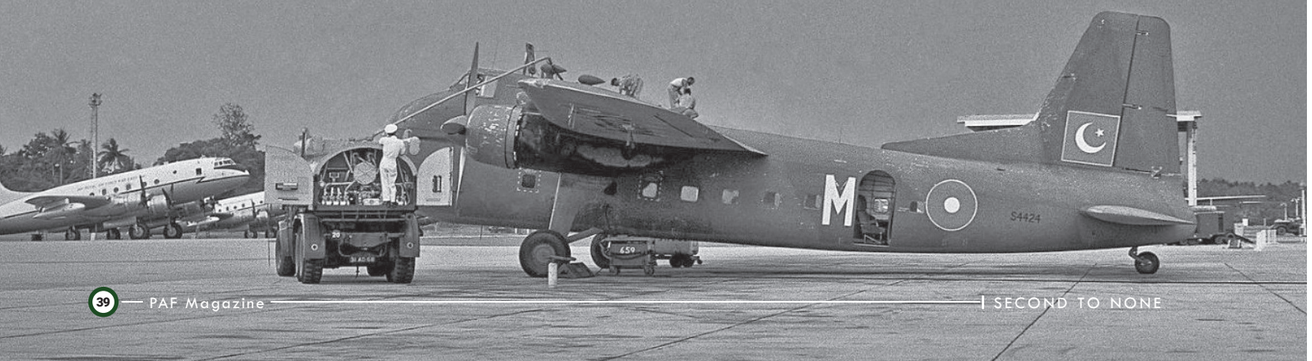
It looks that the new aircraft arrived just in time to take part in flood relief operations in Eastern Pakistan operated by No 6 Sqn during July 1954. Such operations were very intense and required a full effort from the Squadron. During similar operations in 1955 in Pakistan 146 sorties were flown and in 1956 in Eastern Pakistan - 108 sorties.
In September 1953 No 12 Heavy Bomber Squadron was converted into Composite Squadron. In the new establishment, the Squadron had three flights: Air Headquarters Communication Flight operating Dakotas and a single Viking, Target Towing Flight with Tempests, and Heavy Bomber Flight flying Halifaxes. It looks that the Squadron did not operate Freighters, initially, and Freighters joined the fleet only after withdrawal of Dakotas in 1955. It also appears that at the same time few Freighters were modified to carry two 1,800 kg "block-buster" bombs. Limited training took place in night bombing, and it seems it was just a temporary measure to keep aircrew current in bombing missions until B-57 Canberras were delivered from the US in 1960.

In May 1956 Transport Flight of Conversion School moved from Mauripur to Lahore, and on 1 July 1957, No 3 Sqn was established as an independent training unit. It operated 6 Freighters 21P and prepared freshly graduated aircrew from RPAF College, Risalpur to take on operational duties. During 1961, while preparing to phase out the type, Pakistan withdrew 10 Freighters from service, and offered them for sale on civilian market. S-4401 and S-4402 were sold to Straits Air Freight Express in New Zealand, S-4427, S-4432, S-4434 and S-4437 to Trans Australia Airlines, S-4412, S-4416, S-4436 to Ansett-ANA pvt. Ltd in Australia and S-4438 to Pacific Aviation Ltd, Australia. The same year, 1961, few remaining Freighters proved their worth in yet another role when Sindh province was hit by plague of locusts. This was considered a very serious threat that could even cause famine, so immediate action was called for. Four Hawker Sea Furies of No 23 Sqn reconnoitred the area looking for locust swarms and later calling upon five Freighters to cross-spray the effected areas. Field modifications included installation of a 700 gallon tank for chemicals, and spray booms under each wing, containing 50 nozzles each. This allowed single Freighter to spray an area of up to 2000 acres in one sortie. The operation turned out to be a huge success and helped in averting a national disaster.

Top: Freighter 31M S4405 A of No 12 with crops spraying kit during anti-locust operations. (Photo: PAF Archives).

Inlet: Nose of the same aircraft after the return from a sortie. Marks on the nose are smashed locusts. Possibly the only 'aerial victories' of the type! (Photo: PAF Archives).

Bottom: Freighter 31M S4424 M during refuelling at Changi, Singapore. HP Hastings of the RAF visible in the background. (Photo: PAF Archives).



In March 1963 Pakistan received long awaited new transport planes, the state-of-the-art Lockheed C-130 Hercules from USA. They completely outclassed Freighters in every respect. On 30 June 1963 Freighters were officially struck off from No 6 Sqn inventory and mothballed. At the same time No 3 Sqn was number plated, thus making No 12 Sqn the sole operator of the ageing Freighters.
In July 1964 floods hit the Rangpur area in East Pakistan causing heavy damage and leaving about a million of people homeless.

Aircraft of No 12 Squadron were immediately detached to Chittagong to participate in relief operations. This was the last such operation for Freighters. The next year Fokker F-27 Friendship was introduced into the PAF inventory, and the type gradually replaced Freighters. The last four flyable aircraft were sold to Straits Air Freight Express (SAFE) in New Zealand, S-4403 in 1965, followed by S-4406, S-4407 and S-4421 in 1966. Those aircraft, although struck off the PAF inventory and owned by SAFE, were for a short while flown by No 12 Sqn aircrew, including Flt Lt Sohaib Qureshi, to keep them airworthy at the expense of New Zealand's company. The

Freighter 31M coded U of No 12 Sqn. (Photo: PAF Archives).

few remaining aircraft were scrapped in Pakistan, those from Chaklala in a scrapyard in adjoining Dhoke Khabba area of Chaklala air base, and the ones from Lahore at Aluminium Utensil Making. A sad fate following 18 years of faithful service.

Out of the aircraft operated by the RPAF and PAF, S-4403 is preserved at Nelson Founders Museum as ZK-CLU, as the cockpit section of S-4406 is on display at Ferrymead Museum, Christchurch. S-4438 is preserved in Australian National Aviation Museum, Moorabbin Airport, Melbourne as VH-ADL 'Tasmanian Devil'. Unfortunately, out of 81 aircraft on PAF inventory, not a single Freighter was preserved in Pakistan. In author's opinion, the last relic should have been preserved locally, and an exhibit formed around it, commemorating the brave airmen flying hazardous missions to Skardu and Gilgit. Their sacrifice, now forgotten, definitely deserve it.

Line up of freshly delivered No 12 Sqn Freighter 31Ms. (Photo: PAF Archives).

Analysing the Potential of 3D Printing

PRINT ME AN AIRCRAFT

"The power of additive manufacturing cannot be denied as it has revolutionized the way manufacturing procedures are approached. For aerospace, additive manufacturing holds immense potential. From cost-cutting to enhanced performance, the possibilities are endless. The author invites you to take a sneak-peek at this emerging technology and its implications for the aviation industry."

by Muhammad Khan

The world of aerospace thrives on innovation and perpetual adaptation of new technologies. With such complicated processes and equipment, aviation engineers and pioneers are constantly on the lookout for new technologies. From supply in which contractors run out of business before their parts need replacement to manufacturing, which often requires tons of waste to produce a part weighing in kgs, aerospace industry is, by nature, an expensive business. That is precisely the reason why additive manufacturing seems like a godsent for the industry. Although, the technology is still in its adolescence, it offers massive advantages over traditional approaches even now. Let's begin with understanding how the process of additive manufacturing, also called 3D printing, works.

A revolutionary approach to industrial production, additive manufacturing helps create products and parts which are lighter and stronger, with substantially increased efficiency. It is an apt example of another industry entering into the digital realm, rendering huge benefits. Additive manufacturing uses specialized 3D software known as CAD (Computer Aided Design) to precisely design objects which are to be 3D printed. Another method that is being used is 3D scanning, which has recently been developed enough to be operated even on small mobile devices.

The major difference in traditional and additive manufacturing is that in additive manufacturing construction material is added or laid down in layers through intricate processes to create an object. On the other hand, traditional approaches usually use subtraction or removal of excess material to create, using processes to mill, grind, carve, file, etc to reveal the required shape. Even this basic difference between the two approaches is enough to comprehend how additive manufacturing is significantly more efficient of the two.

How does it work?

Additive Manufacturing (AM) usually works by depositing layer upon layer of construction material to create a 3D, physical object. In a nutshell, each layer of material is laid upon the previous partially melted or melted layer of material, fusing them together. The object is first created using CAD, which creates the object in 3D, slicing it into ultra-thin layers. A nozzle or 'print head' deposits the layers of material, guided by the precise data given by the CAD. As the layers cool or are cured, the material fuses together, forming the end object.

Materials used in Additive Manufacturing

Various resources can be used to make material that is used in additive manufacturing. AM uses a diverse set of materials, ranging from complex metal alloys to chocolate. The most commonly used are Thermoplastics like Acrylonitrile butadiene styrene (ABS), polylactic acid (PLA) and polycarbonate (PC).

Metals ranging from precious metals like gold and silver to strategic metals like stainless steel and titanium. Ceramics including zirconia, alumina and tricalcium phosphate.

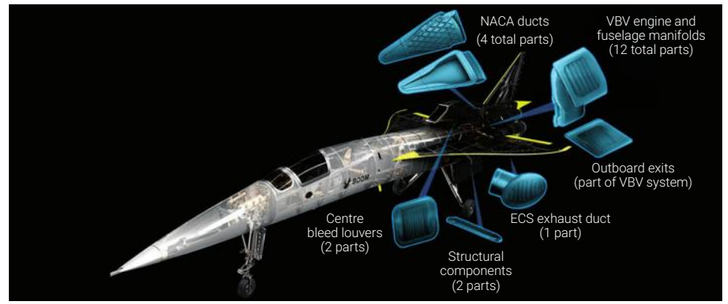
Biochemicals are toughened material which can augment bone structures and growth. They can be created using silicon, calcium phosphate and zinc.

Top: Game Changer- Boom Supersonic's XB-1 has over 300 3D printed parts. (Photo: Boom Technology).

Right: Titanium 3D-printed components of XB-1 are manufactured on VELO3D's Sapphire system. (Photo: Boom Supersonic and VELO3D Business Wire).

Right Bottom: Using 3D printing, Boom Supersonic were able to minimise manufacturing time, aircraft weight, and maximise design flexibility for its XB-1 aircraft. (Photo: Boom Technology).

Title Pic: Booming into the future - Boom Technologies, the leader in supersonic travel, is using 3D printed parts to make supersonic travel affordable, quieter and practical. (Photo: Boom Technology).

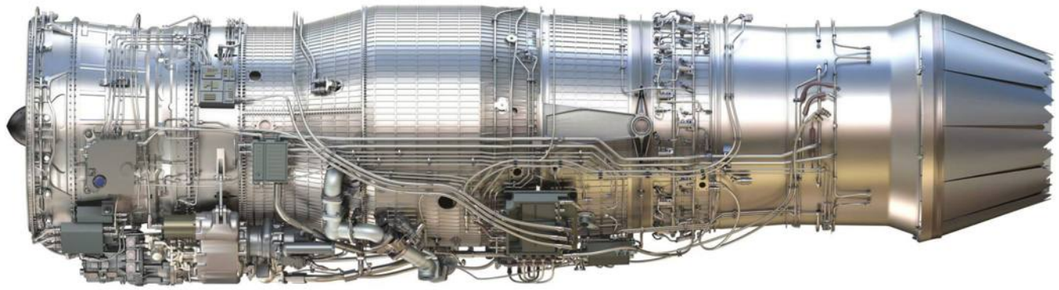


Researchers are currently experimenting with bio-inks made from stem cells to form various human parts, starting from blood vessels to bladders.

Additive Manufacturing in Aerospace

In 2018, General Electric completed a total of 30 thousand jet fuel nozzles by additive manufacturing. The nozzles were 25% lighter and 5 times more durable than their older counterparts. However, it turns out that GE underestimated one crucial benefit which made the nozzle a breakthrough piece of technology. The degree of combustion in jet engines determines its efficiency and these nozzles play a huge part in that process by evenly distributing fuel in the combustion chamber. The nozzles printed by GE had highly intricate veins that provide incredibly efficient fuel spraying. This reduces the engine's fuel consumption by 15%, which is an impressive amount, all considering.

Let's consider another case from USAF, that of a toilet that was to be fitted in a B-1 Lancer. The original toilet was to be replaced and a new one was to be designed, manufactured and fitted. For those who are confused about the fuss



Top: GE's XA100 Adaptive Cycle Engine possesses the unique ability to direct airflow allowing the pilot the alternate between high-thrust and fuel-efficient modes mid-flight. (Photo: General Electric).

Inlet: A 3D printed Sump cover for the F110 engine manufactured by GE. The component is installed in F-15 and F-16 jets. (Photo: General Electric).

surrounding a toilet seat, it would be prudent to remind them that the toilet seat that was to be installed had to function impeccably at thousands of feet in the air, without there being any possibility of it rattling, leaking or malfunctioning. And all of this had to be done without revealing it to enemy radar. And on top of all of this, every single part and component needs to be approved, a process that can take months at a time. This sets the stage to elaborate how strange and complex of a niche aviation spare parts is. Parts and components are made to be tough and to last for decades. The same goes for aircraft and equipment. So, at times, when a decades-old aircraft requires a part, the original manufacturers are long gone. In these cases, the air force has to look for new contractors and manufacturers from the get go. Then, comes the long and tedious process of getting them through bidding, testing and security approvals.

Once approved, these manufacturers have to create the required parts using decades old drawings or reform decrepit moulds. Using conventional methods which include metal forming, casting, machining, and welding, the manufacturers need to have a specialized and highly trained array of equipment, human resources and capabilities. Even with these available, it takes a copious amount of time. And that is if the most effective approach to production is known. Otherwise, that needs to be figured out, as well. For example, the aforementioned nozzle from GE was unsuccessfully casted 8 times during its development phase owing to its intricate geometry.

Even post-delivery, the manufacturers have to wait for funds to be released, another process that takes extensive periods of time. That's the reason working on small orders, even if the air force is promising a small fortune, is not everybody's cup of tea. A statistic released by USAF claimed that through every single quarter, the military has about 10, 000 requests that go unanswered, despite the high pay-outs being offered.

Additive manufacturing can offer solutions or at least make things much significantly better with most of these problems. It can drastically cut down the time and resources needed to build aircraft components. Roughly every fifteen years, the global aviation fleet doubles in size. This puts tremendous pressure on manufacturers, having to consistently create new planes while keeping in line with new legislation. 3D printing can drastically reduce the time it takes to create plane parts, and will soon be the industry standard for manufacturing certain elements.

