

The Renorming of Airpower: The F-35 Arrives into the Combat Force



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By Robbin Laird and Ed Timperlake

This is the latest in a series of Second Line of Defense reports on fifth generation aircraft, and the shaping of fifth-generation enabled combat operations. The report relies largely on interviews and visits conducted in the past eight months.

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INTRODUCTION

This report provides an update of the roll out of the F-35 as of March 31, 2016.

The report is based on interviews with pilots, maintainers, testers and industrialists involved with the program. The F-35 is not a future program; it is here now. The Marines already have their initial aircraft, the USAF is about to declare their first squadron ready for combat and the US Navy will follow next year. Several partners in the program are flying and maintaining their initial aircraft at places like Luke AFB or Beaufort Marine Corps station. And those same allies, have built or are building infrastructure in their countries for the roll out of the F-35 in their countries, as well as to support those of allies which will operate when appropriate off of their national airbases.

According to the F-35 Joint Program Officer, there are currently more than 250 F-35 pilots and 2,400 aircraft maintainers from six nations already trained and more than 110 jets are jointly under construction at the Fort Worth and Cameri production facilities. F-35s are flying at eight operating locations: Edwards Air Force Base, California, Eglin AFB, Florida, Hill AFB, Utah, Luke AFB, Arizona, Marine Corps Air Station Beaufort, South Carolina, MCAS Yuma, Arizona, Naval Air Station Patuxent River, Maryland, and Nellis AFB, Nevada. Jets are also flown at two F-35 depot locations at MCAS Cherry Point, North Carolina, and the Ogden Air Logistics Complex at Hill AFB, Utah. And we learned at Edwards AFB in meetings with maintainers, that more than 150 F-35s are already feeding data into the F-35 digital data base, as part of shaping the way ahead for the maintenance of the fleet.

We have far more material than we can present in a short report, but Second Line of Defense has many interviews, articles and trip reports from visiting those who are putting the F-35 into the air combat fleet and will shape its future. This is about what is now and what is upon the horizon with the aircraft, as an enabler of 21st century combat operations.

The F-35 is a “flying combat system” rather than a classic tactical fighter. It is capable of fighting across the range of military operations and can do so rapidly in a multi-tasking mode. That is, the impact of using F-35s is that one can deploy a force with a lighter logistical footprint, with greater coalition combat capabilities and operate across the ROMO (Range of Military Operations).

As a fleet, the F-35 is an integrated fleet able to share data over great distances via the its wave based communications systems. And it comes as Western forces are augmenting their ability to network forces and to prepare for the next generation of weapons, and learning how to off board weapons, that is one platform identifying targets and guiding a weapon launched from another platform to the target.

The F-35 is the first software upgradeable tactical jet ever built; and the evolution of the software will be determined by the operational experiences of the air combat force.

But the F-35 is not a replacement aircraft; and it will operate with selective legacy aircraft in shaping concepts of operations innovations; but legacy assets will be modernized with regard to the shift in fifth generation warfighting fostered by the introduction of the F-35 global fleet.

Although not a replacement aircraft, there are significant improvements in the design of the aircraft which make it more affordable and viable going forward, including the intersecting R and D into the fusion cockpit as well as the fact that the F-35 is the first 8,000 combat hour operational tactical aircraft ever built.

The F-35 is also the first generation of shaping a globally sustainable tactical aircraft whereby global sourcing and support will be available. This means that one nation’s F-35s can be maintained at the point of

attack with other nation's support structures. This means that the sustainability of a nation's force at an expeditionary point of attack can be supported by the global enterprise.

The F-35 will be a foundational element in the reshaping of 21st century warfighting approaches whereby the ability of a coalition force to operate in the expanded battlespace is crucial for mission success.

The F-35 fusion engine has built into a range of integrated capabilities, which allows to operate in combat areas where legacy jets simply can not unless they are aided by a range of specialized aircraft, such as a jamming assets.

In effect, the introduction of the F-35 shapes a two fold dynamic – First, co-modernization with other air combat assets or highlighting which modernizations in legacy systems are worth the effort and second, shaping dynamic combat learning with the F-35 as the learning aircraft at the center of the effort.

Put bluntly: If you are not in the F-35 learning curve you are staying in the past three decades of warfare.

Several of the aspects introduced here are discussed in more detail by those who are actually using the aircraft and evolving the systems onboard the aircraft. We are drawing largely upon visits and interviews over the past six months in this report but the website has several years of coverage which can be referenced by our readers.

SQUADRON FIGHTER PILOTS: THE UNSTOPPABLE FORCE OF INNOVATION FOR 5TH GENERATION ENABLED CONCEPTS OF OPERATIONS

The skillfulness and success of fighter pilots in aerial combat is an extensively researched yet modestly understood and fundamentally complex concept.

Innumerable physical and psychological factors along with chance opportunities affect a pilots facility for success in air combat.

Perhaps the best narrative of the intangibles of the skill and courage of a fighter pilot was captured by the author Tom Wolfe in his seminal work *The Right Stuff*.

From the first day a perspective fighter pilot begins their personal journey to become a valued and respected member of an elite community, serving as an operational squadron pilot, the physical danger is real.

But so is the most significant force for being the absolute best that a fighter pilot can feel which is day in and day out peer pressure by those they really and truly respect, their squadron mates.

One point that has to be noted is that in the cycle of fighter designs some aircraft have were designed with a crew concept. Examples are the F-4 Phantom II at one time active in the Air Forces of 12 nations, the USN F-14, and some type/model/series (T/M/S) of the F/A-18 and the F-15E.

The two flying warriors regardless of T/M/S and designation RIO-Radar Intercept Officer for Sea Services or WSO-Weapon System Operator for USAF were 100% peer partners and the fighter could not have engaged to fight and win without solid crew mutual support in the cockpit. The use of the term Fighter Pilot in no ways ignores this partnership.

It is just that so far 5th Gen TacAir, F-22 and F-35 are single seat aircraft.

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To understand the intangible of pilot performance and the future combat success of the F-35, Lightning II, one just has to listen to what the military pilots who actually are fly the aircraft are saying, all other critics are second order.

The new batch of F-35 aviators is still being led by Flag Officer aviators (O-7 and above) who have gone before. Those leaders began their fighter pilot journey in earlier generation tactical combat aircraft.

But the intangibles of squadron flying and learning transcend generations.

Until October 2015 Marine Corps pilots flying the F-35B have been second tour pilots. That is, they are pilots with flying backgrounds and with combat experience.

The VMFAT-501 Warlords, the squadron focused on initial combat training at MCAS Beaufort had their first tour “nugget” pilot coming to fly the F-35B. That first tour Naval Aviator serving as a Marine pilot is just the first of thousands that for decades to come will join the F-35 global fighter pilot world.

This is what Lt. General “Dog” Davis (an AV-8 pilot), the Deputy Commandant of Aviation, once the I Pad generation pilots coming into the force:

“I think it’s going to be the new generation, the newbies that are in the training command right now that are getting ready to go fly the F-35, who are going to unleash the capabilities of this jet.

They will say, ‘Hey, this is system will give me. Don’t cap me; don’t box me in.’”

It can never be underestimated how important it is that the now senior aviation commanders, regardless of service or country, had to rise successfully through squadron life to arrive at the top of Wolfe’s pyramid of excellence in their specific combat aircraft whether they flew F-4s, AV-8s, F-14s, F-15s, F-16s or F/A-18s.

It is a brutal fact of winning or losing an air campaign that past combat experience in the air count can count strongly regardless of fighter flown at the time.

The current new cohort of F-35 Squadron pilots, at all ranks, are building on a powerful legacy of air combat forces that have been forged in a life and death cauldron of two magnificent victories.

A perfect example of the generational transition of a tested pilot raising in rank to senior general officer command who is now leading his fighter pilots into the future is the Commanding General of the USAF Warfare Center, Nellis AFB 5, Major General Silveria, who graduated from USAFA ’85 during the Cold War, who now is a qualified F-35 pilot.

From his USAF official bio: General Silveria has flown combat sorties over the Balkans and Iraq and served as Vice Commander at Bagram Air Base in Afghanistan. He is a command pilot with more than 3,800 hours in the T-37, T-38, F-15C/E, HH-60 and F-35A aircraft.

General Silveria’s command saw on January 15th, 2016, the fifth F-35A landing at Nellis, and was the first F-35A fully configured for the planned initial operational capability for the USAF next year.



FIGURE 1 MAJOR GENERAL SILVERIA IN HIS FINAL QUALIFYING FLIGHT AT EGLIN AFB FOR THE F-35.

This specific aircraft addition to the weapons school marked a crucial moment in shaping the way ahead, as General Silveria comments:

“Having this aircraft at Nellis represents the beginning in the operational tests in earnest for the F-35 program and represents the beginning of tactical development of the F-35 at the weapons school.

We have some F-35s here in earlier configurations, but the plane, which landed today, is the plane we will go operational with.

We need this aircraft and this configuration to shape the tactics in taking the aircraft into operation in 2016.

This is the first of many as more F35s will flow into Nellis this year and next.

The pilot who has landed today is the first pilot in the 57th Wing in Nellis, which will be writing the syllabus for the Weapons School with the first pilots graduating from that program in 2018.”

The Past as Prologue

These now senior combat pilot commanders, albeit much junior at the time, achieved two magnificent victories; winning the air rivalry against the USSR in the Cold War and achieving an historic allied success in the magnificent air campaign of Desert Storm.

The lesson for the air power rivalry between the US and USSR is rather straightforward: the technology had to be available but it also had to be successful understood and employed.

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A historical take away from the cold/hot war air battles is that in the air-to-air mission a country that equips its fighters with airborne radar and sensors allows more autonomous action and actually favors tactical simplicity and operational autonomy—even though the equipment becomes more complex.