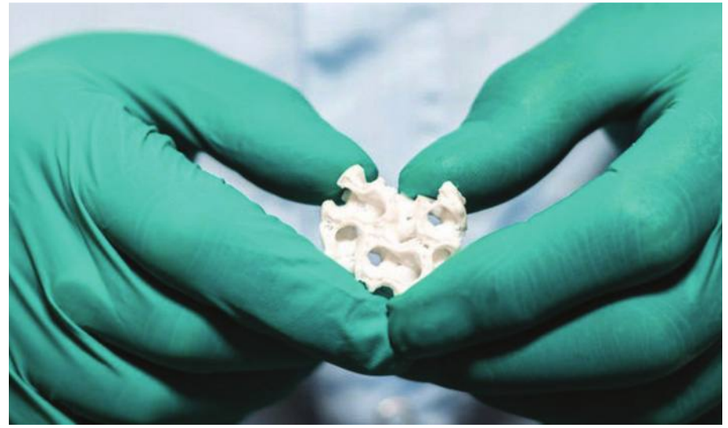
Swedish aerospace firm Saab recently tested a 3D printed polymeric replacement hatch on its supersonic Gripen fighter jet, with very promising results. (Photo: Saab AB).

The inlet shows the closer view of the 3D printed hatch. (Photo: Saab AB).

Most parts that are currently being 3D printed were previously either unavailable or had extensive waiting periods to acquire. Through additive manufacturing, the parts which usually take weeks, months or, in some cases even years to acquire using usual processes, can be printed within days. As the materials used to create the part are known and tested, there is no need to extensively test every material. Long, bureaucratic processes are also eliminated. A single 3D printer can easily manufacture specialized components which previously had to be made using several suppliers and contractors, each adding cost and time. As air forces print and formulate code for more and more parts, its library will grow and the cost of additive manufacturing will drop significantly. As an example, GE ran an experiment to print an old helicopter engine in 2017. They found out that just 6 engineers and a single 3D-printer could displace more than 10 – 15 full suppliers needed to prototype it with traditional methods.

Design

Aviation specialists agree that additive manufacturing has given the industry much-needed freedom when it comes to designing and prototyping. As opposed to conventional manufacturing, additive manufacturing uses specialized CAD software which gives the designer a new level of precision and the ability to leave the heavy chunk of technical aspects to the software. Designers can focus on the creation, solely. Moreover, with the approach that additive manufacturing utilizes, it has become possible to create complex shapes that were simply not possible through traditional metal fabrication. Additive manufacturing also offers creation using multi-materials, printing two different materials on either side. For example, aluminium on the outside and a more conductive metal on the inside. It even allows for increased ruggedness and durability in the design. A honeycomb lattice design is notoriously hard to create using conventional methods. However, with additive manufacturing a lightweight and sturdy honeycomb design is easily achieved.



The 3D printed bone structure that could potentially save countless lives, developed by European Space Agency (ESA) and Dresden University of Technology Hospital and Blue Horizon. (Photo: Medgadget).

CityAirbus is an all-electric, four-seat, multicopter vehicle demonstrator that focuses on advancing remotely piloted electric vertical take-off and landing (eVTOL) flight. (Photo: Airbus).

The efficacy of this technique can be observed in Aurora Flight Sciences' 3D printed aircraft. The ambitious project is a jet-powered, thrust vectoring, blended wing body aircraft which is remotely piloted. The construction of the jet has been completed using beyond surface

Local Motors' Olli is a 3D printed shuttle made by using 90% fewer parts then its assembly-line produced counterpart. (Photo: Local Motors).

The Arcturus T-20 UAV is a medium range aircraft capable of internal and external payloads which recently integrated 3D printed parts. (Photo: LinkedIn.com).

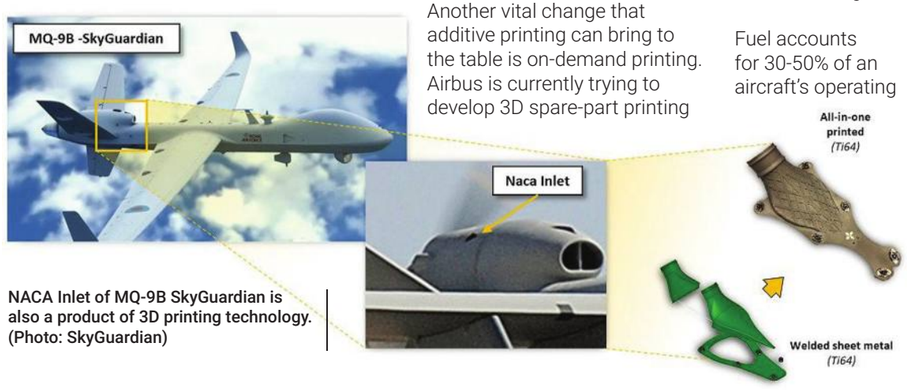
Aerialtronics Altura Zenith UAV is a state-of-the-art drone which owes its versatility and functionality to 3D printing. (Photo: Aerialtronics).

geometry which has only now been made possible via additive printing. Aurora utilized 'topology optimization', an approach that dissects and duplicates structures found in nature. These structures shed excessive internal material for optimum, repetitive structures which offer substantial advantages over older techniques.

Assembly

Another benefit of using additive manufacturing is apparent in the assembly of parts and even aircraft. The wing being developed by NASA and MIT is the perfect example of this structure. A majority of aircraft wings in the future could be manufactured as one single part, instead of manufacturing several smaller components and putting them together. This technique can also be observed in a 3D printed heat exchanger for a catalyst, which is usually made from 300 different components but now can be made as a single part. Additionally, with the advancement of 3D printing using metals, different alloys and metals could be deposited in the part as required, making areas of the part tough, light and so on, making the aircraft much more functional.

Another vital change that additive printing can bring to the table is on-demand printing. Airbus is currently trying to develop 3D spare-part printing units in its storage areas. These storage areas already possess a few thousand parts each for accessible repair. Airbus is trying to equip the areas further with on-demand 3D printing which could potentially 3D print parts which are not available. This will also eradicate any need for sending the parts to complex assembly lines to be finished.



NACA Inlet of MQ-9B SkyGuardian is also a product of 3D printing technology. (Photo: SkyGuardian)

In the aforementioned Aurora 3D printed aircraft, the ability to replace traditionally assembled parts into singular parts paves the way for intricate and complex design which improve performance significantly. Aurora's jet benefits by this approach by 3D printing the fuel tank. The fuel tank now has 3D printed tubing, mounts that connect to the filter and fuel pump and small clamps to attach the fuel lines all in a single 3D printed part instead of being manufactured individually and assembled later. This design had the additional benefit of accurately handling the centre of gravity, a crucial parameter for blended wing aircraft.

Sustainability

Let's examine the usual amount of wastage when using the subtractive method of manufacturing in the aviation industry. To make titanium aircraft components weighing about 300 pounds, the process is initiated with a 6000 pounds block of titanium. The block is then cut down and shaped into the required, precise form. This requires several gallons of coolant and about 5700 pounds of titanium chips that need to be recycled. Other processes have a similar wastage ratio.

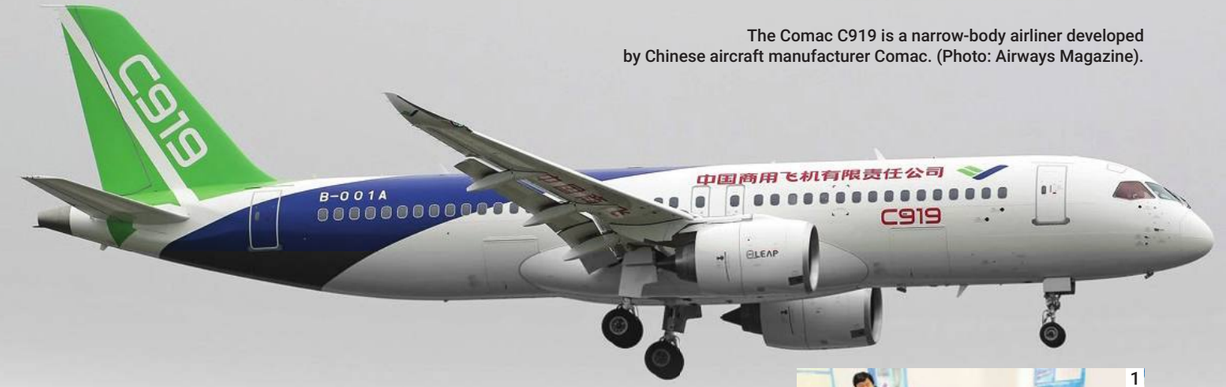
Fuel accounts for 30-50% of an aircraft's operating

>30 % Weight reduction

> 90% Cost reduction

>80% Tooling reduction

3:1 Part consolidation



The Comac C919 is a narrow-body airliner developed by Chinese aircraft manufacturer Comac. (Photo: Airways Magazine).

cost. International Aviation Transport Authority (IATA) made a speculation in 2018 that aviation fuel cost will keep constantly increasing for the next decade. Higher fuel costs mean higher ticket pricing and vice versa.

Fortunately, additive manufacturing is inherently much more efficient. Autodesk, one of the leading CAD software developers, did a proof of concept for an Airbus seat. Using traditional casting and 3D printing processes, a prototype seat for economy class was created. This seat was 56% lighter than its current counterpart. If we look at the fuel consumed by an Airbus A380, replacing the currents seats with these will mean saving 63 tons of fuel per annum, which would mean 190.1 tons of less carbon emissions. This would be equal to taking 120,000 cars off the roads for an entire year. This is how 3D printing can make a significant difference.

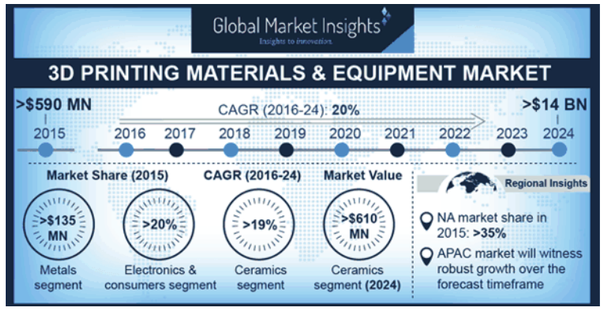
1: Central wing flange 3D printed in titanium for the Comac C919. (Photo: 3dprintingindustry.com).

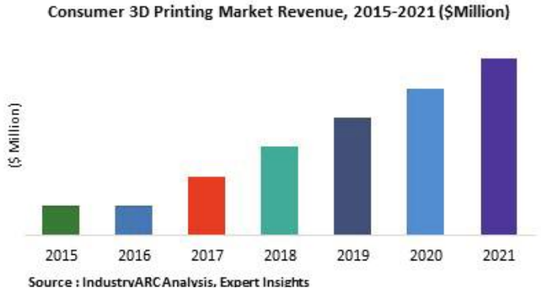
2: U.S. Navy deployed forces are starting to use 3D printed replacement parts to ease the logistics burden of maintaining aircraft like the MH-60 Sea Hawk helicopter aboard the amphibious assault ship USS Wasp. (Photo: US Navy).

The MH-60S Seahawk of the US Navy is one of the first helicopters to receive a 3D printed part, specifically an antenna mount. (Photo: US Navy).

Another aircraft that is in development, which also exhibits the sustainable factor, is the joint venture of Airbus and Local Motors Industries (LMI) from San Francisco. Titled Neorizon, the project includes manufacturing a 'micro-factory' which would hold the capability to build transportation vehicles like drones and automated cars using additive manufacturing. LMI already has experience in the area, with their self-driving shuttle named 'Olli', which was manufactured using 100% 3D printed parts. Neorizon is the next step for LMI. In the current model, cars and other vehicles are manufactured in specialised factories and then shipped to consumers. The idea of Neorizon is to shed this process and have micro-factories which would be erected where the actual demand is. These factories would then manufacture vehicles according to the actual demand, making the model more eco-friendly and sustainable than the traditional one.

According to Toyota, the average car has about 30,000 parts, which requires a huge supply network. 3D printing has the potential to change all of this, making it possible to spot-print parts for vehicles on demand, thus bypassing both the logistical supply problem and the problem of over- or under-stocking inventory.





Early Adapters

Owing to its obvious benefits, additive manufacturing is an area in which all aviation companies are willing to invest big. Aerospace constitutes up to 20% of the market share of additive printing and is growing rapidly. Major companies which are experimenting heavily with 3D printing, include:

Airbus

Airbus is already on its way to having a significant number of their aircraft parts being 3D printed. Some of their planes already have more than a hundred 3D printed parts, most of which weigh less than third of their former weight.

Boeing

Boeing has already acquired over 60, 000 parts using additive manufacturing. Boeing's Dreamliner 737 uses 30 parts made using additive manufacturing and more are being developed.

Etihad

Etihad is scrutinizing its aircraft cabins, examining every part and estimating how much it would cost to 3D print them. Etihad's innovation centre in Abu Dhabi is already working on redesigning non-flight parts and making them better and more efficient to manufacture. Its steps like these has led Etihad to be first airline to be MRO permitted by the EASA to manufacture, and utilise 3D printed parts.

Top: Airbus's THOR takes its first flight (Photo: Airbus).

Right Page Top Left: Detlev Konigorski, Gunnar Haase and Andreas Poppe with their disassembled 3D printed THOR, a small yet promising UAV (Photo: Airbus).

Right Page (Top Right): A complete mock-up of supersonic aircraft shown on an airport has been printed in 3D. (Photo: Boom Supersonic).

Right Page Bottom: Aurora Flight Sciences is a veteran of the UAV world. The giant has currently partnered with Stratasys to dive headfirst into 3D printing for its aircraft. (Photo: www.aero-mag.com).

Limitations of Additive Manufacturing

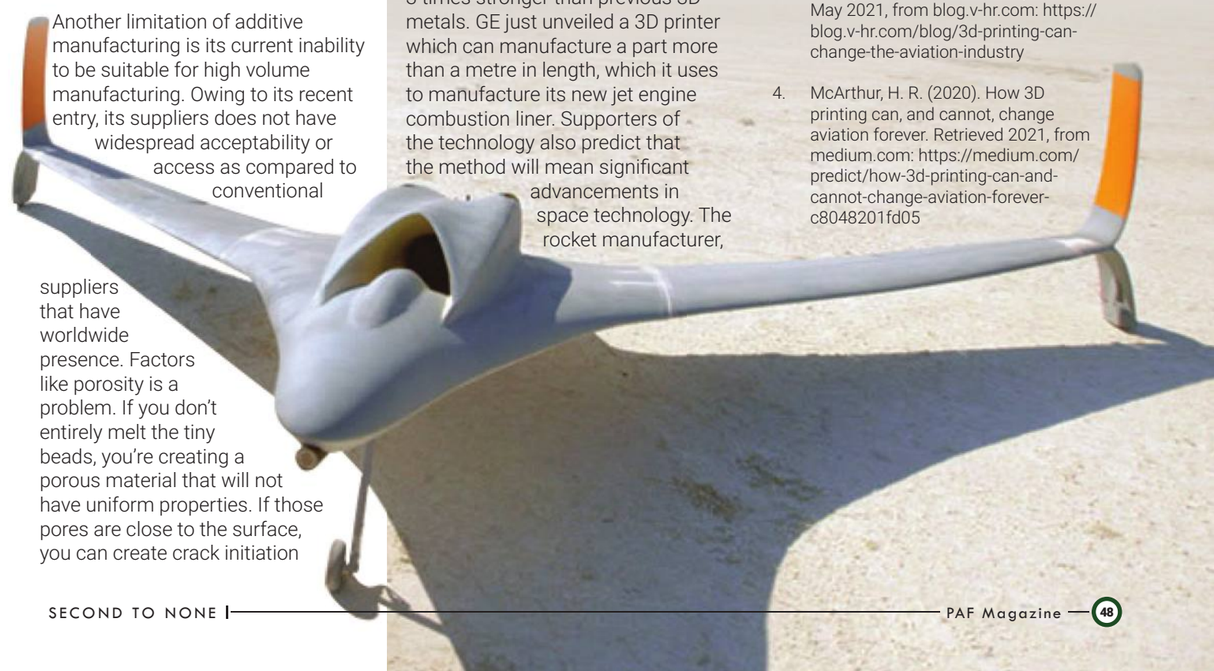
As is the case with all technologies in their infancies, additive manufacturing has its flaws and limitations too. It is not a panacea to overcome all obstacles. The different types each have their shortcomings and flaws, on which researchers are working. For example, it can be expensive, as compared to other methods. Another issue which usually arises is of poor surface finish and rough texture. This, in turn, leads to another shortcoming, the requirement of extensive post-post processing to get the desired results.

Another limitation of additive manufacturing is its current inability to be suitable for high volume manufacturing. Owing to its recent entry, its suppliers does not have widespread acceptability or access as compared to conventional suppliers that have worldwide presence. Factors like porosity is a problem. If you don't entirely melt the tiny beads, you're creating a porous material that will not have uniform properties. If those pores are close to the surface, you can create crack initiation sites, which can be a real problem with things such as aircraft wings. However, these problems are being resolved day by day and it is apparent to all that the importance of additive printing cannot be denied.

Additive printing is still in its infancy yet has already proven itself to be a gamechanger. With new players jumping into its advancement every single day, its only a matter of time before additive manufacturing becomes mainstream in all spheres of life.

Innovations are already underway. The Lawrence Livermore National Laboratory in California has 3D printers that can control metal fabrication on a microscopic level, creating alloys 3 times stronger than previous 3D metals. GE just unveiled a 3D printer which can manufacture a part more than a metre in length, which it uses to manufacture its new jet engine combustion liner. Supporters of the technology also predict that the method will mean significant advancements in space technology. The rocket manufacturer, 'Relativity', predicts that it will soon 3D print 95% of its satellite-carrying rockets.

With funds flowing in and interest soaring high, there is little doubt that 3D printed aircraft will one day fly freely in Earth's sky and beyond.



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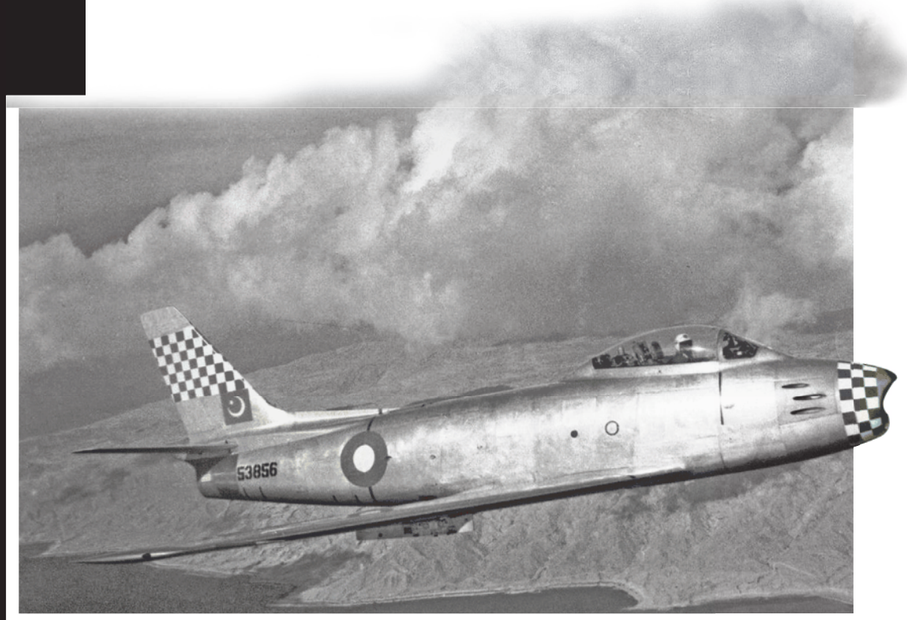
AIR CDRE F S HUSSAIN

PRINCE of PILOTS

Right: In the Cockpit of then newly inducted F-86 Sabre, FS Hussain poses for a photo while flying over Karachi. (Photo: PAF Archives).

Left: The calm before his storm: FS Hussain stands erect with a serene expression on his face, before taking off to play loose and free with laws of physics. (Photo: PAF Archives).



“FS Hussain was a very inimitable sort of pioneer. He has a long list of ‘firsts’ to his name, much higher than the number required to be titled as a successful pioneer. His remarkable mental prowess proved that wit can overtake physical power any day, both of which he possessed ample portions of. However, FS Hussain was made not by the abilities that nature bestowed upon him. Instead, he chose to grab life by the arm and lead it exactly the way he intended it to. The older PAF veterans had the fortune to see him in the skies when they were young and they swear that nor any other pilot came close to his prowess then and neither comes close to this day. Appropriately titled the ‘Prince of Pilots’, FS Hussain was one of those rare breeds of men for whom life is little more than an opportunity to push their limits every second they remain alive.”

by Muhammad Khan

12 March, 1950 was a big day for Pakistan. Iran had become the first nation to accept Pakistan’s sovereignty. And now, the nation’s Shah had arrived in Pakistan for a visit. You could see the posters everywhere. Everybody was thrilled. The air force was no exception. It had chosen its best for a solo display, Flt Lt FS Hussain, banking it all on him. FS Hussain (affectionately known in PAF as ‘FS’) was well-aware of the stakes and had agreed without hesitation. Now, on the day of the ceremony, he stood with his trusty Fury aircraft, making last minute checks. He felt a bit overwhelmed. He knew it was an honour to be chosen for such a task. But now, he was experiencing mixed feelings, pride and nervousness…

He was usually not the one to get nervous. But this…this was different. It was the Shah of Iran. Royalty of the first order. The stakes were very high as the entire nation and its air force has chosen him for this honour. He knew he had to deliver his best. FS started up the powerful 18 cylinder Bristol Centaurus engine of his powerful Fury. It was a perfect day for solo aerobatics at one of the oldest airfields of Pakistan, the RPAF Risalpur. Producing almost 2400 Hp of max thrust, FS took-off for the aerial display which would be remembered for the times to come. He started off with his signature manoeuvre for which he was widely known, 8-pointed slow roll at almost tree top level. Rolling his aircraft just a few feet above the ground, the propeller of his Hawker Fury

was kicking up dust on the runway. The crowd was held spellbound with this death-defying manoeuvre, even the Shah was on the edge of his seat. FS continued with the display, displaying marvels one after another. He made it look like child's play. However, the Shah knew that behind the smooth execution lied hours of painstaking and assiduous practice.

As soon as the display was over, the Shah requested to meet FS Hussain in person. A charismatic conversation thus ensued between the two, leaving the Shah charmed and FS Hussain humbled. In fact, the Shah was so taken with FS Hussain's ability that he ordered his accompanying court poet to write a couplet in honour of the maestro. A rare honour for FS and for the nascent air force.

Humble Beginnings

This is the story of the legendary Fuad Shahid Hussain who rose to international fame during 1950s, mainly due to his breath-taking demonstration of aerobatics in the various air displays held during that time. A competent officer, he was a fighter pilot of highest class who had developed the feel and touch in flying that are seen all too rarely. His accurate and delicate flying skills and his conspicuous courage and dexterity in experimenting with unconventional manoeuvres enabled him to make an aircraft do things that others simply could not.

Above: A Shot Straight from a Hollywood Classic - Flt Lt FS in the cockpit of a Supermarine Attacker, moments before taking off from UK to ferry in the first batch of Attackers. (Photo: PAF Archives).

Bottom: Visiting dignitaries stare in awe as FS Hussain performs death-defying manoeuvres in his Fury over RPAF College Risalpur in the 50s. (Photo: Gp Capt Hussaini painting archives).

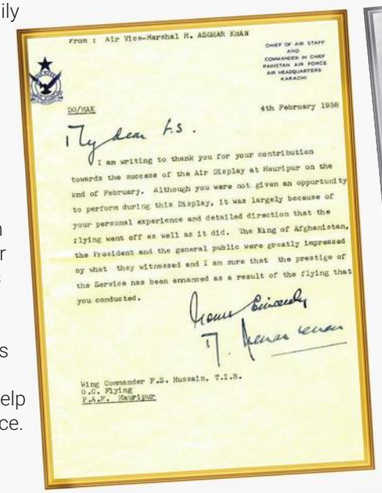
Right Page Bottom: An unforgettable legacy-Gp Capt FS Hussain (centre) with a batch of his apprentices which later proved to be a testament to his training in the wars against India. Seen in the picture are some of the early legends like Sqn Ldr MM Alam, Wg Cdr Bill Latif, Flt Lt Saif ul Islam. (Photo: PAF Archives).

FS Hussain also helped in establishing No 5 Sqn of RPAF, which was formed on 15 August 1947 in Peshawar. The squadron boasted Tempests a formidable aircraft of that time. No 5 Sqn went on to be the first step of several legendary men. FS Hussain can be counted as the top brass among these men and this became apparent from the start.

A Show Stealer

FS Hussain established himself as a flying prodigy from an early point in his career. He was doing slow rolls, flying inverted at tree-top

Above: Air Marshal Asghar Khan, C-in-C, PAF awarding the prestigious SPk to Gp Capt FS Hussain. (Photo: PAF Archives).



from : Air Vice-Marshal M. ASGHAR KHAN

CHIEF OF AIR STAFF AND COMMANDER-IN-CHIEF PAKISTAN AIR FORCE AIR HEADQUARTERS KARACHI

DO/VAK

4th February 1956

Flying Officer F.S.

I am writing to thank you for your contribution towards the success of the Air Display at Mauripur on the 2nd of February. Although you were not given an opportunity to perform during this Display, it was largely because of your personal experience and detailed direction that the flying went off as well as it did. The King of Afghanistan, the President and the general public were greatly impressed by what they witnessed and I am sure that the prestige of the Service has been enhanced as a result of the flying that you conducted.

Yours Sincerely,

T. Asghar Khan

Wing Commander F.S. Hussain, T.I.B.
O.C. Flying
P.A.F., Mauripur

Left Inlets: Commendation Certificate for FS Hussain by Air Marshal Asghar Khan.

Flg Off FS Hussain during early days. (Photos: Zahid Hussain).

level, executing manoeuvres that no young pilot with his level of experience could pull off before him. His reputation grew and he was selected to do what he did best at the first aerial display of RPAF held on Pakistan Day. It was the nation's first Pakistan Day celebration in 1948 and FS Hussain's first aerobatic display in the official capacity. And what a show it was.

A young nation filled with hope, a populace caught in the fervour of being freed from tyranny and a military determined to protect their people with their lives. This was the general degree of passion in Pakistan at the time. And it was contagious to the highest degree. The parade was a symbol of the spirit of a young nation and its people, resilient, reckless and standing strong. FS Hussain was the epitome of this sentiment. Easily the star of the show, the daredevil had a million eyes on him that day. The show started with thrilling manoeuvres pulled off by a Tiger Moth, followed by formation flying by Harvards. These were followed by a death-defying tail-chase executed by 2 Tempests in which FS Hussain was at his best.

FS Hussain dazzled the nation again in 1950, at PAF Base Drigh Road in Karachi. The guest of honour was Prime Minister Liaquat Ali Khan. There were also around 145, 000 spectators to watch the show. FS Hussain started the display with his signature slow roll. This particular manoeuvre requires tremendous skills. FS flew his Fury Fighter inverted at a dangerously low height, with the tail almost touching the ground, at 450 MPH and completed a perfectly executed slow roll.

One of the fans of FS Hussain was the Chinese Premier Mr Chou en Lai as well. During his official visit to Pakistan on

Chou witnesses brilliant air display

KARACHI, Dec. 21: The Chinese Prime Minister, Mr. Chou En-lai, witnessed a brilliant air display by the Sabre and T. 33 jets of the Pakistan Air Force at the Mauripur military airfield this morning.

Mr. H. S. Suhrawardy, the Prime Minister of Pakistan, Mian Jaffer Shah, Education Minister, the Commander-in-Chief of the Air Force, Air Vice-Marshal MacDonald and members of the diplomatic corps saw the thrilling demonstration of precision flight in formations by the young jet wing.

On arrival Mr. Chou En-lai, was received by the Station Commander Group Captain Noor Khan. He inspected a guard of honour presented by a contingent of the Air Force and was introduced to the pilots who were taking part in the display.

Premier Chou En-lai told Pressmen after the display that he liked it "very well". "Your pilots are very well trained," he added.

Four Sabre jets took off in a bid to cross the sound barrier and up at about 30,000 feet at least two generated shock waves when they reached the supersonic speed.

This was followed by a demonstration of air-to-ground strafing by four Sabres which made two attacks and hit the target on the ground with 50 calibre machine-guns.

Led by Wing Commander F. S. Hussain, the crack jet pilot of the Pakistan Air Force, four Sabres then carried out aerobatic manoeuvres in close "box" formation, exhibiting wonderful precision in flight.

The most thrilling event of the morning followed another formation run by T. 33s. Wing Commander F.S. Hussain flying solo at 600 miles per hour performed some beautiful aerobatics and elicited tremendous ovation from the select gathering for numerous "rolls" in the mid-air.

When the demonstration was over, the Chinese Prime Minister shook hands with Wing Commander F. S. Hussain and congratulated him on his performance. Mr. Chou En-lai also posed for a photograph with the pilots who took part in the display.

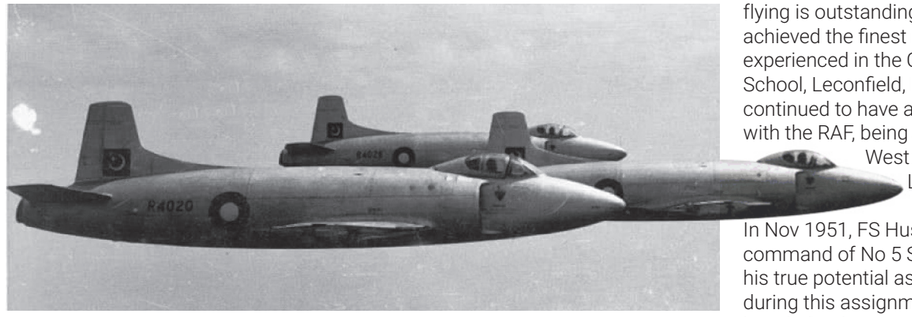
Earlier, he visited the 'mazars' of the Quaid-i-Azam and Quaid-i-Millat and laid floral wreaths on the graves of the Father of the Nation and the first Prime Minister of Pakistan.—APP.

Pak: Times Lahore 22.12.56.

Left: Chinese Premier Chou en Lai poses with legendary FS Hussain after a breath-taking performance at PAF Mauripur in Dec 1956. (Photo: PAF Archives).