In air-to-ground, airborne simplicity indicators are usually smaller formations and allowance to maneuver independently into weapon launch envelopes primarily in a weapons-free environment. Embedding technology into the weapon itself –bombs and rocket-fired weapons– has also made a revolutionary difference.

In air combat a nation must always assume a reactive enemy can develop the necessary technology to try and mitigate any advantages. With the worldwide proliferation of weapons even a second or third world nation might have state-of-the art systems.

The air war over the skies of Vietnam and in the Middle East in the Yom Kippur War was between two aviation technology peer competitors because of USSR TacAir type/model/series (T/M/S) support to aerial advisories.

The lesson on the Cold War US-USSR rivalry is that air combat leaders must be able to adjust during the course of an air battle or war by changing strategy and tactics, to achieve exploitation of the enemy's mistakes or weakness.

Aircrews must be adaptable enough to follow changing commands from leadership and also, on their own initiative, to change tactics to achieve local surprise and exploitation. Like the quote in Animal House: "knowledge is good." In the cockpit, it can be a lifesaver and aid in mission accomplished.

An air-to-air engagement totally slaved to a ground controlled radar attack, the USSR model was a colossal failure and deadly to a lot of pilots locked into such a system.

A bottom-up approach with evolving aircraft system capabilities in a competitive airframe makes for adaptive, creative aircrews that will have a large repertoire of tactical moves and a better chance of getting inside an opponent's Observe, Orient, Decide and Act (OODA) loop.

This is true for both air-to-air and air-to-ground combat missions.

As the history of war in the air shows it was a constantly evolving process of human factors integrated into technology. The Cold War ended well for humanity and a lot of courageous pilots, bold leaders, and smart technologists deserve a lot of credit for this great victory.

The US would be wise to remember the lessons learned and along the way the loss of very good men in the air who paid in their blood for America and our allies today to have the best technology available flown by best combat aviators a country can produce.

And the challenge will be to shape evolving concepts of operations to take advantage of the 5th generation aircraft and the associated new tools of combat.

With respect to the Desert Storm Air Campaign, a US Air Force fighter pilot at the rank of Squadron Commanding Officer (O-5 LTC) succeeded in refocusing the combat potential of airpower that carries forward to this day:

In a Breaking Defense piece published on January 20, 2016, Lt. General Deptula (F-15 Fighter Pilot) looked back at Desert Storm and its applied its lessons to the current air operation in the Middle East:

When the clock hit 0300 on January 17, 2016 in Baghdad, it marked the 25th anniversary of the start of Operation Desert Storm, a turning point in the conduct of modern warfare.

Desert Storm changed major conflict in five principal ways:

It set expectations for low casualties—on both sides of the conflict;

It presaged precision in the application of force;

It introduced the conduct of a joint air campaign that integrated all service air operations under the functional command of an airman;

It established desired effects as the proper focus of strategy and of the ensuing planning and conduct of operations;

And it relied on airpower for the first time ever as the principal force in the strategy and execution of a war.

Ground forces acting as a blocking force while airpower destroyed enemy forces from above during the 43 days of Desert Storm airpower. Only in the last four days of the conflict were ground forces committed to combat with the goal of evicting Iraq's occupying forces from Kuwait.

Desert Storm's opening-night attacks signaled a radical departure in the conduct of war. This was not a linear rollback campaign: It was a strategic campaign using focused attacks against key nodes in a concurrent, simultaneous fashion. More than 150 discrete targets—in addition to regular Iraqi army forces and surface-to-air missile sites—made up the master attack plan for the first 24 hours. The war began with more targets attacked in one day than the total number of targets hit by all of the Eighth Air Force in the years 1942 and 1943 combined.

That was more separate targets attacked in less time than ever before in history.

The first two challenges required technological solutions that simply had not matured until the late 1980s.

Those two solutions were stealth and precision.

To provide insight into the importance of those two developments, during the first 24 hours of Desert Storm, stealth, precision and effects-based planning allowed the use of just 36 stealthy aircraft armed with precision-guided munitions against more separate targets than the entire non-stealthy/non-precision air and missile force launched from the entire complement of six aircraft carriers and all other ships in the theater combined.

That stealthy F-117 force flew fewer than 2 percent of the campaign's combat sorties, yet struck more than 40 percent of all Iraqi fixed targets.

The combat leverage that stealth made possible in the Gulf War can be further seen in the case of the first non-stealthy attack on one target with three aim points on Shaiba airfield in the Basrah area of southeast Iraq.

It took four Navy A-6s dropping bombs, four Saudi Tornado bomb droppers: five Marine Corps A-6Bs for jamming acquisition radars, four Air Force F-4Gs taking out one type of surface-to-air missile system, 17 Navy F/A-18s taking out another SAM system, four additional F/A-18s as escort, and three drones to force the enemy radars to radiate. That made for a total of 41 aircraft, with just eight of them dropping bombs on three aimpoints connected with just one target.

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At roughly the same time, the US had 20 F-117s airborne, with all 20 dropping bombs on 38 aim points associated with 28 separate targets. So less than half the number of aircraft hit more than twelve times the number of aim points.

Enter Today's Squadron Pilot.

Among the most intangible qualities of a combat force are those cultural factors that influence its basic fighting capabilities. These qualities can be of paramount importance.

To take what is the most sensational example, consider the Kamikaze pilot. No mere quantitative assessment of the Japanese tactical aviation forces of the Second World War could have accounted for Kamikazes. Only an assessment of cultural characteristics could have keyed analysts to the possibility. In retrospect, we can understand that the Japanese belief in the divinity of their empire and the cultural abhorrence of shame could allow for creating pilots sufficiently motivated to embrace suicidal missions.

The example of Kamikazes is not representative of this discussion, but only illustrates those cultural factors, despite their intangibility, must somehow be reckoned with.

One of the essential elements of creating a successful combat fighter pilot is simply motivation often expressed as dedication, heart, will, ambition or competitiveness. It captures the qualities of a fighting force that makes its warriors enthusiastic rather than lackadaisical or dispirited.

Of course inside the ever advancing complexities of 21st Century 5th Gen aircraft technology and the resulting con-ops there is a factor of also recognizing a fighter pilots a technological capability match which is the capacity of a pilot to understand and operate the rather sophisticated technology of their state-of-the-art aircraft.

So the challenge for any serious nation that invests in an Air Force is to select, train and employ the best fighter pilot they possibly can. If Fighter Pilots could be engineered like engineering ever advancing physical technology it would have already been done. But that is not the case so an approximation of pilot effectiveness can be made on basis of training until real combat becomes the final and ultimate judge.

Techniques for transforming fledging students into proficient combat pilots have evolved through the years as the result of much research and development. Although training techniques constitute a necessary, although not completely sufficient, component, they are actually becoming increasingly important as weapons and warfare become more complex.

There are, of course contributors to pilot proficiency other than training techniques.

The inborn abilities some pilots seem to possess play a huge part. But there is little reason to believe individuals with these natural abilities exists disproportionately among nations.

In fact the actual combat history of kill ratios show that many nations can produce both Aces (5 kills) and even super-aces with many many aerial victories. What clearly does play a role and can differ significantly from one nation to another are the cultural and social qualities that give air-crews the motivation to fight and the basic capacity to successfully use the technology in the aircraft and weapons they fight with.

"Flying should be an inherently dangerous business to weed out the weak sticks," is a Marine pilot's saying. One would hope that there could be less dramatic and much more cost-effective method for developing aviators.

But a brutal fact of combat is to that be a good combat pilot one must fly the aircraft well right up to the edge of it's flight envelope.

It is in the early training toward their "Wings" all the worlds air forces must train their pilots to simply fly successfully so at least they will not crash their aircraft frequently.

Beyond safely flying around the base flag pole, the real focus of creating a successful Squadron Fighter Pilot rests in the dynamics of combat training and then subsequent proficiency training as the individual rotates in and out of a squadron.

The list is not complete but combat training for the first tour "nugget" has drivers such as a Training and Readiness syllabus (T&R Manual). Different Air Forces have different names but it is a check list of "hops" increasing in complexity that a newly arrived aviator must successfully accomplish to advice in sequence in order to become fully combat qualified.

A key intangible, that should never be overlooked, is the source of instructors during this combat training cycle, along with measurable indices such as live firing/weapons release, and simulator training Combat training is a progression of building block sorties of more and more demanding tactical and weapon training flights that will ultimately rise to the level to operate their fighter against the highest threat environment in the world.

Once an aviator in any nation has achieved the distinction that the leadership thinks they are ready to go to war, they either enter a combat theater, or must continue in demanding proficiency training. Also after their first tour because they may have been cycled out of flying for another assignment, a fighter pilot eventually returning to the cockpit must begin proficiency training all over again.

Elements of proficiency training can include actual combat: which is everything.

It is important to recognize that US and some Allied airpower forces, have had some previous combat flying after Desert Storm, such as over the Balkan sky and in Iraq called Northern Watch and Desert Fox. US airpower has been engaged in constant combat since soon after 9/11.

Like the legacy of WWII to the Cold War and Deseret Storm this demanding combat flying, thankfully with far fewer casualties, is a huge factor experienced by this generation as they advance in rank to lead the next generation of Squadron Pilots.

Time in the air, and specifically time in type doing tactical flying is of utmost importance.

Without actual combat intensive training can include advanced exercises such as Red Flag and also very specific focused training such as going through the Top Gun program. Such programs greatly influence not only proficient tactical flying to edge of the envelope, but also create a critical dynamic fed-back loop of ever improving combat tactics to fight and win.

This is very evident a Fallon because, a perfect example of real time dynamic development of combat con-ops was described by Rear Admiral Scott Conn, (F/A-18 Fighter Pilot) Commander Naval Strike and Air Warfare Center:

Question: We found it interesting that your strike integration training involves as well regular dialogue with the deployed carriers and apparently you work in support of the deployed fleet as well in shaping TTPs, which they might need in ongoing operations. Could you speak to that process?