Bottom: Sqn Ldr FS Hussain, OC No 5 Sqn (centre) along with under-command officers after proudly bagging the Perry Keene Inter-sqn armament trophy in 1952.(Photo: PAF Archives).

Right Page Above: Sqn Ldr FS Hussain leading a formidable formation of Supermarine Attackers over Karachi. (Photo: PAF Archives).



Centre: In 1952, No 11 Sqn, under the command of FS Hussain, formed an aerobatic team with the curious name of 'Paybills' which was PAF's first jet aerobatic team on the newly inducted Attackers. Here, the 'Paybills' are depicted pulling over Manora at Karachi. (Photo: Gp Capt Hussaini painting archives).

Bottom: Flt Lt FS Hussain (centre), along with pilots, getting ready to ferry the first tranche of Supermarine Attacker from UK to Pakistan. (Photo: PAF Archives).

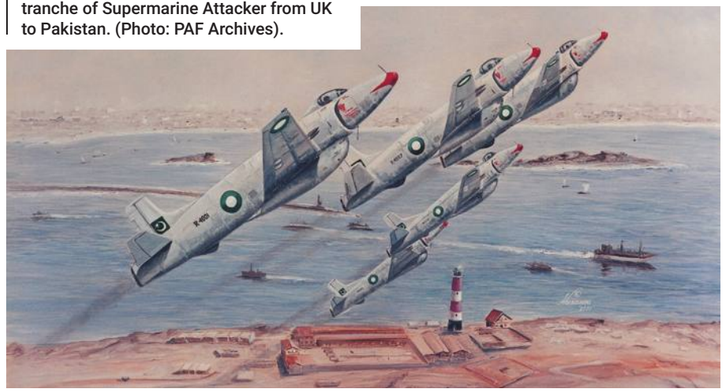
> FS Hussain would loop an Attacker or a F86 inverted all the way. At Karachi Flying Club we witnessed him do these very crazy manoeuvres in a Tiger Moth bi-plane. Spin it from 2000 feet and scare the crap out of us all. But every second and inch during manoeuvres, he was in total control. – Air Cdre Sajad Haider

22 December, 1956, FS Hussain was once again called upon to perform for the premier. He enthralled the spectators at PAF Mauripur with his perfectly executed moves. After the display was over, the Premier requested to meet him in person to admire his ability, a true honour which he rightfully deserved.

A Rare Honour

In 1949, RPAF had recognized the substantial potential that FS possessed. At the time, there was a prestigious course being offered at Central Gunnery School at Leconfield, UK. RPAF selected FS Hussain to be the part of this course. It turned out to be an apt decision. His performance left many in awe. A fearless pilot from an unknown land, exotically reckless in his demeanour, created significant buzz in those times. At the end of it all, FS Hussain led the course with the highest air-to-air and air-to-ground gunnery scores ever achieved by a commonwealth pilot. The Commandant of the Central Gunnery School had this to say about him, "This officer who is a member of the Royal Pakistan Air Force, for combat flying is outstanding in every way. He achieved the finest result in the air ever experienced in the Central Gunnery School, Leconfield, England." He continued to have a long association with the RAF, being a graduate of the West Raynham Fighter Leaders' School.

In Nov 1951, FS Hussain took over the command of No 5 Sqn. He showed his true potential as a visionary leader during this assignment and won many laurels for the squadron. Under his able leadership, his under command fighter pilots learned the secrets of fighter flying and gelled together as a team. His efforts bore fruit on 12 Feb 1952, as the squadron won the precious Perry Keene Inter-Sqn Armament Competition Trophy for the first time.



Left: A picture of Flt Cdt FS Hussain (Sitting first from right) from his training days at RIAF. (Photo: Zahid Hussain).

Centre : Always a Man of Style - A cheerful FS Hussain poses with his 'Hot Rod' at PAF Base Mauripur. (Photo: Zahid Hussain).

Bottom: In a briefing session during a visit to the USAF training institutions. Accompanied by AM Rahim Khan, Wg Cdr Mitti Masood. (Photo: PAF Archives).

Right Page Above: Station Cdr Mauripur, Gp Capt FS Hussain along with visiting foreign dignitaries at RPAF Mauripur. Wg Cdr Bill Latif (2nd from left) also visible. (Photo: PAF Archives).

Right Page Centre: Young Flg Off FS Hussain along with fellow officers of No 4 Sqn RIAF during a visit to Japan after WWII. (Photo: Zahid Hussain).

Right Page Bottom: Shah of Iran, PM Liaquat Ali Khan along with other dignitaries witnessing an aerial display at RPAF Risalpur in 1950. (Photo: PAF Archives).

Enter the Jet

FS Hussain also played a pivotal role when PAF's transitioned from piston to jet engine aircraft. The Attacker was a British-built aircraft and it was PAF's first jet fighter. FS Hussain was chosen to lead the team that had been entrusted with the task of ferrying these new Attackers from UK to Pakistan. It was not an easy task. The stakes and risk involved was monumental. Fortunately, FS Hussain was the best man for the job. He played an instrumental role in planning the ferry route which went through Istres (France) Malta, El Aden (North Africa), Nicosia (Cyprus), Baghdad (Iraq) and Karachi. The route was challenging, however, he prepared it meticulously. The flight was uneventful and the aircraft reached Drigh Road without any problems. On arrival, the aircraft were commissioned in No 11 sqn, thus it became the first jet squadron of PAF. FS Hussain became the Flt Cdr operations of the squadron. His experience made him the quintessential figure when it came to modern aircraft. The British Attackers had some inherent problems. The most prominent pertained to its hydraulics, which led to under-carriage troubles while landing. The PAF pilots, with considerable help from FS Hussain, were soon able to overcome these problems. In 1952, No 11 Sqn formed an aerobatic team under his command, with the name 'The Paybills'. This was Pakistan's first jet aircraft aerobatics team, unsurprisingly formed by the legendary FS Hussain.

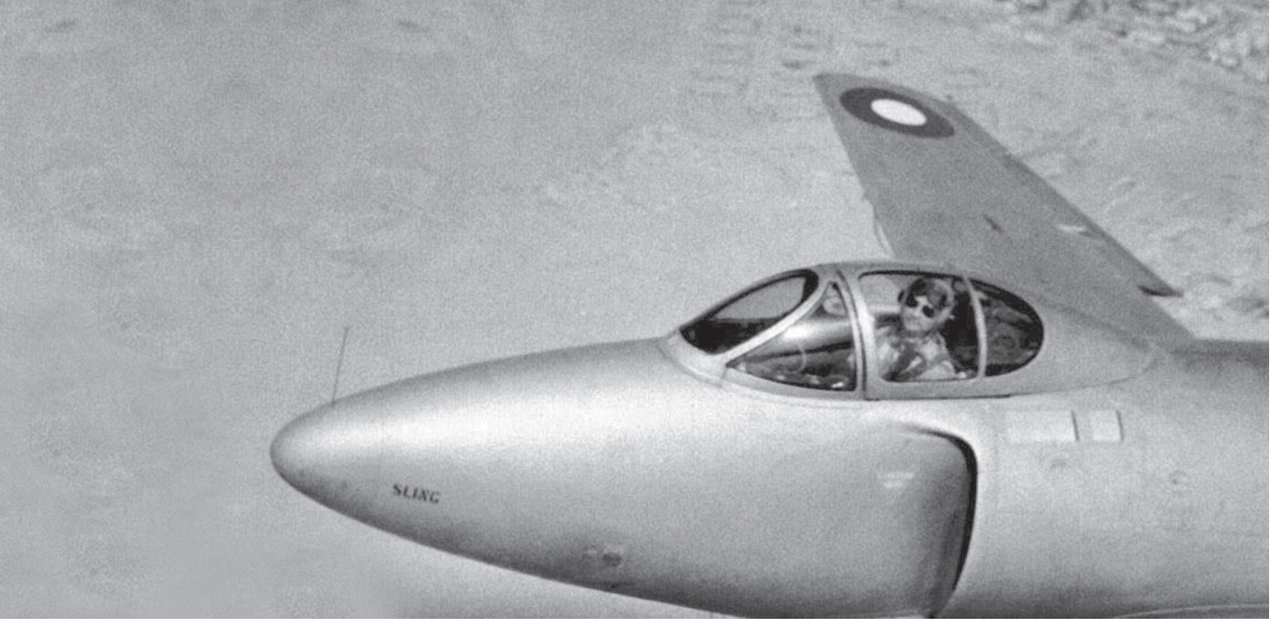
> Shah of Iran was so taken with FS Hussain's flying skills that he ordered his accompanying court poet to write a couplet in honour of the maestro. A rare honour for FS and for the nascent air force.

A Role Model

After dazzling thousands from all over the globe, FS Hussain was tasked with quieter yet equally important responsibilities. The most important was the command of the Mauripur (now Masroor) Air Base from 1961 to 1964. During these four years, he had prepared a batch of pilots which would go on to excel in every sense of the word, each more skilful than the last. MM Alam, Allaudin, Younus, Muniruddin, Sarfaraz Rafiqui, Saif-ul-Azam and Bill Latif are just a few of his students. These men would go on to defend the nation fearlessly in the 65 war, each emerging as a world-class pilot in his own right. But no matter how high they flew later in their lives, all of them considered FS Hussain a mentor, a teacher and, above all, a great human being.

"FS Hussain, the greatest fighter pilot PAF ever had. He would loop an Attacker or F-86 inverted all the way, and at Karachi flying club we witnessed him do these very crazy manoeuvres in a Tiger Moth bi-plane. (He would) spin it from 2000 feet and scare the crap out of us," reminisces Air Cdre Sajad Haider (Retd), (legendary PAF fighter pilot of 1965 war). "But every second and inch during manoeuvres, he was in total control. God bless his soul," adds Air Cdre Sajad Haider (Retd).

When the 1965 war broke out, FS Hussain was a senior commander at AHQ and played an important part in success of PAF against the enemy. From formulating operational plans to implementing them



in its true letter and spirit, FS Hussain proved equal to the task. After the war, Air Marshal Nur Khan tasked him to establish a flight safety institute in PAF. He worked day in and day out for making this possible in a very short span. FS Hussain travelled to the US for a comprehensive course on 'Air Force flight safety and accident investigation'. On his return, he established the Flight Safety set-up in AHQ. Today's flight safety structure of PAF owes a lot to the tireless efforts put in by FS Hussain during those testing times.

The Sad Demise

Nearing the end of his career, Air Cdre FS Hussain was serving as the Assistant Chief of the Air Staff (Training) at AHQ. It was during this tenure that his health started to decline. PAF's ex Air Chief, Air Marshal Zafar Chaudhry has very adequately summed up the reasons of his sad demise in his book 'Mosaic of Memory', he wrote:

"FS was totally dedicated to his profession and had only one desire and ambition in life: to stay in the flying business. Thus, when he started developing a physical disorder rather early in life, his reaction was to conceal it and to ignore it so that it should not lead to his being removed from flying status- a situation he was simply not prepared to accept. His love for flying far exceeded his concern for his own wellbeing; he simply could not imagine a life without the thrill of flying and, therefore, continued to pretend that all was well. The insidious malady remained untreated and, tragically, by the time it became obvious, it had already passed the stage of treatment. The Prince of Pilots died when still short of 45-leaving the PAF and the world of flying so much the poorer."

The legend took his last breath on 9 April 1969. He was laid to rest with full military honours. A large number of senior officials from military and civil institutions attended his funeral. His fans, devotees and admirers from all walks of life also attended his last rituals. He left behind an incomparable series of firsts and a legacy which inspires pilots even today. There is no doubt that the memory of the 'Prince of Pilots' won't fade from the annals of Pakistan's history for a long time to come.

Above: Forever the Showman - Sqn Ldr FS Hussain tilts the plane for an aerial shot while flying over Karachi. (Photo: PAF Archives).

Bottom Left: Gp Capt FS Hussain along with family. (Photo: Zahid Hussain).

Bottom Right: FS Hussain with his loving daughter. (Photo: Zahid Hussain).

Farewell to Prince of Pilots-A collage of the funeral and burial ceremony of the great FS Hussain, the man that shall never be forgotten. (All Photo: PAF Archives).

The Legend Immortalized

In 2008, PAF decided to honour the hero once again. It was proposed that a gallery be erected in his honour at the PAF museum, Karachi. It was to be curated with exhibits to pay tribute to the legend. As the endeavour progressed, FS Hussain's son, Zahid Hussain was invited by the then Air Chief Marshal Tanvir Mehmood Ahmed to Air Force Day dinner. During the ceremony, Zahid Hussain surprised everybody by presenting his father's flying helmet to the air chief. However, this was not where the surprise ended. Upon receiving the helmet, the air chief was overwhelmed with emotion as he found out that FS Hussain's flying gloves were still lying inside the helmet. Even Zahid Hussain was unaware of this fact all these years. It was a touching moment. It was very much apparent that the gloves in FS Hussain's helmet had been last stored there by the maestro himself and had remained untouched since then. The same helmet, along with other personal items of the legend, have been exhibited in a special corner in PAF Museum dedicated to the him. Since then, it has become one of the most sought-after display on the itinerary of the enthusiasts visiting the PAF Museum.

Story of F-20 'Tigershark' Trials by PAF

Trying it Out

Gp Capt (later retd as AVM) Abbas Mirza readies for training flight in F-5F aircraft at Edwards air base, California USA.

"Easy to fly, a capable jet with a powerful time-tested engine, quick deployment capability from sitting on the ramp to being in the air in minutes, endorsed by the greatest of test pilots Chuck Yeager, all in all a neat and cheap package, was the quick-response high-performance F-20 'Tigershark'. Was it a missed opportunity for the PAF? The author travels back in time and brings back to us an interesting story lost in time."

by S.Khalil

Wearing Pakistani Flag and PAF roundel, F-20 Tigershark being flown by Gp Capt Abbas Mirza over Mojave desert, California. (All Photos AVM Abbas Mirza unless specified).

Pakistan has had to guard its borders against a sudden possible attack from a belligerent enemy minutes away. This has always held true. Its first line of defence has always been its formidable air force.

Potentially unfriendly countries were flying fast and high, not to mention their well-armed, smooth and manoeuvrable aircraft that outclassed the jets of their opponents, dragging Pakistan into an unnecessary arms race. The Pakistan Air Force had to put all its efforts into strengthening its fleet, investing in modern jets with new levels of reliability, especially when air force played a decisive role in safe guarding the nation during 1965 and 1971 wars.

PAF was always in search of a combat aircraft that could carry out all its required tasks, had a modern design, and above all easy to maintain. With the start of the Afghan war in late 70s that need was felt even more. While some jets such as the 1950s Mirage in the PAF fleet offered high performance, the French made delta wing fighter was an aging technology and was also not a multi role fighter. Other platform on the PAF inventory was the Chinese F-6 which was just stick and rudder and was no match to the Soviet fighter aircraft in the likes of Su and Mig series.

To make up for so many shortcomings, the PAF turned to the west. With the assumption of PAF command in July 1978, the then CAS, Air Chief Marshal (ACM) Anwar Shamim was also well cognizant of these developments. Also, these were the times when Afghan war was well underway and the Reagan administration had become amiable to Pakistan in supporting the Mujahideen against the Soviets. The thrust of the PAF was to acquire the already-into-production F-16s which were the cutting edge of technology.

Owing to ACM Anwar Shamim's effective diplomatic efforts, the

AVM Abbas Mirza (Retd) who test flew the F-20 explained why the aircraft did not meet the PAF air staff requirements.

PAF succeeded in procuring the most sought after F-16s from the US. However, their number was limited to only 40, much lesser than the PAF requirement. To augment and complement these handful number of F-16s, PAF needed a low-cost fighter that was state-of-the-art, fulfil all the ASR (Air Staff Requirements) perform variety of roles and was easy to maintain. Initially, three US jets were shortlisted by the PAF, Fairchild Republic A-10 Thunderbolt, LTV A-7 Corsair-2 and the Northrop F-20 Tigershark. All the aerial platforms were potent in their categories, and were also combat proven during various conflicts around the world.

During his visit to the US in the early 1980s, ACM Anwar Shamim, met with representatives from Northrop. The giant jet manufacturers offered the PAF America's newest and most dependable tactical fighter, the F-20 Tigershark. It came from an impressive lineage of aircraft developed by Northrop. It looked similar to the F-5 and the F-5F, but under the skin it was a very different beast.

It was the most modern and reliable fighter flying then, with advanced avionics systems and performance needed to dominate the air combat arena. Instead of two, it was fitted with a tested and proven single 404 engine, the same monster that powered Northrop's reputable F-18 Hornet. The F-20 could launch weapons that the F-16 then could not and came fitted with beyond visual range (BVR) radar when the fighting falcon did not. The Tigershark was going to be a welcome upgrade especially to replace the F-6 and the PAF wanted 100 of them. But it was amazing that a fighter with the fastest scramble time, using half the fuel, several times more reliable than any of its competitors, and less than half maintenance cost, was not adopted by the Pakistan Air Force. What killed the F-20?

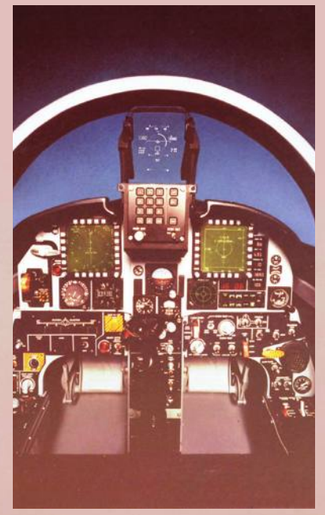
Above: Gp Capt Abbas Mirza after flying the first solo flight on F-20 Tigershark.

Top Right: Gp Capt Abbas Mirza flew few training sorties along with instructor in F-5F before test flying the F-20.

Right Above: Performing last minute checks before taking to air in a F-5F trainer aircraft.

Right Bottom: Gp Capt Abbas Mirza gets pointers from his instructor pilot during a ground training session. Unfortunately, the same instructor, later, died while performing demonstration flight on F-20 in South Korea.

Right Page Centre: Cockpit of F-20 Tigershark appears to be 'ahead of its time' as compared to its competitors.



The Trials

Between 1982 and 1984, a unique opportunity presented itself to try out the Tigershark. Under special instructions from the CAS, Air Vice Marshal Abbas Mirza (Retd), a Gp Capt then, was sent to US on

F-20 Tigershark Specifications	
Maximum Speed	Mach 2 class
Sea level rate-of-climb	52,800 feet/minute
Combat ceiling	54,700 feet
Take-off distance	1,600 feet
Scramble order to brake release	52 seconds
Scramble order to 29,000 feet	2.5 minutes
Time to 40,000 feet from brake release	2.3 minutes
Acceleration Time	0.3M to 0.9M, at 10,000 feet 28 seconds
Sustained Turn Rate	0.8M at 15,000 feet 11.1 degrees/second
Maximum Load Factor	9g
Length	46 ft 6 in
Height	13 ft 10 in
Wing Span	26 ft 8 in
Internal Fuel	5,050 lbs
External Fuel	6,435 lbs
Take-off Weight	clean 18,005 lbs
Combat Thrust/Weight ratio	1:1
Combat Weight	50% fuel, 2 AIM-9 missiles 15,820 lbs
Maximum Weight	27,500 lbs
Armament	▸ Two AIM-9 missiles ▸ Five pylons, more than 8,300 lbs external armaments

Gp Capt Abbas Mirza takes off for his first familiarization flight on F-5F trainer.

a special assignment to find out ways and means to modernize PAF's air defence systems. On his arrival, he was deputed with Northrop, to test fly the F-20 and submit an assessment. Abbas Mirza was to become one of the few test pilots to fly one of the F-20s, of which there were only three in operation for demonstration flying.

Early in the morning, they would fly him to the famous Edwards Air Force Base in the middle of Mojave Desert in California, where he got acquainted with the F-5F before conversion to the F-20. From starting to landing, he would get pointers from some of the best American test pilots, who would discuss the aim of every manoeuvre, learning invaluable lessons in extremely detailed briefings.

"My test pilot instructors were highly professional. In no time we developed a good relationship and became close friends. Unfortunately, one of the pilots with whom I flew my first mission later died while performing a F-20 demo flight in South Korea. These are dangers involved in this profession and we have to live with it throughout our careers. I still feel sorry for him," reminisces AVM Abbas Mirza with a heavy heart.

The ground schooling and training continued for some time. Then came the day Abbas Mirza tested its performance - max take off, rate of climb, max Gs, acceleration, manoeuvrability to whatever limits he could push the Tigershark and not just aerobatics and loops and slow turns etc.

He called it one of the best platforms for defence that could get off the ground, carry modern weapons, manoeuvre rapidly and intercept in a few minutes from a cold start.

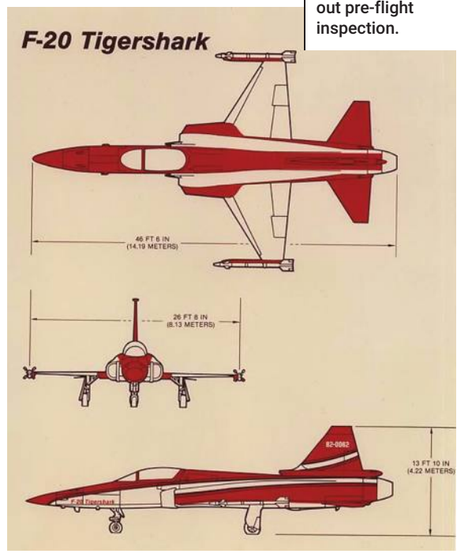
"The F-20's electronics had been updated to levels that in

Left: Gp Capt Abbas Mirza poses for the camera after completing the first training flight on F-5F trainer.

Bottom: All Smiles-A Northrop representative congratulating Gp Capt Abbas Mirza after completing first solo sortie on F-20 Tigershark.

Right Page Bottom: F-20 Tigershark in PAF livery scheme resting on tarmac at Edwards air base, California. (Photo: Keith C Svendsen).

Left Inlet: Gp Capt Abbas Mirza carrying out pre-flight inspection.



some ways were superior to the first batch of the F-16 delivered to Pakistan in 1982," Abbas Mirza said looking at some of the pictures of himself sitting in its cockpit and reminiscing.

On September 1, 1984, with an F-5 chase plane, Abbas Mirza flew the first solo mission from Edwards Air Force Base, home to all prototypes and the citadel of all test flights. "I lit the afterburner, got airborne and did a max rate climb at 450 knots and was at 30, 000 feet in less than two minutes. The jet had good acceleration. Then descended to 5, 000 feet for inverted flying and max 9G turns all the time trying to lose the tail aircraft," he said remembering, what he called was a memorable mission.

On the second one-hour mission, Abbas Mirza tested its handling at slow speeds, formation flying and chasing the lead aircraft.

The Verdict

While there was no doubt that the Tigershark possessed advanced handling characteristics, however, it lacked in some areas in which PAF was primarily interested in. "The main drawback was that I was not able to evaluate its live weapons delivery and weapon control systems because they were not ready at that time. There was no knowing how the aircraft would perform as a weapon system," Abass Mirza recollects. During his stay at the base, he urged upon the Northrop authorities to let him test the performance of the aircraft while delivering weapons. However, that never materialised.

"By then a change was taking place in aircraft structures to minimise radar

Northrop manufactured three prototypes for demonstration flights across the world. The fate of these aircraft is as follows:

- Serial No 82-0062 (Northrop serial number GG.1001) – crashed at Suwon Air Base, South Korea on 10 October 1984. Pilot killed.
- Serial No 82-0063 (Northrop serial number GI.1001) – crashed at CFB Goose Bay, Canada on 14 May 1985. Pilot killed.
- Serial No 82-0064 (Northrop serial number GI.1002) – the only serving aircraft is presently on display at California Science Center in Exposition Park, Los Angeles, California.

signatures, to fly supersonic without the afterburner, capable of launching long range BVR missiles, depending not so much on stick and rudder, and to have the ability to see first and fire first. That was the direction given to me by the air staff, and the F-20 was not in that category," Abbas Mirza expanded.

In his report to the PAF, Abbas Mirza's final conclusion was that the F-20 was designed to be inferior to the contemporary US jets that the US was adamant on selling to developing countries with meagre budgets and low-level threats. No country bought it. Not even the United States Air Force (USAF). "None of the air forces showed interest in the aircraft despite its hectic demo flight schedules across the world. There was no point acquiring these aircraft for PAF. This is what I recommended to air staff on my return to Pakistan," Abbas Mirza added. The air staff agreed with his recommendations and shelved the F-20 procurement once for all.

Vastly superior to the Mirage III and Mirage V, and the F-6 and the A-5, a system very close to the F-16, perfect for the Indo-Pak scenario back then, the PAF decided not to settle for second best. Despite aggressive marketing campaigns, the Tigershark failed to obtain sales. By the end of the 1980s, the low-cost F-20 died its natural death.

Where ACES MEET

Together We Train and Rise

Earlier in April this year, residents around an operational Pakistan Air Force base noticed an increase in military aircraft activity. Even the roar in the air sounded different. It was the Saudis, in their Tornados, who had come to join the big boys club. Pakistan Air Force officers stood on the flight line to welcome the pilots of Royal Saudi Air Force that had come to take part in the PAF's premier joint exercise "ACES Meet 2021-1". Warm welcome, exchange of pleasantries and souvenirs were the order of the day. Tornados, parked alongside their counterparts including F-7Ps, JF-17s, veteran Mirages and the F-16s presented a scene seldom seen at a PAF airbase. Observers from various allied countries also rallied together to learn from each other's experiences which remained the hallmark of this premier international exercise orchestrated by PAF ACE (Air Power Centre of Excellence).

ACES Meet 2021-1

Every "ACES Meet" exercise is unique and this one in April was no exception. While the USAF, Bahrain, Egypt and Jordan air forces sent their teams of international observers, this year the RSAF showed staunch support by participating with their Tornados.

"PAF's 'ACES Meet' exercise has been held annually since 2017. Over the years, it has attracted a large number of nations and taken their cooperation and collaboration to new heights. As always, the editorial team takes the reader by the hand and gives them a first-hand account of the two-week long exercise that saw allied air forces churning out their best."

by Editorial Team

Title Photo: A Saudi Tornado arriving at a PAF operational base to participate in Exercise ACES Meet 2021-1. (Photo: Awais Lali).

Right: PAF F-16's moments before take-off for an exercise training mission. (Photo: WO Iftikhar Muhammad).

'ACES Meet 2021-1 at a Glance'

Glimpses of various participating aircraft during Exercise ACES Meet 2021-1 (All Photos: WO Iftikhar Muhammad)

Over the period the exercise has promoted long lasting friendship and deepened understanding of cultural values between the peoples of the supporting countries.

"The combined exercises give us an opportunity to work together and show how closely aligned we are in terms of our objectives across the spectrum of joint operations," said Air Cdre Ahsen Yousuf, Commandant ACE, at the inauguration ceremony of the exercise.

The two-week long training exercise provided aircrews the experience of multiple, intensive air combat sorties in the safety of a training environment.

The goal of the PAF's premier combat training operations was to subject airmen as well as ground troops to the most extreme environments. It prepared the pilots, for taking up complex missions and also to familiarize them with the capabilities and problems of the forces around them. The joint missions were planned meticulously so that life-threatening mistakes were reduced. The highlight for this year's exercise was its scenario based build up which simulated conflict escalation from insurgency to all-out war. The exercise commenced with CT (Counter Terrorism) phase with increasing difficulty level leading to employment of large force.

Tornados, Thunders, F-16s streamed low and fast while ground forces comprising PAF SSWs, Saudi and USAF Special Forces carried out military drills across the Thal desert. Variety of missions saw F-16s and the JF-17s combat jets working hand in hand with the Saudi Tornados. PAF's EW assets and force multipliers also remained the key component of the exercise.

A separate day during the exercise was kept for a visit by various dignitaries. Air Marshal Syed Noman Ali, Vice Chief of the Air Staff, Pakistan Air Force along with Major Gen Eid Bin Barrak Al-Otaibi, Commander King Abdul Aziz Air Base visited and reviewed the exercise on 5 April. The dignitaries visited the operational areas and witnessed the air ops being carried out by combat crew.

They also remained with participating airmen for some time and appreciated their professionalism. Earlier on their arrival, Air Commodore Ahsen Yousaf, Commandant Airpower Centre of Excellence gave a comprehensive brief about the salient features and progress of the exercise. The Vice Chief expressed his satisfaction over the operational preparedness of the participating units and the overall conduct of the exercise.

The Backdrop

This was not the first time that this premier exercise was conducted by PAF. Its history dates back to 2015 when the PAF leadership realised the need to formulate a formal mechanism; first to ascertain threat tactics and then develop an effective counter-tactics in present day technologically savvy and fluid environment. To achieve this prime objective, a new setup named 'ACE' (Airpower Centre of Excellence) was established in 2017 with a mandate to develop and disseminate tactics, procedures, techniques and solutions to PAF combat units. Besides, the role and task of ACE also included enhancement of the combat potential of PAF crew through near realistic, role specific and objective oriented training. The mandate given to ACE was creation of an integrated environment, governed by tough training standards, in order to evolve tactics & counter-tactics through a continuous process of analysis, research & development.

A Saudi Tornado getting ready for a training exercise mission.
(Photo: WO Iftikhar Muhammad)

Saudi pilots after a mission during ACES Meet 2021-1 (Photo: ACE).

In the backdrop of Tornados, Royal Saudi Air Force contingent pose for a photo along with their PAF counterparts at their arrival to participate in ACES Meet 2021-1. (Photo: ACE).