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Admiral Conn: NSAWC innovates in peacetime while providing the reach back support to adapt in war. We are in regular communication with the deployed carriers, and provide technical and tactical reach back support to address observed shortfalls in combat to existing TTPs.



FIGURE 2 ED TIMPERLAKE WITH REAR ADMIRAL CONN AFTER THE SECOND LINE OF DEFENSE INTERVIEW NOV 2014

An historical example of how NSAWC provided reach back support to the forward deployed warfighter was in the early stages of Afghanistan operations. Ground commanders needed aircraft to strafe at night. To do this strafing mission at night, aircrew needed to put an airplane below mountaintops, perhaps in a valley, provide bullets precisely and then pull off target, and not fly into the terrain.

When NSAWC got this request, in a matter of weeks because it wasn't overnight, a couple weeks, we came up with the tactics, techniques, and procedures for the fleet to execute that mission. We then folded those TTPs into our training for follow on deployers.

And the connectivity we have with the fleet through modern communications allows for an ongoing combat learning process between Fallon and the fleet and this flow of information is central to the process of training in the 21st century."

The Squadron Pilots Get Their Hands On The F-35

Before the first F-35 Lightning II took off, American and allied defense industries were put to the test: build the very best. They have met that challenge.

"Scientists dream about doing great things. Engineers do them" from the James Michener book Space. The quote originated from one of the legendary American Aeronautical Engineers, Jack Runckel who began with NACA before WWII and finished with NASA. As many history books state: During World War II, NACA was described as "The Force Behind Our Air Supremacy."

Just like the aviators who will fly the F-35 who are well trained and the top of the famous Tom Wolfe's "pyramid" in his book *The Right Stuff*, there is a team of engineers – American and Allied — in the defense industry and at the U.S. world famous test centers such as Pax and Edwards, who are equally dedicated and at the top of their profession in giving the warriors the best possible weapon system.

Many who have never made the effort to engage, understand and recognize the US envy of the world defense industry's remarkable success often target the very honorable and dedicated workforce with extremely negative comments.

American, USAF, USN and USMC and Allied F-35 test pilots day in a day unheralded at personal risk to themselves and always the possibly of bring tragedy to their loved ones, have mostly been ignored while still leaving critics in their jet wash.

For example, it was very telling that only three media outlets were present at Navy Pax when the Italian Test Pilot "Ninja" a former Tornado pilot with only 50 hours in type made his record setting flight across the North Atlantic in winter flying an F-35 manufactured in a brand new facility in Italy with only 15 hours on the airframe.

Every generation of test pilots flying the latest T/M/S fighter addition to their service at both Patuxent River Naval Air Station and the USAF Test Center at Edwards AFB have the most fundamental question always asked by their leaders— How to hold them back?

As the very first F-35s rolled off the factory floor and entered the military testing world, it is critical to note that the pilots testing the F-35 to the edge of the envelope were Squadron Pilots first.

From Chuck Yeager's great success as a fighter pilot in WWII (a double ace, 11.5 kills including a German jet) to his breaking the sound barrier, to the Mercury 7 Astronauts, three Navy Pilots, three AF and the US Marine John Glenn who were first American's in space, to today's test pilots it must be noted that they all began in an operational Squadron.

Test pilots being squadron pilot warriors first is not unique to the American flying services as the collection of other nations test pilots fully integrated into the F-35 flight and operational test regime proves.

One of the most impressive and again little noticed fact of the F-35 progression toward Initial Operational Capability (IOC) with US and Allied flying forces is that they are a team of peers around the globe. Never before has such a wide raging state-of-the-art test/IOC effort been attempted and now has been proven successful.

The F-35 is essentially a combat aviation club that is only limited by the imagination and skill of those who will fight the aircraft in the air.

As the F-35 moves into squadrons in different nations with different potential combat challenges around the globe all fighter pilots share a unity of purpose. Using the trite cliché "global commons" does not come close to what is occurring.

It is much more co-equal partners in 5th gen combat sharing in which the quest of being part of a team of victorious killers is much more the "combat commons" that all aspire to join.

Pax river test pilots in a 2010 interview of USMC Test Pilots "Squirt" and "Tinman" to a 2016 interview with US Navy Test Pilots "Dutch" and "Tonto" capture the evolving maturity of the test cycle for fleet wide US Sea Service IOC Squadrons.

"Squirt", test pilot of the year shortly after our interview and a former F/A-18 Squadron pilot was deeply involved in the pilot/helmet/fusion cockpit interface, which is a critical component of the XXIst Century Man-Machine Revolution. With the very real computer revolution moving with light speed into the 21st Century there is now a powerful design dynamic at work —the man-machine interface.

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With the very real capability of three dimensional sensing and being able to distribute information to other arfighters, airborne and on the ground or at sea the relationship of the individual pilot to knowledge of the bigger air battle is truly revolutionary.

“Tinman” a former USMC AV-8 pilot who flew in the at sea trials marveled how easy the F-35 was to fly and put the nose tire in a one square box on the pitching deck of the USS Wasp.

Consequently one of the most underappreciated aspects about the test program is how the concurrent learning among the various test centers provides enhanced confidence and accelerates testing with all T/M/S of this new aircraft.

The cross learning from the USMC F-35B, the service’s first T/M/S to achieve IOC, to the USAF F-35A to the USN F-35C model — with the preparation of the first RAF F-35B squadron — has meant that the USN can operate its Cs more rapidly and with more confidence and capability than in a traditional single-model aircraft test program.

his fact was brought out five years later in early 2016, at Pax when “Dutch” a very accomplished Navy fighter pilot with over 600 cats and traps in the F/A-18 stressed how stable the F-35 will fly around the boat.

During the Vietnam War, there were tests done of carrier pilots’ heart rates which were actually higher when landing on a carrier than when being shot at over Hanoi:

“The flying qualities are excellent and the machine systems built into the plane significantly enhance the ease of landing and taking off from the carrier.

Basically with the F-35 you get your mission cross-check time back.

Normally once you start the approach your scan is solely meatball, line up, and angle of attack. Your mission cross-check time behind the ship is zero because you’re just doing that scan.

With the F-35 and its enhanced flight controls and superb handling, the aircraft doesn’t deviate much from the desired flight path, which greatly eases the workload on the ball and frees up your scan. —It almost makes flying the ball a relaxing task!”

The fact that the Navy Test Pilots will rotate back into combat was not lost when Tonto made a seminal combat point about the generational shift from F/A-18 Hornets to the USN F-35C:

“How do you see the F-35 affecting tactical training?”

Answer: With the current air wing (i.e, with the Super Hornet and Hornet as the tip of the spear), we are wringing out our tactics for a tactical advantage, which is also, at the same time, at the edge of the envelope for survival.

We are spending a lot of time making sure that we have the right tactics and the mastery of those tactics by pilots to survive and succeed.—It is about keeping a level of competence and capability where you’re not going to die.

There are points where you have a twenty second window.—You miss that window and you might be blown up!

When you’re traveling at those speeds, we are talking really only a couple of seconds that you have. And, if you’re not performing tactics exactly as they’re prescribed, you put yourself in a kill zone.

With the F-35, we are jumping a generation in tactics and now looking at the expanded battlespace where we can expand our impact and effect. You need to take a generational leap so we are the ones not playing catch up with our adversaries.”

While test pilots are wringing out the F-35 and ignoring critics, senior officers are constantly challenged to fly top cover against know-nothing second and third order derivative critics whose only contributions are creating crossed referenced ignorant public articles written by cubical commandoes whose only real skill is creating google search interlocking fields of fire.

General Mike Hostage (F-15 and F-16 Fighter Pilot) the past commander of the US Air Combat Command (ACC) made the effort to qualify in the 5th Gen F-22 Raptor could put a very credible marker down for the public debate in our Breaking Defense article:

“I was fortunate to fly the airplane (F-22); I learned what I didn’t know. I was writing war plans in my previous job as a three star using the F-22s in a manner that was not going to get the most out of them that I could’ve because I didn’t truly understand the radical difference that the fifth gen could bring.

People focus on stealth as the determining factor or delineator of the fifth generation. It isn’t; it’s fusion. Fusion is what makes that platform so fundamentally different than anything else. And that’s why if anybody tries to tell you hey, I got a 4.5 airplane, a 4.8 airplane, don’t believe them. All that they’re talking about is RCS (Radar Cross Section).

Fusion is the fundamental delineator. And you’re not going to put fusion into a fourth gen airplane because their avionic suites are not set up to be a fused platform. And fusion changes how you use the platform.”

Picking up the viewpoint from the Navy’s Director of Air Warfare, Rear Admiral Michael Manazir USNA ’81 another cold-then hot war- fighter pilot flying F-14s then the F/A-18 one can see the unity of vision and purpose driven by the introduction of the F-35, while also recognizing the specific challenges that each of the US combat aviation services face.

“It is about how the sea services overall were being transformed by the ability to work more effectively with the other US services and other nations. Too often in defense discussions, focus is on a particular platform — a ship, a plane, a vehicle — and not on how new platforms work with what we already have to enhance the force as a whole.

What the Ford-class, the Joint Strike Fighter, and future unmanned platforms bring is the ability to pull the information in and be an epicenter of an enlarged and extended reach for the joint and coalition force.

With its ability to push data back to the ships and across the international coalition of F-35 operating nations, the F-35 is more than just a new strike fighter: It is part of fundamental change in the way the sea services operate across an extended, integrated battlespace.”

In building a body of knowledge at the pilot level, Marine leadership joined forces with the visionary Secretary of the Air Force Mike Wynne and COS Buzz Mosely, who in partnership with AF Chief General Buzz Moseley (F-15 Fighter Pilot) created a special flying billet in an F-22 Raptor Squadron for a Marine Fighter Pilot Lt. Col. Chip Burke.