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Another important task entrusted to ACE at the time of inception was to conduct international exercise by the name of 'ACES Meet', annually. For this purpose, allied countries gather every year at a PAF operational base on the invitation of ACE. The exercise mainly involves Composite Air Operations by assets of allied participating nations in synergy with PAF fighters and combat support assets simulating joint action against conventional and sub-conventional threats. Successes achieved by PAF's in eliminating asymmetric threat during operations Rah-e-Nijat, Rahe-Rast and Zarb-e-Azb while achieving minimal collateral damage remained the guiding principles for the conduct of exercise. That's why, to share its experiences with friendly countries, ACES meet includes a valuable CT phase. This important phase involves Intel build up, employment of fighter aircraft, ISR platforms utilizing precision munitions through assistance of JTACs (Joint Terminal Attack Controllers) and C2 (Command and Control) platforms for successful mission achievement. The phase is curated in near-realistic environment through integration of ground manoeuvres simulating the Blue forces and terrorists. This year's exercise saw seamless joint operations in terms of coordination and integration and the air and ground forces operated in complete synergy.

Culmination of Exercise

The multi-national international air

1: Air Marshal Syed Noman Ali, Vice Chief of the Air Staff along with participants of the ACES Meet exercise. (Photo: ACE).

2: A Saudi Tornado prepares for a mission during ACES Meet exercise. (Photo: ACE).

3: Air Marshal Syed Noman Ali, Vice Chief of the Air Staff presenting a memento to Saudi Defence Attaché. (Photo: ACE).

exercise “ACES Meet 2021-1” concluded at an Operational Base of Pakistan Air Force on 8 April, 2021. A closing ceremony was held in this regard. Air Commodore Ali Naeem Zahoor, Base Commander of an operational base was the chief guest at the occasion. His Excellency Nawaf Saeed Al-Malky, Ambassador of KSA to Pakistan graced the ceremony as guest of honour. Air Vice Marshal (Pilot) / Staff Awad Abdullah Al Zahrani, Defence Attache KSA and Colonel Wallin David, Air Attaché USA were also present in the ceremony along with observers from Bahrain, Egypt and Jordan.

Addressing the participants of the exercise, the chief guest said, “PAF is happy to share its experiences and expertise in the field of Counter-Terrorism Operations with RSAF and USAF. At the same time, Exercise ACES Meet has also provided a good opportunity for us for mutual learning.” He further said, “With the successful and meaningful conduct of exercise, we have consolidated our resolve that we stand by each other as allies and friends.” He said that the exercise boosted readiness to fight and improve interoperability alongside friendly nations. “ACES demonstrates the responsiveness and commitment of partner air forces to regional security in the region,” he stressed.

His Excellency Nawaf Saeed Al-Malky, Ambassador KSA to Pakistan while sharing his views with the audience thanked Pakistan Air Force for arranging the joint operations, especially in Covid-19 situation. He said that such exercises increase the comradeship and professional excellence of the participants. Colonel Wallin David, Air Attaché USA also congratulated Pakistan Air Force on successful completion of the exercise.

Friendships were made at the individual levels during the ACES Meet, while the air forces developed long term strategic alliances needed to address future challenges and ensure security and prosperity of the allied nations. It would be justified to say that through ACES Meet, the PAF has become an extremely effective instrument of foreign policy.

A Saudi Tornado takes off for a training exercise mission. (Photo: WO Iftikhar Muhammad)

1: All Geared Up- PAF SSW personnel pose for the camera before launching for a CT Ops mission on a C-130 aircraft. (Photo: ACE).

2: PAF SSW team along with RSAF & USAF crew during a JTAC mission in Thal desert. (Photo: ACE).

3: Saudi Defence Attaché presenting Momento to Air Cdre Ahsen Yousuf, Commandant ACE. (Photo: ACE).

4: Air Cdre Ali Naeem presenting Memento to HE Nawaf bin Said Al-Malki, Ambassador of KSA to Pakistan during an inaugural session of exercise. (Photo: ACE).

5: Group photo of member of PAF, RSAF and USAF Special Forces during Exercise Aces Meet 2021-1. (Photo: ACE).

ARTIFICIAL INTELLIGENCE

LEADING TO 4th INDUSTRIAL REVOLUTION

“Artificial Intelligence (AI) is here to stay. What initially looked like sci-fi, only limited to movies and novels, is rapidly becoming reality. AI with its immense potential is making giant strides in all imaginable industries, and aerospace is no exception. While deliberating upon its evolution, the author analyses how this emerging paradigm is setting the ground for the fourth industrial revolution of our era.”

by Air Cdre Raza Haider

The 1st Industrial Revolution (also known as mechanical revolution) spanned about 100 years from mid 18th century to mid 19th century with the introduction of mechanical production, steam engines, rail tracks, etc. The 2nd Industrial Revolution (also known as electrical revolution) spanned from late 19th century till early 20th century and made mass production possible with introduction of electricity. The 3rd Industrial Revolution (also known as computer revolution) began in 1960s with the development of semi-conductors, computers, electronics and internet.

Now we are at the door step of 4th Industrial Revolution (IR-4) dominated by Artificial Intelligence (AI), smart machines, powerful sensors, Internet of Things (IoT) and intelligent micro gadgets. We can also say that IR-4 refers to the intelligent integration and networking of machines and processes with the help of information and communication technology. In fact, IR-4 has already started shaping our lifestyle, personality, working, communication mediums, thinking and; therefore, important to devise the policies and procedures at national as well as an organizational level to smoothly adapt changes in our emerging new environment and convert the ‘associated challenges into opportunities’.

What is 4th Industrial Revolution?

4th Industrial Revolution (IR-4) is defined as a ‘fusion of advanced and emerging technologies using the power of digitization and information technology’. IR-4 is expanding in a much faster pace as compared to previous revolutions and it is envisaged that IR-4 will dominate the world by 2030. These include advanced robots, advanced simulation, augmented reality, 3D printing, integrated systems, cyber security, Internet of Things (IoT) and big data analysis. In my opinion, the key technology would be the IoT which actually connects different intelligent devices like aircraft, machines, computers, televisions, mobiles, etc through networks and generating ‘big data’ for algorithmic results for accurate decisions.

> “Economic, social and technological sectors may be re-organized to take full advantage of 4th Industrial Revolution (IR-4) innovations for driving us towards sustainable development goals.”

IR-4 Changing Our Life Style

Based on years of surveys and interviews conducted in various parts of the world, our work and lifestyle shift is imminent within a decade as emerging technologies have started to enter in public domains to a significant degree. Therefore, it is important to know the areas which would be shaped by IR-4; to prepare our organizations / country for upcoming trends and associated benefits / challenges out of which few major ones are appended in subsequent paragraphs.

Machines Connectivity through ‘Internet of Things’

The Internet of things (IoT) is the network of physical objects (called as things) that are installed with sensors, software and other advanced technologies for the purpose of connecting and exchanging data with other devices through Internet enabling decisions based on algorithms. For example; modern aircraft are installed with multiple types of sensors which are real time connected with the ground equipment for integrated maintenance and logistics support systems to have predictive maintenance and recovery for quick turnaround. Similarly, in consumer market; IoT devices are a part of the concept of smart homes which includes networking of lighting, heating, air conditioning, TV, security systems, kitchen devices, etc and even savings by automatic energy and environmental management. Similarly, companies are integrating

their products with cars for automatically turning up the heaters in snowy countries just short of reaching home.

Big Data Analytics for Decision Making

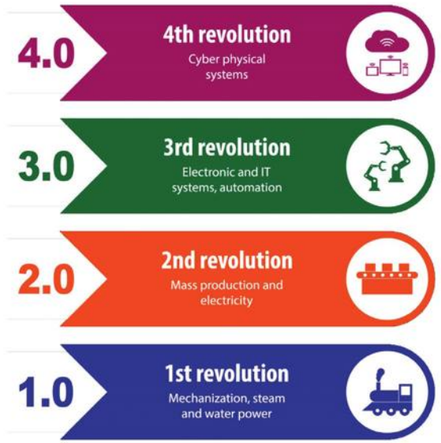
Data is increasing day by day (getting double every 1.2 years) and organizations are working to develop algorithms to utilize their data for accurate decision making. Big data is a field to analyse methodically extract information through prognostics or analytical formulas from data sets that are too large to be dealt through traditional data-processing software. The term big data also tends to refer to the use of predictive analytics and user behaviour analytics to extract value from data. In case of aviation, big data possesses a lot of utility by converting aircraft and associated equipment data to Big Data for analytics and subsequent utilization in maintenance and operations.

Microchips in Humans

People are getting more and more dependent on gadgets and connected devices for communication, location, health, etc. Old examples are heart pacemakers or acoustics implants and trials are in progress for implantable nano-chips (RFIDs). It is envisaged that nano-chips would be implanted inside every human body in future; to serve as identity cards or passports, mobile phones, brain waves readers, healing medicines, password, logon to mobile or computers, etc. For example; as a trial, chips are inserted in hands of individuals between forefinger and thumb to open secure elevators, doors, unlock mobile phone / laptops and store digital business cards. Similarly, health monitoring is under trial by sending "smart dust" of sand grain size inside body which may detect, record and transmit health information to medical monitoring centres for predictive actions.

Individual Presence on Internet

Today 4.57 billion people (60% of the world) are active internet users and connected to the internet. In future, internet access and wifi would not only be a luxury but a basic right of people like electricity or water and would be available to the complete globe. With its growing influence on individual consumers and large economies alike, the internet has become an increasingly vital part of our day-to-day lives. While it may have many positive outcomes, digital presence would have its own challenges as it possesses remarkable linkages with daily lifestyle. Building and managing digital relations would be a social challenge especially for children when they would be sharing ideas and seeking guidance from strangers (instead of parents/ family), find and be found and maintain virtual contacts throughout the world.



Super Computer on your Mobile

Today's smart phone possesses more computing power than former super computers of room size and is actually a super computer in our pocket. Currently, 3.5 billion (45%) of world population using smart phones and expected to keep growing @ 9 percent per year and would hit 7.2 billion by 2023. Over time, smart phones have replaced laptops as phones getting smarter day by day. It makes sense that smart phones will now serve as our primary computing devices in future; as performance gap between smart phones and laptops keeps widening and users upgrade their smart phones at a faster rate than their notebook PCs.

3D Printing

3D printing or additive manufacturing is a process of creating object by layer to layer printing from a 3D CAD model. 3D printer is fast and economical as compared to traditional manufacturing of 'removing layers' instead of 'additive layers' and has a capability of making more complex models with simple equipment. For example, in health sector; 3D printing can make tailor-made human parts through a process known as bio-printing and first use of 3D printed spine was done in 2014 to replace cancerous vertebra in neck with new vertebra; which was modeled from original vertebra of patient.

> AI based maintenance not only enhanced flight safety, aircraft availability and cost effectiveness, but also leads to accurate trends, procurements and budgeting.

IR-4 in Aircraft Predictive Maintenance

Generally, there are two types of maintenance which are followed in the aviation world. Unscheduled maintenance which is carried out once item has malfunctioned and scheduled maintenance which is based either on calendar or hours of operations, calculated on the basis of statistics or MTBF of components.

In IR-4, concept of 'AI based networked predictive maintenance' emerged with the advent of artificial intelligence and big data. In this concept, monitoring of aircraft parameters is carried out through sensors using real time data for condition-based maintenance instead of scheduled / preventive maintenance. Moreover, AI based maintenance can also have following additional advantages:

- AI based maintenance not only enhanced flight safety, aircraft availability and cost effectiveness but also leads to accurate defect trends, procurements and budgeting.
- Big data results can enable the maintenance crew to make data driven decisions instead of individual decisions.
- AI based maintenance provides individual aircraft tracking and fleet health by providing quantitative information like sorties, inspections, components tracking, configuration management, upgrades, etc.

Way Forward

We cannot deny that we are at the beginning of Industrial Revolution-4. Stephen Hawking said 'Whereas the short-term impact of AI depends on who controls it, the long-term impact depends on whether it can be controlled at all'. IR-4 impacts will ultimately be determined by our ability and efforts to tailor it in a way to safeguard our interests. In this regard, under mentioned are few recommendations as a way forward:-

- IR-4 'challenges' may be first 'identified' and subsequently transformed into 'opportunities' by ascertaining IR-4 effects and impacts in future.
- Awareness and understanding in all public and private sectors of Pakistan may be enhanced through syllabus reviews at educational / training institutes.
- Economic, social and technological sectors may be re-organized to take full advantage of IR-4 innovations for driving us towards sustainable development goals.
- Due to high trend of data-intensive technologies in defense, education, health, media, sports, agriculture and industries, 'Big Data' analysis field may be promoted in Pakistan owing to rising demand of Information management specialists in future.
- A comprehensive policy may be developed at national and organizational levels to shape IR-4 for coming generations.

> In case of aviation, Big Data possesses a lot of utility by converting aircraft data to 'Big Data' for analytics and subsequent utilization in maintenance and operations.

FINEST HOUR

TALE OF DEFECTED AN-26

"The training of aircrew has always remained the hallmark of PAF, thanks to its prestigious training institutes. It is this rigorous training and skill which led a crew of transport wing to ferry a defected Afghan air force AN-26 aircraft, which they had never flown before, that too under grave threat from the enemy. This untold tale will inspire our readers for a long time to come."

by Air Cdre Khalid Kamal (Retd)

It was a pleasant and relieving sight. Two Mirage aircraft flying above us in zig zag patterns, providing aerial protection against any possible Russian attack. We were aware that the patrolling Russian fighters were waiting for us to get airborne. Their target was their own aircraft, AN-26 that defected to Miranshah.

It was a regular day in the squadron. I was relaxing in the crew room. Someone informed me that my officer commanding (OC) Wg Cdr Ghafoor, was planning to fly an Afghan AN-26 aircraft that had defected to Miranshah airport. This Russian Antonov-26, a twin-engine turbo prop light multi-purpose transport aircraft, was on a routine flight from Kabul to Kandahar. However, instead of continuing to its destination, it entered Pakistani airspace and landed at a disused airfield of Miranshah.

Back then, I was a co-pilot on the F-27 Fokker Friendship aircraft in No 12 VIP Squadron. Being young and perpetually on the lookout for thrill, I considered myself suitable for this mission and went straight to OC's office. I saw him sitting with senior navigator Sqn Ldr Zulfiqar with planning maps spread on his table. After saluting them I said, "Sir, if you need a co-pilot for this mission, I am available."

They both looked up to me and Wg Cdr Ghafoor said, "Do you know what sort of mission is this, it's extremely dangerous and could turn out to be fatal. The Russians would try and shoot down this plane as soon we get airborne from Miranshah. So, you better think before you volunteer for this".

Upon my insistence, they agreed to let me fly with them as co-pilot. Next morning, I reported with my night kit and we were flown to Miranshah on Beechcraft by Sqn Ldr Khalid and Flt Lt Naeem. At Miranshah we were greeted by Pak Army officers. We wanted to visit the aircraft to make ourselves familiar with it but was advised not to, due to the firing going on from across the border. The aircraft had been camouflaged by covering it with tree branches.

Title Photo: Afghan AN-26 is a valuable addition to PAF Museum Karachi. (Photo: PAF Archives).