The Honorable Mike Wynne, Secretary of the USAF together with General Buzz Moseley Chief of Staff working with the full visionary support of LtGen George Troutman, Deputy Chief of Staff Aviation, USMC to put a non-USAF pilot into an F-22 to jump start USAF thinking and to gain better joint force understanding the transition.

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Secretary Wynne and Chip Burke had a seminal meeting and discussion at the F-35 initial “school house” Eglin AFB where the first F-35, USMC, USAF and USN Squadron pilots were being transitioned to the Lightning II.

As Wynne explained:

“Finding the enemy, fixing the enemy, and destroying him is a fleet task, not the individual aircraft or squadron. What’s going to happen now is we’re going to go up there and find the enemy, and assign it away.

This affects training because we now need to train pilots to think from the standpoint of command and control so the training approach would need to be modified as the training became more advanced.

How do you begin to start the process so that when they get to advanced pilot training that they really understand that one of the things that they’re going to have to learn is this core syllabus is going to take them into a command-and-control ops, rather than that of the traditional fighter pilot.”

And that is exactly what is happening at the Marine Aviation Weapons and Tactics Squadron -One, Yuma, with the USAF Weapons Schools and home to Red Flag at Nellis AFB and the Naval Strike and Air Warfare Center, NAS Fallon.

As previously mentioned, a key intangible that should never be underestimated for combat success, is the source of instructors during a squadron pilots combat training cycle.

These three different services graduate schools of studying and perfecting combat flying; USMC- MAWTS, USAF -Weapons School, and the Navy’s-NSAWC, are the absolute top of the Fighter Pilot pyramid in both turning out the best combat instructors while also focusing on a flying curriculum to embed selected Squadron Pilots who undergo their post-graduate training back into their Squadrons in order to instill in all their mates the most current tactical thinking on how to fly, fight and win any air battle in any threat conditions in any part of the globe.

In the summer of 2015 the USMC declared VMFA-121 ‘The Green Knights’ IOC with the F-35B and thus that fighter squadron became the first operational F-35 combat squadron in the world. Commandant of the Marines, General Joe Dunford, who is now Chairman of the Joint Chiefs of Staff announced IOC :

“VMFA-121 has ten aircraft in the Block 2B configuration with the requisite performance envelope and weapons clearances, to include the training, sustainment capabilities, and infrastructure to deploy to an austere site or a ship. It is capable of conducting close air support, offensive and defensive counter air, air interdiction, assault support escort and armed reconnaissance as part of a Marine Air Ground Task Force, or in support of the Joint Force.”

Interviewing Lt. Col. Gillette the first Commanding Officer of 121 while he was transiting to F-35 by standing up the Marine F-35 training squadron, VMFAT-501, Warlords, at Eglin AFB, he stressed the importance of combat experience to shaping the approach, which the jet will follow as it is integrated into USMC operations.

“The USMC with its experiences in Libya, Iraq and Afghanistan certainly has logged significant understanding of how combat jets are used to support the MAGTF and ground forces overall.

The warriors are bringing the war to the airplane. The airplane is not going to war for the USMC by itself. In other words, operational experience precedes the F-35 B and it is being melded into this new piece of equipment.

This experience of the past decade is being taken forward into the next and will be an important part of shaping the operational approach for the first decade of the F-35B and its experience with the USMC.

The ability of the airplane to ingest information from all different sources, fuse it, will now level the playing field to some extent between the seasoned flight lead, who is doing the communication with the guy on the ground, and the rest of the squadron.

The plane will immediately transmit all the situational awareness built into the plane and provide it to the least experienced member of the flight squadron. And that will happen just like that.”

The key to the future, as demonstrated at Yuma is to put the F-35B in the hands of the operators.

The pilots of VMFA-121 are working very closely with USAF pilots as the Air Force prepares for its IOC in 2016, fellow Naval Aviators in the USN are also clearly involved



FIGURE 3 SQDN LEADER HUGH NICHOLS AT BEAUFORT AIR STATION IN FRONT OF RAF F-35B. JUNE 2015, CREDIT PHOTO SECOND LINE OF DEFENSE

As Major Summa, the Executive Officer of VMFA-121 at Yuma, who is now LtCol Summa CO of VMFAT-501 at MCAS Beaufort SC, put his Squadron/MAWTS learning in a joint service perspective;

“Working with the other service pilots provides an important window on where we want to go with the concepts of operations of the aircraft. We have different backgrounds, Harrier, F-18s, F-16s, F-22s, and F-15s, but we understand that given the commonality of the aircraft these different backgrounds suggest common ways ahead. We are all able to contribute to the way ahead for a common aircraft.

And already some very different ways of operating are suggesting themselves.

Historically, there is a one to one relationship between combat aircraft and mission support aircraft in doing certain types of initial insertion missions.

With the F-35 and its combination of stealth and fused combat missions we can reduce dramatically the need for mission support aircraft in initial operations. For example, a non-kinetic electronic warfare option is one button push away.”

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The co-location of VFMA-121 with MAWTS-1 is an important part of the introduction of the aircraft.

While VFMA-121 is now operational, MAWTS-1 is responsible for the tactics and training for USMC aviation. F-35, MAWTS instructors are flying with VFMA-121 to shape evolving concepts of how to standardize fleet operations for the new aircraft.

As a former CO of MAWTS-1 then the Commanding General of 2nd Marine Air Wing, Major General Robert Hedelund put it: “VFMA-121 will figure out how to kill the enemy more effectively and MAWTS will standardize the approach.”

And soon very soon Allied Air Forces, along with more USMC, USAF and USN F-35 Fighter Squadrons will be standing up and reaching IOC. All F-35 Fighter Pilots will be part of a global combat enterprise, unified but diverse, in full partnership such as the world has never seen before.

AND it all begins with trained squadron pilots.

LESSONS LEARNED AT PAX RIVER

Developmental testing is a fact of life for operational fleets. As one test engineer commented during our visit to Pax River, “we continue to do developmental testing on the Super Hornet here at Pax.” And with more than 50,000 flight hours on the F-35 fleet and an operational squadron with the Marines, to be joined by the USAF this year and the Navy next year, the F-35 fleet has already taken off.

The F-35 has become tactically operational in the USMC while the aircraft is undergoing developmental testing by the Pax River and Edwards AFB with an F-35 Integrated Test Force (ITF) for the USAF and USN . What is not widely understood is that the ITF is managing the ongoing developmental testing for the life of the program.

With the scope, complexity and concurrent global reach of the F-35 program, a new approach to testing was set in motion.

The program is one of “spiral development” in which combat F-35 Type/Model/Series (T/M/S) airplanes emerge throughout the process to operate as effective combat assets, even while the developmental testing for all three types of F-35s continue. Put bluntly, the F-35B in the hands of the Marines is a fully “up” combat aircraft (both airframe, sensors and weapon systems) addition to the USMC Air/Ground team. All Squadron Pilots in Marines, USAF and Navy, will be backed up by the best test community in the world at Edwards and Pax. This partnership forged for decades will continue a dynamic synergistic combat way for the entire life of the F-35 Global Enterprise.

For the Lightning II, the past decade of putting together a unique, and innovative approach to shaping the F-35 fleet has paid off and has built a solid foundation for the decade ahead. As US fighter pilots and their partners generate fleet and ultimately combat experience that will lead to never ending innovations and developmental testing.

Put bluntly, if you waiting for the end of developmental testing come back in 30-40 years. Meanwhile, the F-35 fleet will have reshaped air combat operations.

The global enterprise is a key part of what happens at Pax River. The UK is an integral part of the team, and as Gordon Stewart, UK MoD flight engineer at Pax described this powerful and productive partnership:

This is the most integrated test team I have ever worked on. As we work the way ahead, it might be a UK person, a Lockheed person, or a US government person who provides the best solution. It is a very well integrated team at the working level.

It is a very different test process than in the past, although what is happening in the F-35 program is the way we are approaching the future as well. In the past, there was much more serial testing.

Twenty years ago when I first started, the contractor would do something and then throw it over the fence to the government, which would look at it, approve it and then pass it on to the operator.

Now with the pace of technology, and the role of software, we have a much more integrated process. We are shaping the evolution of the aircraft as it goes out the door as well.

At Pax, we are testing a software version ahead or a couple ahead of what the fleet is getting at the moment. In effect, we are testing the next iteration of the aircraft.

And the Edwards and Beaufort efforts provide important pieces to the evolution as well. We have an integrated RAF and Royal Navy team at Edwards. 17 (R) squadron at Edwards is a mix of RAF and RN.

At Beaufort, we have a UK team and one of our aircraft, and we are working closely with the USMC. That is another key element of the joint integrated effort, from our point of view.

In an historic first there was no clearer example of the global nature of the program when the first F-35 to fly across the Atlantic landed at Pax River. At 1430 on February 5, 2016, the first Italian made F-35A flew into the pattern at Patuxent River Naval Air Station, Maryland and touched down. The Italian AF pilot call-sign "Ninja" had only flown the jet for 50 hours previous to his seven hour trans-Atlantic dead of winter flight. And most amazing for reliability the airplane, which was the first built in Italy itself, had only 15 flight hours prior to the trans-Atlantic flight completed the entire mission "up and up" with no "gripes" or maintenance problems.

The landing of AF-01, which flew first in Italy in September, was by one of the Italian pilots trained at Luke AFB in the Fall and highlighted the progress of the program. The flight from Cameri to Pax River added some hours to the program, which has now more than 50,000 hours flown by the fleet to date.

Historically, allies and partners who operate U.S.-generated fighter aircraft would do so sequentially over time as the type/model/series progressed, with U.S. fighter pilots flying the newest jets first and then allies next as production was generated off of U.S. lines.

For example, the first flight by the U.S. of the F-16 was in 1977, however, it took until 2001 for the first USAF F-16s to be introduced into the Italian AF. Under the terms of a USAF and Italian AF agreement named the "Peace Caesar" program was the lease of F-16s to make up for shortfalls in Typhoons in the Italian Air Force fleet.