Left Bottom: Flt Lt Khalid Kamal pose with Afghan AN-26 after flying a historic mission. (Photo: Air Cdre Khalid Kamal Retd).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We were taken to officers, mess of an Army unit and there we met the pilots of the defected aircraft. They were kept in a locked room. We found out that the Afghan captain of the aircraft had already dispatched his family to Pakistan and then defected the aircraft to seek asylum. His co-pilot was furious with his decision and was continuously fighting with him. He had legitimate reasons to be angry. He could have sent his family to Pakistan, as well, if the captain had informed him of his plan in advance.

It was 23 September, 1984 and we planned our departure early in the morning before dawn. However, it was delayed due to some operational issues. After getting ready we asked the army guys to take the Afghan captain to the aircraft to help us in checklist procedures. He was told that he was going with us to a city in Pakistan and would assist in flying. He was extremely happy to know that and went with us enthusiastically. On the other hand the co pilot was even more irked on this development. We were safely escorted to the aircraft. After taking our seats we asked the Afghan captain to help us start the engines. He happily did what ever we asked him. After we were ready for taxi out and take off, he was told that he would not be flying with us. He got extremely upset and annoyed and had to be forcefully removed from the aircraft by army personnel. On his way out, he flipped a switch on the flight engineer panel which we did not notice.

> Russian Antonov-26, a twin engine turbo prop light multi purpose transport aircraft, was on a routine flight from Kabul to Kandahar and instead of continuing to destination it entered Pakistani airspace and landed at a disused airfield of Miranshah.


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1: The Crew- From L to R, Sqn Ldr Zulfiqar Ahmed (Navigator), Wg Cdr Ghafoor (Captain), Flt Lt Khalid Kamal (Co-pilot), WO Shabbir (Flight Engineer). (Photo: Air Cdre Khalid Kamal Retd).

2: Beautiful side view of Russian AN-26 parked at PAF Museum. (Photo: PAF Museum).

3: Bubble canopy on the side of the fuselage provides unobstructed field of view to the navigator of the aircraft. (Photo: PAF Museum).

4: Another view of Afghan AN-26 parked at PAF Museum, Karachi. (Photo: Wg Cdr Mudassir).

Right Bottom: For quite sometime, the aircraft remained parked at PAF Chaklala (now Nur Khan) wearing PAF colour scheme and markings. (Photo: Alan Warnes).

AN-26 Specifications	
Crew	Five (two pilots, one radio operator, one flight engineer, one navigator)
Capacity	40 passengers / 5,500 kg (12,100 lbs)
Length	23.8 m (78 ft 1 in)
Wingspan	29.3 m (96 ft 2 in)
Height	8.58 m (28 ft 2 in)
Cruise speed	440 km/h (270 mph, 240 knots)
Range	2,500 km (1,600 mi, 1,300 nmi) with maximum fuel Range with max payload: 1,100 km (680 mi)
Service ceiling	7,500 m (24,600 ft)
Rate of climb	8 m/s (1,600 ft/min)

It was a bright sunny day and the hills of Miranshah looked fascinating. After take off, we were flying on easterly heading, in the valley at very low level. This was done to avoid becoming a target of Russian fighters patrolling the border and waiting for us to be visible. There was a strong fear and it was expected that we could be shot down by Russian missiles. The sight of PAF Mirage fighters above us flying in zig zag pattern to match our speed and to protect us from any enemy misadventure was heartening and moral boosting.

Wg Cdr Ghafoor had flown the same type while on a deputation to Iraq. He was handling it confidently and in an extremely relaxed manner. Sqn Ldr Zulfiqar was accurately navigating through the hilly terrain towards our planned destination and I was enjoying the thrill while handling the radio communications and pressurization system. I contacted Mianwali tower after entering their training area and the air traffic controller inquired about our destination. I very proudly refused and said, "unable to disclose due to operational reasons".

We headed towards PAF Base Murid and Wg Cdr Ghafoor landed the plane with ease and in a highly professional manner. While taxiing towards Tarmac we noticed some part of aircraft touching the ground surface. The ramp of the aircraft had open-up upon touch down and was dragging on the surface. This happened due to a selection of the switch by the Afghan captain while leaving the aircraft. Otherwise a very dangerous mission ended safely owing to the professionalism of my Captain Wg Cdr Ghafoor (late), Navigator Sqn Ldr Zulfiqar (late), Flight Engineer WO Shabbir (late) and of course the deterrence and protection provided by the fighter squadron of the PAF.

The Beechcraft with same crew was there to fly us back home.

A Tribute to a Warrior

Story of an Unsung PAF Hero

"Sqn Ldr Muhammad Ashfaq, who left us recently, has a career to his name that shall echo in the hall of fame for decades to come. This is the inspiring story of an unsung PAF hero who selflessly answered the call of duty during both wars with India, leaving behind a legacy for the nation to cherish."

by Air Cdre Muhammad Ali, SI (M) (Retd)

The air at a graveyard in Lahore stands still. Six airmen in fresh cut blues stand in a funeral parade formation, over a freshly dug grave, perspiring in the city's summer heat. Guns roar in salutation, the funeral parade leader bellows out a caution. Air Rank Officers lay down floral wreaths on the mound of Earth and pay their respects. All in attendance observe the graceful ceremony in silent mourning; a hero has been laid to rest, six feet under. A fearless Air Warrior and recipient of the Tamgha-e-Jurat for his gallantry in the 1965 war, Sqn Ldr Muhammad Ashfaq's death marks the end of a glorious chapter on the PAF's history pages. A standalone verse from the Holy Quran presents testimony to this moment: Every soul shall taste death, and only on the Day of Judgment will you be paid your full recompense. Passed silently to the afterlife in the Holy Ramadan of 2021, the deceased presents the example of the death of a pious man, as promised by Allah SWT.

Humble Beginnings

In retrospect, Sqn Ldr Ashfaq embraced a graceful death preceded by an illustrious life. A servant of faith, a solider of the green flag and a patriot in blues, Sqn Ldr Ashfaq's career had humble yet prestigious beginnings. He was born into the house of Muhammad Sharif, a studious businessman hailing from Quetta. The family made their living from 'American Shoe Shop', a renowned shop of Quetta. Muhammad Ashfaq spent an untroubled adolescence in these carefree initial years. Then, came the first tumultuous event of his life. The area was rocked by the great earthquake of 1935, resulting in overwhelming losses. Muhammad Ashfaq's family was no exception. The business no longer viable, Muhammad Ashfaq's family were forced to leave Quetta and moved to Lahore, their city of origin. It was there, in the streets of old Lahore that Muhammad Ashfaq grew up. He completed his Matriculation from Watan High School in Lahore, going on to join the prestigious Islamia College in 1946.

Although too young to grasp the significance of the division of the Subcontinent, an indomitable humanity was already observable in Muhammad Ashfaq when the nation was born in 1947. The grief-stricken refugees arrived in droves from India with nothing but the clothes on their backs. A large number of refugees were housed in Lahore. Muhammad Ashfaq was one of the hundreds of college students who worked tirelessly at Walton Refugee Camp to make life a little easier for their new countrymen.

Illustrious Career

The formation of Pakistan had stirred a new fervor in Ashfaq. It was an inspiring time. The horrible calamities that the refugees had grown through were being compensated by the compassion of their receivers. Everybody wanted to play a part. It was amidst these conditions that Muhammad Ashfaq decided to take his chances with the newly erected RPAF. He was successful. He was

CWO Ashfaq in the cockpit of C-130 aircraft. (Photo: PAF Archives)

Gp Capt Hussaini's depiction of bombing run by a C-130 over Indian artillery regiment deployed along BRB canal on the night of 21 Sept, 1965. The aircraft was piloted by Wg Cdr Zahid Butt along with WO Muhammad Ashfaq as the loadmaster of the aircraft. (Photo: Gp Capt Hussaini).

inducted into the nascent air force as an airman and enlisted in the 4th airmen entry of the young RPAF. The group was sent to Kohat on 4 August 1948 and then, later on, to Drigh Road to polish their technical skill. Muhammad Ashfaq's progression in his career makes it abundantly obvious that he possessed a knack for the technical jobs. This tenacity of his further developed in the form of a six-month course in Karachi where he was trained as a WOM – II (Wireless Operator Mechanic).

Around this time, PAF required competent and skillful aircrew for its newly acquired Dakota and DC-3 aircraft. By then, Muhammad Ashfaq had successfully completed the conversion course to become an Air Signaler, exhibiting consistent promise in every role that he had served in. This was the reason owing to which Muhammad Ashfaq was amongst the first to be trained on the new aircraft. He was inducted into the No 6 Sqn as his first posting as a Load Master/Ground Signaler.

This experience was not in vain and he was shortlisted to be trained to fly the technologically superior C-130 Hercules when PAF inducted the more versatile aircraft into its inventory. Muhammad Ashfaq was selected for a training course in USA on the newly inducted aircraft. He also had the honour of ferrying the first C-130 aircraft to Pakistan.

Flg Off Muhammad Ashfaq, TJ on graduation day. (Photo: PAF Archives)

Role in 1965 War

The time of the 65 war was filled with brilliant and innovative strategies that enabled the nation to hold its own against India. One of these ingenious strategies thought up by the transport wing was using the Hercules as a heavy bomber. The idea held substantial potential. Being the senior most loadmaster of No 6 Sqn, WO Muhammad Ashfaq along with a team of C-130 crew was tasked with making a feasibility report. Using the Jamrud firing range as their testing ground, the team ascertained that the aircraft could only be used in a bomber role if its ramp was removed and the rear door was shut in the 'up' position. Keeping the Hercules in same configuration, few test missions were flown dropping dummy bombs in Jamrud. The trials proved to be a huge success and PAF leadership decided to put the idea to a practical test. The test of their ability came on 12 September, 1965 as the first bombing mission of the Hercules was launched. The target had been set. It was the area of Lahore-Kasur sector, where the Indian army was advancing at a fast pace. The aircraft had been loaded with 25000 lbs of bombs. This had been done in the supervision of the master loader, Muhammad Ashfaq. The aircraft took off in the dead of night, under the leadership of OC No 35 wing, Wg Cdr Zahid Butt. Carrying this lethal load, the unarmed Hercules advanced towards its target. Arriving at their destination, Flt Lt Rizwan

Left: C-130 crew during a mission briefing session minutes before the launch of first ever bombing mission against Indian Army targets around BRB canal during 1965 war. WO Muhammad Ashfaq seen sitting in second row in centre. (Photo: PAF Archives).

Bottom: WO Muhammad Ashfaq (standing first left) along with the C-130 crew which carried out numerus bombing missions against Indian ground forces during 1965 war. (Photo: PAF Archives).

(navigator) gave the green light and the bombs were unleashed. Tied to a strap only, Muhammad Ashfaq was hanging out from the door in the open air, observing the loads of bombs dropping on the enemy. The enemy was caught in complete surprise. They had not imagined in their wildest of dreams that PAF could use an unarmed C-130 as a heavy bomber. Moments later, the entire area turned into an inferno leaving behind huge debris of enemy's war machinery. The mission had been a success. There was retaliating ack ack fire but the Hercules descended down to tree level and returned unharmed.

Muhammad Ashfaq also flew some of the important supply dropping missions much before the advent of declared war. In April same year, the Pakistani ground forces desperately needed supplies close to LOC in Kashmir. The only viable option to achieve this objective was to air-drop the much needed supplies by a C-130 aircraft. Ashfaq flew numerous air-drop missions and helped secure an air bridge for their brethren in Khakis.

His Finest Hour

Muhammad Ashfaq's role in the 1965 war had not yet come to an end. The crew's next target was Indian heavy artillery guns deployed near Lahore. These guns were firing at Lahore mercilessly killing dozens of innocent civilians. The guns needed to be obliterated without a moment's delay. The crew set out on 21 September, as the sun set on a blood-soaked horizon. This time, however, the Indians were prepared. Muhammad Ashfaq and his crew was greeted by an onslaught of ack ack fire. The captain manoeuvred to avoid the fire and somehow managed to reach the target. On captain's command, the bombs were jettisoned out of the mighty Hercules. However, some stacks of the bombs failed to release. It was a great threat to the safety of the aircraft that too under intense enemy fire where each and every second was crucial. Without any hesitation, Muhammad Ashfaq decided to act immediately. Risking his life, he went on and physically released the stack of bombs one by one, an act of utmost bravery only he could have performed. The effort was not in vain and all the bombs dropped out of the aircraft. By the time it was done, the same guns that had been slaughtering civilians a few minutes prior were now a smoldering heap of rubble. Next day, GOC of Lahore appreciated the heroic effort of daring C-130 crew in his letter to AHQ.

Left: Flg Off Muhammad Ashfaq having lighter moments with comrades. (Photo: Sqn Ldr Ashfaq's family Archives).

Centre: Sqn Ldr Muhammad Ashfaq during his young days. (Photo: Sqn Ldr Ashfaq's family Archives).

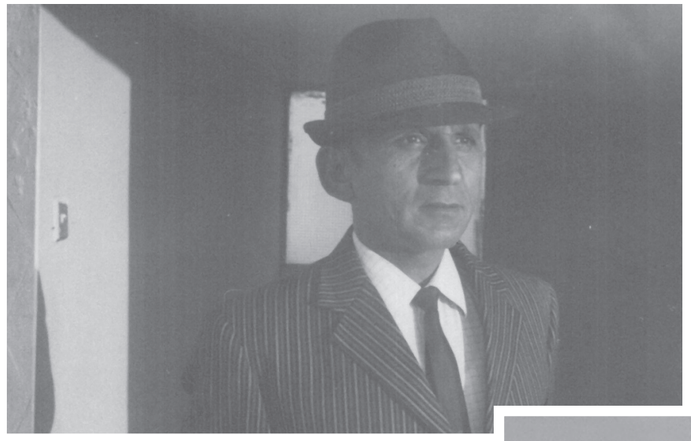
Career until Retirement

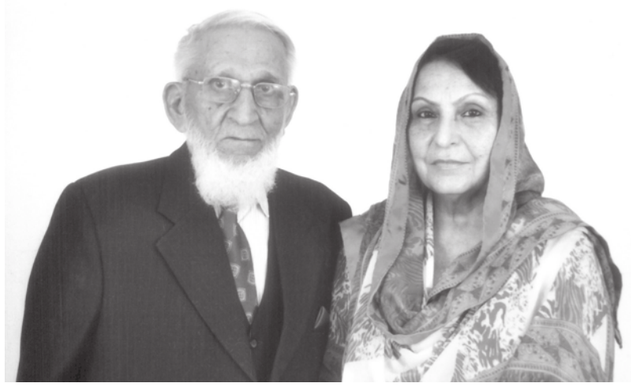
During 1971 war, Ashfaq was once again called upon by No 35 Wing to participate in bombing missions on C-130 aircraft. He flew several such missions and also helped train others to perform these missions with precision. After the 1971 war, he went on deputation to Kuwait as a load master instructor. During this tenure he also participated in the Arab-Israel War. On one occasion during his deputation, he had the honour of flying Mr Yasir Arafat on a VIP aircraft.