Put in blunt terms, the Italians are flying the most advanced U.S. combat jet in current production at the same time as the U.S. services. This provides a unique moment in history and a clear opportunity for shaping new global capabilities.

A key aspect of the global nature of the program is the ability of the fighter pilots of different services and nations to share experiences. With regard to the transatlantic flight, Ninja commented:

I talked with the Marines about their flight – they went from Yuma to Pax – and their flight plan to come over in 2014. They were very helpful. Semper Fidelis is what I have to say about that.

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Ninja also underscored that the advantage of learning to operate the aircraft from the ground up was an opportunity to shape new combat approaches as with all members of the first ever concurrent state-of-the-art international fighter program. Training, Tactics and Procedures (TTPs) will be applied, critiqued and modified over and over by all Air warriors in the F-35 global consortium. Diversity of experiences can lead to unity of purpose to always have the best TTPs to fight and win in air combat.

The pilots interviewed in January and February 2016 at Pax River highlighted a number of key qualities of the F-35 which they valued and which would allow combat fleets to shape innovative new approaches moving forward.

Among the key qualities highlighted were the following:

- The excellent flying qualities of the aircraft and the advanced flying controls;
- The human-machine interface which allowed the pilots to focus on the mission, rather than flying the aircraft;
- The enhanced safety and security with regard to flying off of or onto amphibious ships or carriers; Because of a very significant feature of the stability of the aircraft which would directly lead to expanding mission training time versus pure flight training about the carriers.
- The integration of the sensors along with the touch screens allowing very flexible management of the mission.

Ninja provided his perspective on the F-35 after he landed in Pax River from the Azores.

The great thing about the F-35 is that the human-machine interface (HMI) is so good and so built around the pilot that you don't have to learn how it works. You just use it. You can configure the screens to configure for the mission.

The aircraft is built to understand; you are building a strategy, not focusing on managing the sensors or really focused on the flying function.

I was able to see the aircraft surrounding me through the clouds, such as keeping distance with my tankers, by using my helmet and the Distributed Aperture System and see the C-130s below me below the clouds.

Because we were at Pax, we had a chance especially to talk with carrier pilots as well. For these pilots, the coming of the F-35 C to the carrier is a significant step forward for the U.S. navy. It is about moving from the limits imposed by the current air wing, and getting on with the innovation suggested by Rear Admiral Manazir to fight more effectively in the extended battle space.

The US Navy cycles operational pilots into the test program and back again. One operational carrier squadron fighter pilot who is now in his test pilot tour at Pax in the F-35 program will go back to the fleet and he put it very bluntly about the impact of the F-35C:

With the current air wing (i.e, with the Super Hornet and Hornet as the tip of the spear), we are wringing out our tactics for a tactical advantage, which is also, at the same time, at the edge of the envelope for survival.

We are spending a lot of time making sure that we have the right tactics and the mastery of those tactics by pilots to survive and succeed.

It is about keeping a level of competence and capability where you're not going to die.

There are points where you have a twenty second window. You miss that window and you might be blown up.

When you're traveling at those speeds, we are talking really only a couple of seconds that you have.

And, if you're not performing tactics exactly as they're prescribed, you put yourself in a kill zone.

With the F-35, we are jumping a generation in tactics and now looking at the expanded battlespace where we can expand our impact and effect.

You need to take a generational leap so we are the ones not playing catch up with our adversaries.



FIGURE 4 FLYBY OF F-35CS OVER THE USS NIMITZ DURING DEVELOPMENTAL TESTING, FALL 2015.

And looking forward with regard to the F-35 and its evolving capabilities, Ninja highlighted a number of key aspects.

This is one of the first aircraft that you can take off and after about two flights dropping bombs, and firing weapons.

Your mission systems are so good that you can start operating weapons very early in your training and operations.

We have to air-to-air pilots working with air-to-ground pilots and merging the cultures.

You are not focusing on your sensors; you are focusing on the end objective of your mission.

The big difference with this aircraft is situational awareness.

You see everything, and I mean on the surface and on the ground and you command attack, defense and electronic warfare functions within the aircraft.

In short, the plane is here and is already reshaping the thinking of several air powers, the USMC, the USAF, the USN, the Australian RAAF has generated its Plan Jericho to leverage the plane, the RAF sees it as a key part of its triple transition involving modernization of Eurofighter intersected with the F-35s flying from their new carrier, the Italians are doing a double transition with Eurofighter modernization with F-35s, the Norwegians and Dutch are preparing to fly an all fifth generation fleet. And all of these squadron pilots are currently flying together at Luke AFB with the F-35As and for the USMC and RAF at Beaufort Air Station with the Bs.

The future is now

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(Visits to Pax River, January and February 2016).

LT. COL. RAJA CHARI TALKS ABOUT THE WAY AHEAD WITH THE F-35: THE RENORMING OF AIRPOWER SEEN FROM EDWARDS

An organization is known by the individuals that make it successful, and there is no more demanding organization than a Combat Fighter Squadron. To become a successful fighter pilot it all begins with their first tour Squadron experience in beginning their personal journey to make a difference for those yet to come. The legacy of an organization and a base can also provide insights since it may be a cliché but the past is prologue.

We were fortunate to interview one such Fighter Pilot. Lt Col Raja Chari, Director of the F-35 Integrated Test Force and Commander of the 461st Flight Test Squadron (FTS), Edwards Air Force Base, California. He is a senior pilot with combat experience and more than 2,000 flying hours in the F-35A/B/C, F-15C/D/E, F-18, F-16, T-38A/C, T-37, and T-6.

Following undergraduate pilot training at Vance AFB, OK and F-15E training at Seymour Johnson AFB, NC, Lt Col Chari served as an F-15E Evaluator Pilot and Chief of Standardization and Evaluation at Elmendorf AFB, AK and RAF Lakenheath, United Kingdom, where he gained operational experience in the Pacific and flew combat missions in Operation IRAQI FREEDOM.

Lt Col Chari served at Eglin AFB executing flight test on F-15 aircraft to include the introduction of the first Active Electronically Scanned Array (AESA) radar on the F-15E. He is also a graduate of the U.S. Army Command and General Staff College. Lt. Col Chari's full bio is at end of the article)

His command has a storied combat history (taken from wiki) :

The 461 FTS squadron performs flight testing on the F-35 Lightning II.

In the early days of WW II, the 461st Squadron was deployed to England aboard the RMS Queen Elizabeth and served in combat as a part of the VIII Fighter Command from October 1943 to May 1945. The 461st ran operations in preparation for the invasion of the European continent; they supported the landings in Normandy and the Allied drive across France and Germany. The squadron flew P-47 Thunderbolts until replaced by P-51 Mustangs in November 1944. Aircraft of the 461st were identified by a magenta/blue diamond pattern around their cowling, carrying fuselage code "QI".

From October 1943 until January 1944, the squadron operated as escort for B-17 Flying Fortress/B-24 Liberator bombers that attacked industrial areas, missile sites, airfields and communications.

Fighters from the 461st engaged primarily in bombing and strafing missions after 3 January 1944. Its targets included U-boat installations, barges, shipyards, aerodromes, hangars, marshaling yards, locomotives, trucks, oil facilities, flak towers and radar stations.

The 461st bombed and strafed the Arnhem, Netherlands area on 17, 18 and 23 September 1944, in order to neutralize enemy gun emplacements that were providing support to Allied ground forces during Operation Market-Garden. In early 1945, the squadron's P-51 Mustangs clashed with German Me 262 jet aircraft. The squadron flew its last combat mission, escorting B-17's dropping propaganda leaflets, on 7 May 1945.

As for the legacy of a military base, driving on Yaeger Blvd, Edwards AFB to interview Lt Col Chari says all one needs to know about the storied history of USAF high performance testing of the future aircraft that will continue to dominate combat aviation in the 21st Century

Question: When did you come to the command?

Answer: About nine months ago. I came from the Rapid Capability Office where we focused on an accelerated acquisitions process for urgent operational needs.

Question: What were your expectations when you came to the command about the program?

Answer: I knew very little about the F-35 programatics when I was informed I was going to take command. With all the negative press out there, my first task was to get ground truth on the program.

When I went to Eglin to learn to fly the plane, I saw a lot of F-35s on the tarmac, and that was a key ground truth - the program is way beyond getting out the gate.

Indeed, when I got here [to Edwards], we were on the cusp of IOC for the USMC F-35; that was a launch point for me as well. The ship has sailed on the F-35 program. We have this awesome airplane, now how do we get the best out of it? That is my task.

Ground truth and some press reporting seem a bit out of whack with one another.

And really it feels like what NASA must have been like in 1969; it is a once in a generation thing to get IOC on a next generation aircraft, and the excitement around here is palpable. You are going to talk about this experience for the rest of your life, being present at the creation and evolution of F-35 combat capability.

Question: We discussed the so-called F-16 and F-35 dogfight with colleagues earlier today, what is your take on this amazingly blown out of context story?

Answer: My first week here that story came out. I found the whole thing amazing because it did not even involve a simulated combat sortie. We were going after some particular test points. The F-16 was simply a test aid, not in a dogfight with the F-35.

The story was simply spun and used by those who like to spin stories.

Because this happened just after I got here, I reached back to the leadership to determine whether this would have a chilling effect on our pilot reporting and discussions and was given clear guidance that we were not testing in response to the press, we were testing to evolve the aircraft. That was made very clear from the top down. We are looking for accurate test and evolution of the aircraft, not a managed press campaign. Somebody else's distortions are not going to deter our discussions.

And really, discussing the F-16 with the F-35 would be like a horse cavalry officer discussing the tank during the First World War. You know the tank can not jump across the trench like a horse does! That is correct and absolutely irrelevant.

The USAF Chief of Staff has us focused on the target of dominance in 2035 and not just carrying the legacy approach and fleet forward. The F-35 is a big part of that forward thinking.

Question: Where are you with regard to USAF IOC?

Answer: We finished IOC testing on the USAF IOC software as of last Fall. We have been working on the next block or cluster of capabilities for the aircraft. Recently, the program with inputs from us and OT, decided to go back to the AF IOC software to look at an anomaly in the missions systems to enhance the stability of those systems interacting with one another. It is really about improving , but with the overall approach of still pushing the Full Operational Capability (FOC) software in the next block as far as we can

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go and then determining what we should do in that block vs what should be moved into a future block of the software.

Since we are focused on multi-ship formations, we are working on the stability of the exchange of information among the aircraft.

We are driving the evolving capabilities hard and will be throughout the life of the program. We are pushing the limits of technology; that is the point of what we are doing here. If we weren't having challenges, it would mean we had set the bar way too low.

Question: There is an evolution of the tactics coming from places like Yuma and Nellis as they start to learn fifth generation combat F-35 style.

How does that feed in to your efforts?

Answer: The OT squadron here is a clear player in that domain and we work together closely and feedback goes both ways.

But the tactics OT is developing are very different. We are likely not going to do visual formations with the F-35 tactically; you are operating over multiple tens of miles and flying distributed ops where you can have completely different functions or tasks being performed by those aircraft within the same four-ship. You are essentially spreading out the geometry of air combat. You are not simply operating in or patrolling a lane but operating a much wider variable geometry.

Question: How do you see the interaction between dynamics of change for C2 and the F-35 fleet?

Answer: The F-35 is generating the air picture, which changes the situation for the AWACS dramatically. It does not need to tell me what I can see better than what I can already see; but it will become more like an airborne air battle manager.

And as the F-35 intersects with ground, sea and other air systems, the entire Command and Control (C2) operation changes as well. The new challenge will be to get the right information to the right person at the right time; not just providing point outs on radar contacts like previous fighter/Airborne Warning and Control System (AWACS) integration.

Put in blunt terms, each F-35 is its own C2 platform. The CNI is a key system here whereby software can generate waveforms for the jet. The Communications Navigation and Identification (CNI), is a set of processors and antennas that generate waveforms that can be UHF or VHF waveforms, a TACAN, data link, or whatever waveform you want it to be. It's just whatever software you've created will allow the pilot to pick and choose. This is a revolutionary foundation for the evolution of C2 in the air.

The F-35 is a key tool in transitioning to how we will do air warfare differently as we push decision making and target determination capabilities to the edge of the battlespace, or to determine where effects need to be created. Other systems will become part of this evolving approach but the F-35 is the game changer that will take us there.

Biography

Lt. Col Raja Chari is the Director of the F-35 Integrated Test Force and Commander of the 461st Flight Test Squadron, Edwards Air Force Base, California. He directs an integrated team of over 1,000 active duty, government civilians and contractors, in the planning, execution and reporting of F-35 Developmental Testing.

Lt. Col Chari graduated from the U.S. Air Force Academy where he double majored in Astronautical Engineering and Engineering Science while minoring in Mathematics. He was awarded a Charles Stark Draper Laboratory Fellowship and attended graduate school at the Massachusetts Institute of Technology, where he developed methods for automated orbital rendezvous.

Following undergraduate pilot training at Vance AFB, OK and F-15E training at Seymour Johnson AFB, N.C., Lt. Col Chari served as an F-15E Evaluator Pilot and Chief of Standardization and Evaluation at Elmendorf AFB, AK and RAF Lakenheath, United Kingdom where he gained operational experience in the Pacific and flew combat missions in Operation IRAQI FREEDOM.



FIGURE 5 F-35 BEING TANKED OVER THE DESERT NEAR EDWARDS AFB BY AN AUSSIE KC-30A TANKER. FALL 2015.

After graduating from the U.S. Naval Test Pilot School, Lt. Col Chari moved to Eglin AFB where he served as an evaluator Test Pilot, Chief of Weapons and Assistant Director of Operations.

Lt. Col Chari was the project pilot for the F-15C and E's APG-63(v)3 and APG-82(v)1 Radar Modernization Programs bringing cutting edge Active Electronically Scanned Array radars to the USAF and flew critical envelope expansion and validation missions for a variety of weapons including AIM-9X, AIM-120D, GBU-28, and JASSM.

Additionally, Lt. Col Chari oversaw a team of military, civilian and contractors in planning, executing, and reporting on flight test missions for four different weapons systems. Lt Col Chari served in the CENTCOM Joint Operations Center as a time sensitive targeting officer, monitoring and authorizing dynamic targeting against high value targets and individuals.

After graduating from the U.S. Army Command and General Staff College, Lt. Col Chari was a program manager for an ACAT-1 Program in the Air Force's Rapid Capabilities Office. He led a Deputy Secretary of Defense priority program overseeing a multi-billion dollar effort and rapidly delivered a critical combat capability. Lt. Col Chari is a senior pilot with combat experience and more than 2,000 flying hours in the F-35A/B/C, F-15C/D/E, F-18, F-16, T-38A/C, T-37, and T-6.

Ed Timperlake's Personal Note:

Having been present in the Pentagon for the Office of Net Assessment and also at the CIA during the late seventies as the developer of the TASCFORM-AIR math model, I saw the "Fighter Mafia" up close.

In fact to understand what he was saying, I sat through John Boyd's lecture twice.

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The one thing that struck me was residual anger directed at both the F-14 and F-15. In fact, in one briefing talking about the evolving AIM-120, the briefer was mocked for putting what was loudly stated as bogus potential kill-ratios.

History has written a far different story as the F-15 has been shown to be the most successful fighter ever put into the hands of a Squadron Combat Fighter Pilot—Eagle has a Kill Ratio of over 105 to 0.

F-35 MAINTENANCE AT THE EDWARDS DEVELOPMENTAL TEST TEAM: LAYING THE FOUNDATION FOR THE OPERATIONS OF A GLOBAL FLEET

During the OT-2 aboard the USS Wasp, a young British maintainer made a simple point about the F-35: Lt. Cdr. Kitchen from the Royal Navy commented during a round table aboard the Wasp in May 2015:

“The F-35 can be surrounded by myth and legend. But it is a real testimony to the capabilities of the maintainers of the Royal Navy, the Royal Air Force and the USMC to adapt to the new technological challenges.

Their knowledge of aircraft systems is now being applied to a new air system and taking steps forward into the unknown. It is a testament to the professionalism of these maintainers that they are just getting on with the job of making this aircraft work.

Every single person involved in this detachment is passionate about this aircraft and not just because it is a sexy looking aircraft but want to see it working in every operational environment.”

That perspective certainly was reflected in meetings which we had with maintainers for the Developmental Test Team at Edwards AFB. Indeed, what you could see was a very dedicated team of young maintainers from the USAF along with contractors working to shape a way ahead with regard to the maintenance of the F-35 as a global fleet.

With the “myth and legend” comment in mind, the vast literature on the failings of the ALIS or Automated Logistics Information System largely misses the point. This is a foundational system for doing maintenance differently; and the foundation will be built upon to shape over the decade ahead a capable system to manage a global fleet.

The day we visited an F-35C was in the bay on which the maintainers were working. Let us ponder that point. We were at a USAF base and they were maintaining a Navy aircraft.

Mary Parker, Deputy for Logistics for the Developmental test team, explained the difference between the DT and OT sides of the house at Edwards.

“We are a Developmental Test Group, which means we have a Flight Test Control Engineer (FTCE) for every flight and an engineering pool, in addition to the maintainers who collectively work the Health Reporting Codes (HRCs) through to the Anomaly Fault Resolution System (AFRS). We are in the business of shaping a more effective maintenance product in terms of health monitoring data accuracy.

In contrast, the Operational Test Group or an Operational Test Squadron, has a Crew Chief in charge that knows the complete aircraft and he works the problems within his team. As the Crew Chief encounters problems he needs assistance with, he'll submit an Action Request (AR) through ALIS to receive information to reach a resolution for the problem. ”

The plane talks to the maintainers; the computer brick is pulled from the plane after a flight and the mission as well as maintenance data is plugged into the IT management systems.

This is now; this is today.

The maintainers plugged in their information as they do the maintenance rather than entering paper trails into an IT system at a later date. There is a complete digital history of the aircraft, who maintained it, what they did and when they do it.

This is now; this is today.

One can go to the ALIS system and see that aircraft and its condition from a maintenance situation and when it goes to depot, the complete accurate digital history is part of what the depot can then work with, and their work in turn, will go into the digital system as well for the line maintainers to have direct access to.

This is now; this is today.

What is a work in progress is taking that information and building squadron and fleet records which can provide a global picture of the fleet. But without the foundation, which has already been built and is operational today, a global picture and system would not even be imaginable.

This will take time, because the data needs to be built, and flow into the system, with the system itself being adjusted to the operational realities, which will become available over time. It takes a decade for a new combat aircraft and its combat team to gain enough operational experiences to really know what that aircraft can do under global combat conditions. The F-35 will be no different.

But what will be different is that the F-35 is global from birth, and global information generated from the beginning. And as the global fleet deploys information for areas as far from one another as Australia to Norway will input real world operational data into a global maintenance system. And the data generated will provide significant inputs as well to the manufacturing process and the redesign of parts as those parts are tested in operations. This is a digitally based combat learning cycle within which maintenance is built in as an integral part.

It sounds simple; but it has never been done before.

When visiting the maintainers at Edwards, it is clear that these young people know they are part of something new and something exciting. As Lt. Col. Chari put it with regard to the effort:

“Really now is like NASA must have been like in 1969; it is a once in a generation thing to get IOC on a new generation aircraft, and the excitement around here is palpable. You are going to talk about this experience for the rest of your life, being present at the creation and evolution of F-35 combat capability.”