Muhammad Ashfaq returned to Pakistan in 1974 and was offered commission in PAF. He graduated from PAF Academy Risalpur on 19 December 1975. From thereon, Muhammad Ashfaq left his mark while working in several units and serving on key appointments, proving his mettle everywhere he went. For a very long time, he remained load master instructor at the prestigious Transport Conversion School of PAF, imparting quality training to the transport air crew. Large number of transport pilots, navigators, loadmasters are his students and hold him in high esteem, even today. After clocking more than 9500 flying hrs on different transport aircraft, his long and prestigious career came to an end on 8 March 1983.

"People like Ashfaq are rare now a days. Pious, humble, thorough professional and above all a man of faith, Ashfaq was the source of inspiration for many. During 1965 war, he was charged up, carried out his duties with utmost dedication. I am lucky to fly with such comrades during war times," reminisces AVM Sardar Muhammad Asif (Retd), a PAF war veteran.

Taking stock of Muhammad Ashfaq's life, it unfolds like a saga of human resilience and progress. A man who knew that life is truly lived in endless enhancement, facing boldly all that may come in the process. A thorough professional, a proud son of the soil, a helpful colleague, a caring husband and a devoted father, Muhammad Ashfaq left an impression on the hearts of all that he met. "One of the glaring aspect of his towering personality was his unflinching faith in Allah Almighty. Always content, always smiling and always ready to sacrifice for others. Role models like him would continue to inspire the generations of Pakistani youth for the times to come," said Maj Najeeb Ahmed (Retd), nephew of the deceased while paying huge tributes the one and only, Sqn Ldr Muhammad Ashfaq, TJ.





Left: Sqn Ldr Muhammad Ashfaq with his better half, Fakhira Begum. (Photo: Sqn Ldr Ashfaq's family Archives).

Citation of Tamgha-e-Jurat

"Master Aircrew Muhammad Ashfaq, while performing the duties of an aircrew during the War, undertook the maximum number of missions against the enemy. In addition to flying several missions, he personally supervised the ground handling of the aircraft, which involved a great deal of time and effort. He most conscientiously devoted himself to the work assigned to him with utmost enthusiasm without any regard for personal comfort or the dangers involved. In spite of long hours of work on the ground as well as in the air, his cheerfulness and willing cooperation was commendable. He is therefore awarded with TJ."

Right: C-130 crew which carried out variety of combat missions during 1965 war. From L to R: Flt Lt Sardar Asif Khan, Flt Lt Rizwan Ahmed, Flt Lt Viqar Abdi, unknown, Sqn Ldr Masood Khan, Wg Cdr Zahid Butt, WO Muhammad Ashfaq. (Photo: PAF Archives).

Switzerland selects F-35 Lightning II for future air defence requirements

BY: ANDRÉ ORBAN

(Photo: Maarten Van Den Driessche)

The Swiss Federal Council announced Lockheed Martin's F-35 Lightning II is the aircraft selected from its New Fighter Aircraft competition.

"We are honoured to be selected by Switzerland and look forward to partnering with the Swiss government, public, air force and industry to deliver and sustain the F-35 aircraft," said Bridget Lauderdale, Lockheed Martin's vice president and general manager of the F-35 Programme. "With the selection, Switzerland will become the 15th nation to join the F-35 program of record, joining several European nations in further strengthening global airpower and security."

The Swiss Air Force will receive F-35A aircraft, a sustainment solution tailored to Swiss autonomy requirements, and a comprehensive training programme.

The F-35 selection will deliver economic and technical advantages to the nation for decades to come. Swiss industry will have the opportunity to participate in research and development, production and sustainment opportunities that will extend their capabilities into the future. As a new participant in the F-35 programme, Switzerland will benefit from Lockheed Martin's dedication to autonomy and sovereignty in integrating indigenous solutions.

To date, the F-35 operates from 21 bases worldwide, with nine nations operating F-35s on their home soil. There are more than 655 F-35s in service today, with more than 1,380 pilots and 10,670 maintainers trained on the aircraft.

Germany Signs on for Five Boeing P-8A Poseidon Aircraft

BY: SEAPOWER STAFF

BERLIN — The German Ministry of Defense signed a letter of offer and acceptance for five Boeing P-8A Poseidon aircraft under the U.S. government's Foreign Military Sales (FMS) process, the company said in a June 30 release. With this order, Germany becomes the eighth customer of the multimission maritime surveillance aircraft, joining the United States, Australia, India, the United Kingdom, Norway, Korea and New Zealand.

"Boeing is honoured to provide Germany with the world's most capable maritime surveillance aircraft," said Michael Hostetter, Boeing Defense, Space & Security vice president in Germany. "We will continue to work with the U.S. government, the German government and industry to establish a robust sustainment package that will ensure the German Navy's P-8A fleet is mission ready."

The P-8A Poseidon offers unique multimission capability and is the only aircraft in service and in production that meets the full range of maritime challenges faced by European nations. Deployed around the world with more than 130 aircraft in service, and over 300,000 collective flight hours, the P-8A is vital for global anti-submarine warfare, intelligence, surveillance and reconnaissance and search-and-rescue operations.

"Bringing this capability to Germany is not possible without the contributions of German industry," said Dr. Michael Haidinger, president of Boeing Germany, Central & Eastern Europe, Benelux and the Nordics. "With the P-8A, we will expand our collaboration with German companies, create new jobs and contribute to long-term local economic growth."

German companies that already supply parts for the P-8A include Aljo Aluminum-Bau Jonischeit GmbH and Nord-Micro GmbH. Recently, Boeing signed agreements with ESG Elektroniksystem-und Logistik-GmbH and Lufthansa Technik to collaborate in systems integration, training, support and sustainment work. By working with local suppliers, Boeing will provide support, training and maintenance solutions that will bring the highest operational availability to fulfill the German Navy's missions. **(Source: seapowermagazine.org)**

Germany has signed a letter of offer and acceptance for five Boeing P-8A Poseidon aircraft under the Foreign Military Sales program. (Photo: BOEING)

(Photo: TNA)

Boeing to boost UK Royal Air Force Chinook fleet with 14 H-47 extended-range Chinooks

BY: ANDRÉ ORBAN

U.S. Special Operations Command awarded Boeing a $599 million Foreign Military Sales contract approved by the U.S. Department of State to deliver 14 extended-range Chinook helicopters to the UK Royal Air Force (RAF).

The extended range Chinook gives the RAF fleet more versatility to execute the domestic and international heavy-lift missions that only the Chinook can facilitate.

"These Chinooks are the future of heavy-lift, built on an existing foundation of advanced capability and life cycle affordability," said Andy Builta, Boeing vice president and H-47 program manager. "This contract for Block II aircraft sets the stage for the next 60 years of Chinook excellence on the battlefield."

Boeing and the RAF recently celebrated the 40th anniversary of the first Chinook delivery to the UK. Boeing will also celebrate the 60th anniversary of the Chinook's first flight later this year.


(Photo: Airbus)

Airbus delivers the 100th A400M

BY: ANDRÉ ORBAN

Airbus has reached 100 A400M deliveries with MSN111, the tenth A400M for the Spanish Air Force. The aircraft performed its ferry flight on 24th May from Seville to Zaragoza, where the Spanish A400M fleet is based.

In the same week, the A400M global fleet also achieved the 100,000 flight-hours landmark performing missions worldwide for all eight customer nations. All A400M operators have been able to operate the aircraft intensively for Covid-19 emergency response missions, as well as to conduct joint, collaborative operations. These milestones clearly demonstrate the maturity of the A400M programme on all fronts.

New capabilities

Recently the A400M successfully conducted a major helicopter air-to-air refuelling certification flight test campaign in coordination with the DGA (French Directorate General of Armaments), completing the majority of its certification objectives, including the first simultaneous refuelling of two helicopters.

Russia Is Building a Single-Engine, 'Hypersonic' Fighter Jet

BY: KYLE MIZOKAMI

The unnamed fighter would likely complement the larger, heavier Su-57 fighter jet and would use at least some of the same components.

According to an industry source via Russian state media's RIA Novosti, the fifth-gen fighter will have one engine, a reduced radar signature, "super manoeuvrability," and thrust vectoring capabilities. The source also said the plane could be offered in manned and unmanned versions.


(Photo: ANADOLU AGENCY)

Thrust vectoring involves the use of rotating exhaust nozzles. Most fighter jets can only generate thrust in the direction in which the nozzles are pointed (in the same plane as the airplane's nose). But a jet equipped with thrust vectoring nozzles, a Sukhoi specialty, can produce thrust in different directions. This allows for some incredible manoeuvring—just watch what a Sukhoi Su-35 did at the 2013 Paris Air Show.

Navy Drone Refuels Fighter Jet, a Key Step Toward Adding UAVs to Carrier Wings

BY: CAITLIN M. KENNEY

The Boeing MQ-25 T1 sends fuel to a U.S. Navy F/A-18 Super Hornet during a June 4 test flight, the first time an unmanned aircraft has refueled another aircraft. (Photo: BOEING)

A Navy test drone refueled a crewed fighter jet over Illinois, a key step in the service's plans to incorporate unmanned aircraft into carrier air wings.

Two test pilots flying an F/A-18 Super Hornet took on some 325 pounds of fuel from an MQ-25 T1 Stingray unmanned aircraft while evaluating various aspects of flying near the drone.

"Friday's historic test gets us one step closer to providing MQ-25's critical capabilities to the fleet. To build that foundation for integrating manned and unmanned platforms to give our forces the competitive advantage to keep ahead of the evolving threats in the 21st century," Capt. Chad Reed, the program manager for the Navy's Unmanned Carrier Aviation program office, told reporters.

The Boeing-built MQ-25 is to become the first unmanned aircraft added to carrier air wings, for which it will handle some intelligence, surveillance, and reconnaissance tasks along with its refueling duties.

The refueling test flight took place from MidAmerica Airport in Mascoutah, Ill, according to the Navy. The Super Hornet, carrying two test pilots, approached the drone and evaluated several aspects, including its stability in close proximity to the aircraft, the drone's wake on the fighter, and the deployment of the fuel hose and refueling basket, Dave Bujold, Boeing's MQ-25 program director, said. During the test flight, the drone transferred 300 pounds of fuel at 10,000 feet from its fuel pod, and later transferred 25 pounds at 15,000 feet.

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- Will be required to appear for written test in subjects of General Science, Mathematics, English and Urdu.
- Those who qualify written test will be called for Intelligence Test, Preliminary Medical, Interview and Final Medical (CMB) on basis of merit.
- The Candidates wearing glasses for defective vision need not apply for Admission.

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Prospectus including Admission Form can be purchased from PAF College Sargodha and the following PAF Information & Selection Centres for Rs. 1,500/- on all working days from 12 July, 2021 to 13 September, 2021 (except weekly / gazetted holidays) from 0900 hrs to 1400 hrs. Those who desire to have the Prospectus posted to them, should send a Bank Draft worth Rs. 1,800/- (for inland despatch) and Rs. 2,500/- (for despatch abroad) in favour of PRINCIPAL PAF COLLEGE, SARGODHA. Admission Form may also be downloaded from our website www.pafcollegesargodha.com. Post the Admission Form duly filled as per the instructions, to Admission Section PAF College, Sargodha.

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- Boys studying in Cambridge system can also apply.
- Should be a male citizen of Pakistan or Azad Jammu & Kashmir.
- Candidates will be required to appear in written test (English, Urdu, Mathematics & General Science).
- Those who qualify the written test will be called for Intelligence Test / Initial Medical / Interview & Final Medical (CMB) on basis of merit.

LAST DATE OF SUBMISSION OF APPLICATION FORM 29 SEP, 2021
WRITTEN TEST : 17 OCT, 2021






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TRANSWORLD TRANSWORLD

At Transworld Aviation we are committed to quality

TRANSWORLD

"TOGETHER WE ACCOMPLISH"

AVIATION SERVICES & SOLUTIONS

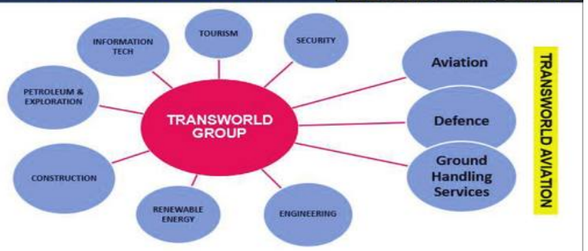
INTRODUCTION

TRANSWORLD

- 22 years in business
- State of the art warehouse and MRO facility - 200,000 sq ft
- Leading distributor and stockist in the region for the Defense & Aerospace industry
- Complete Supply Chain & logistics management
- Technical Solutions

TRANSWORLD STRENGTH

TRANSWORLD



CREDENTIALS & TRACEABILITY

TRANSWORLD

AS 9120:2009 and ISO 9001:2008 Certification

FAA AC 00-56 accreditation

Aviation Suppliers Association (ASA-100) – Accreditation

Traceability Documents – EASA F-1, FAA 8130, COC

Member – Trace

ITAR Compliant

UAE Environment, Health and safety compliant

ASA MEMBER AVIATION SUPPLIERS ASSOCIATION

ASA-100 ACCREDITED ASA AVIATION SUPPLIERS ASSOCIATION ASACB

TRACE Anti-Bribery Compliance Solutions

ISO 9001 CERTIFIED

ANAB ACCREDITED

BRANCHES & CUSTOMERS

TRANSWORLD

Middle East , Africa, SAARC, ASEAN region

- Commercial, Business & General Aviation operators
- Defense and para-military forces
- Training organization
- Maintenance & repair organizations

TRANSWORLD

Transworld Aviation FZE, UAE
Tel: +971 4 8053000; AOG: +971504695111
help@tas-dubai.com; www.tas-dubai.com
Plot No: MO 0608, Round About 13,
Jebel Ali Free Zone, Dubai, UAE

DISTRIBUTORSHIPS

TRANSWORLD

Lasersab, VDC, Bell Helicopter, Garmin, Aerospace Products, McMurdo, Bombardier, Gielle, Rockwell Collins, Honeywell, Capewell, IBH-IMPEX, Vector Aerospace, Cobra Systems, Stomil, Tronair, Aero Precision, Eaton, Olayan Kimberly-Clark, 5.11 Tactical Series

SERVICE AGREEMENT

TRANSWORLD

AVMATS, Sabena, Donaldson, Cascade Aerospace, Thales, Sparton, Raytheon, Maxcraft Avionics Ltd, Buffers Marine, Dresser-Rand, MSA, Gallet, Alpine Aerotech LP, ARINC, Novae Technology, Wärtsilä, VA Technology Engines, Inc., itp, Davis, EP3

SUPPLY CHAIN SUPPORT

TRANSWORLD

Harlow, Berfoli, Vulkan Couplings, Strata, Rogerson, Sigma Marine, Dräger, Kaman, EnerSys, Lürssen, Ural Works of Civil Aviation, Henkel, Dormac, Caterpillar, Ultra Electronics, Hyundai, AIM MRO, SMC, Safran, Jotun, Hempel, Heico, Alesco, Moog, MAN

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(Photo: Awais Lali).

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NATIONAL DEFENCE THROUGH SELF RELIANCE

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A SYMBOL OF EXCELLENCE IN AVIATION

PAC Board, Kamra

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