This is true not just for the pilots but clearly for the maintainers as well; and it is an air combat system operated by an air combat team.

Our host for the tour was Mary Parker, Deputy for Logistics for the Developmental Test Team. We discussed maintenance and operational support practices and systems with Staff Sgt. Cody Patters, Crew Chief, R.J. Veron, AF-3s Aircraft Supervisor, Staff Sgt. Rachel Simmons, Avionics Technician, Mr. Jesus Rivera, Avionics Technician, TSgt Jeremy Jackson, Mr. Rusty Phillips, Weapons Expeditor, Senior Airman Jessica Meehan, Weapons Technician, Staff Sgt. Jason Noyes, Low Observable Technician, TSgt Andrew Williams, Egress Technician, and Mr. Greg Guevara, Mechanic/Technician.

Second Line of Defense

In addition, we spent time with the Life Support personnel, Mr. Jim Kristo and Ms. Jackie Williams, involved with the helmet as well and got a sense of the way ahead with that system, which obviously work (we saw that with Ninja flying the Atlantic in version 2 of the helmet and having nothing but praise for his helmet as well – not needing to turn around in flight was certainly something he mentioned after he landed at Pax River.)

It is difficult to convey the richness of what we learned during the site visit, but seeing the equipment, crawling under the jet and talking with personnel conveyed as sense of a competent team shaping a clear way ahead for the digital airplane and the fleet. By the way, there are more than 150 flying aircraft feeding data already into the ALIS system, with more than 50,000 flight hours.

Obviously, these maintainers came from legacy programs, F-16, F-15, A-10, B-1, B-2, and F-22. We asked all of them what their expectations were when they came to the program, and they ranged from excitement, to an expectation of complete discontinuity, to in one case concern that his plane was being replaced.

But across the board, the comment was that the plane was much easier to maintain than their legacy aircraft, but it was “different” because it is a digital system. There was also the comment that changes that they would have like to see in their legacy aircraft were anticipated and built into the F-35 program. In this sense, although a digital aircraft, many of the changes built into the program are built upon what came before and changes which maintainers wanted to see.

When it came to a major shift from the current USAF IMDS or Integrated Maintenance Data System to the ALIS or Autonomic Logistics Information System, the Crew Chief explained that the new system incorporated a number of changes which his generation of maintainers thought was needed to IMDS but done in an integrated manner.

In his view, systems are like children which go through growth cycles, and that “ALIS is in its Toddler phase.” But the foundation was solid and the integration of what had been disparate maintenance systems was a key advantage of the system.

It is a point of entry system, and he had already seen gains in accuracy of input in information. The integrated system makes it easier as well for the new maintainer to operate at a higher standard than a newbie on a legacy aircraft.

“With the IMDS, experienced maintainers have a number of ‘cheat books’ they developed to navigate to whatever screen number you need to find the information which you need for a particular task. ALIS presents the data much differently and you can get rid of your old ‘cheat books’.”

But you have to learn the system; it is different.

“If you bring a legacy mindset to this and think in IMDS terms, you will not get it. You need to enter a more integrated digital workspace and learn how it works. Then you not only get it, but you can find ways to improve the experience and pass on your recommendations which can be later incorporated into the ongoing revisions of the system.”

Put in simple terms, the maintainer is facing culture change, and the maintainers at Edwards are part of the Cultural Revolution associated with bringing into service a digital aircraft. What was being put in place, according to the crew chief, was “smarter maintenance. The USAF is getting smaller; we are expecting more from less people and this kind of maintenance system is crucial to get there.”

The experience we had at Edwards reminded us of the comments made by Col. Seymour, one of the pioneers in bringing Osprey into the USMC, about the challenge of cultural change with regard to maintaining the Osprey.

“A key challenge is to let the maintainers know they are not stakeholders but Marines. For example, I had a gunny sergeant who said he preferred CH-46s to Ospreys. “He said that I’m a 46 guy.” I looked him in the face and said, “Well, you’re in the wrong unit, gunny. There are no 46 that’s left here on the East Coast. You want me to get your orders to Okinawa, because, you know, that’s the only place for flying 46s.”

I told him that you don’t get a vote. This is not a democracy. Conway decided. McCorkle decided. Hagee decided. Amos decided, you know, we’re going to fly the Osprey. It is what it is, so either embrace it or leave.”

He then underscored where that Gunny is now in terms of working the Osprey. “The same gunny now will brag about being, the gunny who fixed problem X, Y, or Z in the maintenance department on a V-22. He owns it now. It’s like okay, you know, it worked, it’s normalized if you will, and that’s why you see this, this growing success. Success begets success internal to the Marine Corps culture.”

We saw the same approach and the same attitude at Edwards – get on with it and make the new plane, and the new maintenance culture the new norm, rather than trying to think in terms of the last century’s approach.

With regard to avionics or mission systems maintenance, the maintainers talked about how they used the screens in the cockpit similar to how Major General Silveria had discussed how the pilots do: they configure the screens to the task and to support their work flow to get the outcomes they need to get to.

“The cockpit gives us easy access through the multi-function displays and touch screens to the information about the mission systems. We can modify the screens to do the maintenance task required. The screens make ergonomic sense and are easy to work with to shape the work approach to get the job done.”

With regard to weapons and weapons loading, we learned that a major step ahead was that the training weapons did not need to be armed at the end of the runway with a specialized team of weapons loaders. The weapons for the F-35 can be loaded onto the aircraft, over the various weapon stations on the aircraft, and armed by the pilot in the cockpit. The airplane can load as much as 18,000 pounds of ordinance on the A and C models, and 16,000 on the B model. For example, the plane will carry 8 small diameter bombs, in a 4 plus 4 configuration inside the A and C models.

With regard to Low Observable Maintenance, the F-35 is radically different from earlier stealth coated planes, for it is built into the aircraft, and is maintained as such. The maintainers took us through the steps of how to maintain LO on the aircraft, and then took us to the ALIS system to show us the LO page for the particular F-35C which was in the hanger that day. The ALIS screen showed everywhere on the aircraft that repairs had been made, what repairs had been made and by whom and on what date.

By a process of external examination of the airframe after a fight, the maintainers and then the crew chief do a visual examination to determine if a repair is needed. They then go to the ALIS system and bring up the needed repair and trace the repair from the screen and then take it to the airframe to guide the repair process.

In the various ALIS discussions, the point was highlighted that because of the accurate data built around each aircraft in the squadron and the squadron itself, it would possible to build out fleet knowledge over time, as the flight time and operational experiences get built into the fleet. This would include understanding of things like weapons and LO maintenance because they are integrated as well into the ALIS system.

Second Line of Defense

We learned many other things of interest as well, such as the fact that the tool crib to support maintenance for the F-35 contains the same amount of tools to maintain all three variants, as those necessary to maintain a single legacy aircraft, such as the F-15.

We learned that several legacy systems had been designed out of the F-35 making the maintenance process easier, more rapid and more accurate. A key example was that the actuators did not leak hydraulic fluid and you did not need a MULE to be put in place to maintain a complex hydraulic system on the F-35 – it used self-contained reservoirs on the actuators themselves.

One maintainer highlighted that because the plane talked with you, you could work with the data in the computer to work on the systems rather than having to power up the aircraft, to get the information necessary to shape your work process.

“The plane will show you on the screen what is wrong with it. You do not have to have the jet on to hear what is wrong. This will clearly help newbies from the beginning be better maintainers.”

Another aspect was the management of health indication codes (i.e. HRCs).

“With legacy aircraft, you would get the codes and then have to go look them up. The F-35 gives you the codes and what they are in the same process. This accelerates your ability to get on with the maintenance cycle.”

Tires are one of the few items built-up in the backshops which remain on an F-35 maintenance line. Each variant uses a different tire for the obvious reason that each is designed for a different operational environment.

“We do use largely the same procedures for all three variants for tire replacement and to date we are seeing normal wear and tear on F-35 tires comparable to legacy aircraft.”

A Marine Corps maintainer on the team had come from the Harrier.

“Many of the changes we wanted to see on Harrier maintenance have been incorporated into the F-35.”

We also had briefings on the seats and the helmet, and given Ed Timperlake’s experience of having had to bail out of a two-engine jet on fire, he was impressed with the progress on the seat to facilitate safe ejection. When we visited the Life Support technician, we learned that he had come from the USN and was a parachute technician, which created an instant bond between a Marine Corps pilot whose life was saved by a Navy parachutist technician’s accurate work!

The helmet is form fitted to the pilot for it is crucial to have the symbology of the cockpit projected directly in front of the pilot’s eyes. “But it is of course not bolted into the head of the pilot and can move around which may require him to adjust in flight as needed.”

In short, the “right stuff” is not just in the air; it is on the ground as well. And as the pilot in the air owns his aircraft in combat; the crew chief and his team on the ground own their aircraft to get it combat ready. And at Edwards they are part of the team preparing the way for a digital age information warfare “flying combat system.”

(Visit to Edwards AFB to visit F-35 and KC-30A test teams in March 2016).

THE DEPUTY COMMANDANT OF AVIATION DOWN UNDER: PLAN JERICHO MARINE CORPS STYLE

The Williams Foundation hosted a seminar on new approaches to air-land integration. The terms of reference for the conference were as follows:

Air forces need to be capable of delivering air and space power effects to support conventional and special operations in the land domain. Air-Land integration is one of the most important capabilities for successful joint operations.

The last decade has seen a significant shift in how airpower has supported ground operations. With the introduction of systems like Rover, the ability of airpower to provide precision strike to the ground forces saw a significant change in fire support from a wide variety of air platforms. Precision air dropping in support of outposts or moving forces introduced new capabilities of support.

Yet this template of air ground is really focused on air support to the ground whereas with the shift in the global situation, a much wider set of situations are emerging whereby the air-ground integration approach will become much wider in character, and the ability to insert force rapidly, as a precision strike capability, and to be withdrawn will be a key tool in the toolbox for decision makers.

Fifth generation enabled operations will see a shift to a distributed C2 approach which will clearly change the nature of the ground-to air command system, and the with the ability of fifth generation systems to generate horizontal communications among air assets outside the boundaries of a classic AWACs directed system, the change in C2 will be very wide ranging.

The seminar will explore how the ADF can take advantage of Army's Plan Beersheba and Air Force's Plan Jericho to enhance Air-Land integration

Quite obviously, the evolving capabilities of the USMC are clearly convergent with the approach, which Williams wished to foster for the future of the ADF. Lt. General Davis highlighted at the beginning of his presentation that when he attended the Avalon Air Show and then head of the Royal Australian Air Force (RAAF) introduced Plan Jericho, it was clear that the Marines and the RAAF were on the same page.

"I went back to the Commandant and said that we need to work more closely with the RAAF because with Plan Jericho they are onto something big with regard to innovation."

The presentation was hard hitting, comprehensive and clearly on target for the Australian audience.

As Air Commodore Steve Robertson, Commander Air Combat Group and a former exchange officer with the USMC, commented, "If you think this was hard hitting, it was mild compared to some Marines. The Marines are gung ho about the future and shaping new combat capabilities. They do not like to lose."

This theme was central to Davis's presentation – the entire point about combat innovation was to be the best force, which America could deliver to any global crises at any time. "We want to be the best partner to our friends; and the most feared enemy of our foes."

Technology is important to this effort, and he highlighted that the Osprey being brought into the force was a generator of "disruptive change," but the kind crucial to real combat innovation. But change is difficult; and the critics prevalent."

Second Line of Defense

The Renorming of Airpower: The F-35 Arrives into the Combat Force

He noted that if we held this conference 12 years ago, and the room was filled with Marines we would hear about all the things the Osprey could not do and why we should not go ahead. “If we brought those same Marines into the conference room now, they would have amnesia about what they thought then and press me to get more Ospreys and leverage it even more.”

But it is not just about technology – it is about “equipping Marines, not manning the equipment.” His point was that you needed to get the new equipment into the hands of the Marines at the earliest possible moment, because the young Marines innovate in ways not anticipated when the senior leadership gets that equipment to them.

He provided several examples, but one was about the F-35. He argued that there was no doubt that the F-35 is the right plane for the USMC. Now that it is in the hands of Marines, they are innovating in ways which the leadership really did not anticipate and much more rapidly than might be imagined.

He described an event where the Commandant was going witness a Yuma to Nellis scenario in which F-35s would be used to support Marines in the maneuver space. He went to the Marines working the exercise and asked was everything ready for the Commandant?



FIGURE 6 F-35B ABOARD USS WASP DURING DT-2 TRIALS MAY 2016. CREDIT: SECOND LINE OF DEFENSE

The answer was: “Sir we are not going to do exactly what you asked for and are not ready to do it that way?”

Davis commented: “The Commandant is just about here, what are you talking about?”

The Marine answered: “Frankly, the scenario you suggested was not tough enough for we wanted to take our F-35s into a more advanced SAM belt to get through and then support the Marines on the ground.”

Davis was a bit taken aback, but the innovation already evident by the squadron pilots was rewarded with a demonstrated success on the Nellis ranges.

The Commandant was impressed, and although a ground combat Marine, he argued “we need to get that plane into the hands of Marines as fast as we can.”

The DCA noted throughout that the RAAF focus on bottom up innovation with the Plan Jericho processes was what the Marines felt was central to real combat innovation. And shaping the way ahead was really about leveraging the new platforms, shaping key enablers and then ensures that whatever follow-on platforms are bought that they build upon but push the innovation envelope.

He saw the tiltrotar experience as a crucial baseline and saw the future of Marine Corps rotor wing as tiltrotar. He saw the Cobras, Hueys, and Yankees replaced over time by a new generation tiltrotar aircraft. He favored one, which would be two seaters, and able to be either manned or unmanned to provide for the kind of flexibility which the Marines would want to reshape the capabilities and approach of the assault force.

His version of the Plan Jericho approach to building a more integrated assault force was as follows:

Every platform a SENSOR, every platform a SHOOTER, every platform a SHARE/CONNECTOR, and every platform an EW NODE.

And throughout he highlighted that the Marines were preparing for the high end fight and enhanced capabilities to operate throughout an expanded maneuver space, and able to operate from land, and sea sequentially, concurrently or jointly as the mission demanded.

With regard to equipping that force, he saw the need to build on fifth generation capabilities, multi-mission everything, spiral develop everything and leverage bottom up combat innovation.

He concluded that he saw a great opportunity to work with an ADF in transformation as the Marines went down a similar path.

(Note: Lt. General Davis made his presentation in Canberra at the Williams Foundation Conference on March 17, 2016. The Royal Australian Air Force is shaping an integrated 21st century air force built in part around the F-35 and to open the aperture of change, the former Chief of Staff of the RAAF, Air Marshal Geoff Brown, launched the Plan Jericho approach, which is about reducing barriers and leveraging assets like the F-35 as a driving force for enhanced joint combat capability.

The Williams Foundation is pursuing a unique effort to look at the evolution of combat forces under the impact of the coming of the F-35 to their force. This effort is unique in the world, namely, an advanced Air Force – in a few years the oldest aircraft they will fly is the C-130J – preparing for the F-35 with integrated combat as a key focus.

The first effort was focused largely on the F-35 and looked at air combat 2025, which provided a look at fifth generation and its capabilities and how that could transform the force. The RAAF leadership has maintained from the outset that without culture change, adding 5th generation, is just that, additive. They want it to be transformative.

The second effort was the airpower Conference in Copenhagen, where the same theme was the focus of attention, but with a broader set of actors. The only USAF folks there actually did not contribute to the transformation conversation but just talked about airpower, but the RAF, the Dutch AF, the RAAR, and USMC representatives certainly did, and Ed Timperlake and I talked to the broader transformation effort and what it would take.

The third effort was the conference held on the heels of the RAAF's big Airpower Conference where day 1 was an opportunity for the three service chiefs to speak, as well as foreigners such as PACAF.

The second day was focused specifically on providing an update on the RAAF's Plan Jericho, and the co-directors of the program started the day with several contributors talking about different aspects of recent change efforts.

Second Line of Defense

The Williams Foundation seminar was held the day after the Jericho discussion. This was the first of the sessions which are intended to look at applied transformation so to speak. If fifth generation is transformative, how might it be applied to air-land and air-sea integration?

This session was focused on new approaches to air-land integration.

The terms of reference were as follows:

Air forces need to be capable of delivering air and space power effects to support conventional and special operations in the land domain. Air-Land integration is one of the most important capabilities for successful joint operations.

The last decade has seen a significant shift in how airpower has supported ground operations. With the introduction of systems like Rover, the ability of airpower to provide precision strike to the ground forces saw a significant change in fire support from a wide variety of air platforms. Precision air dropping in support of outposts or moving forces introduced new capabilities of support.

Yet this template of air ground is really focused on air support to the ground whereas with the shift in the global situation, a much wider set of situations are emerging whereby the air-ground integration approach will become much wider in character, and the ability to insert force rapidly, as a precision strike capability, and to be withdrawn will be a key tool in the toolbox for decision makers.

Fifth generation enabled operations will see a shift to a distributed C2 approach which will clearly change the nature of the ground-to air command system, and the with the ability of fifth generation systems to generate horizontal communications among air assets outside the boundaries of a classic AWACs directed system, the change in C2 will be very wide ranging.

NINJA DISCUSSES HIS FLIGHT ACROSS THE ATLANTIC

On Feb. 5, 2016 , he Italian Air Force's first F-35, AL-1 with code "32-01" and markings of the 32 Stormo Wing landed at Naval Air Station Patuxent River, Maryland, at the end of the JSF's first ever transatlantic flight.

The aircraft was piloted by "Ninja," an Italian Air Force test pilot, belonging to the Reparto Sperimentale Volo (Test Wing) from Pratica di Mare, and who had successfully completed his initial F-35 flight training at Luke AFB in November 2015.

To put this in perspective, the pilot had only 50 flight hours of F-35 flying experience.

And the Lightning II which Ninja flew across the North Atlantic in winter had only 15 flight hours on before he took off on his historic flight. 32-01 was the first plane to come off of the Italian assembly line at Cameri Italy.

And this was done in the middle of winter, flying in and out of cloud layers over the turbulent North Atlantic against 120-knot headwinds. It was remarkable flying.

After his 7-hour flight he sat down with reporters to discuss the flight and what he sees as the way ahead for the F-35 program.

"We started from Cameri.

We had bad weather.

For the first day, we went from Cameri to Lajes AFB in the Azores via Palma de Mallorca.

This was the first time the F-35 had landed in Portugal.

We had to wait out the weather for a day and then flew the 2000 plus miles past St Johns to Halifax to the Boston area and then we arrived in Maryland.

For safety and security reasons, we had four air refueling during this second leg, and given how bad the weather was the fourth refueling was done close to Pax River again for safety and security reasons.

The flight lasted 7 hours.

We had to go through a Cold Front and heavy headwinds (120 knots).”

Question: You flew in formation and through heavy clouds, we understand?

Answer: We had four aircraft total; and kept tight formation; and refueled in the clouds as well.

We had two C-130s just in the case; the tanker, a Typhoon headed to Red Flag and the F-35.

Question: So you were in a new aircraft, single engine, flying in the middle of winter across the North Atlantic in heavy headwinds?

Answer: That characterizes it.

Question: Did you hand fly the plane to stay in formation?

Answer: The plane is very reliable, and I hand flew some times, but auto pilot handled a great deal of the flight.

Question: What about the air refueling events?

Answer: We had 100% success even in the clouds; the big thing here is that the plane is very stable and reliable with no problems.

We had no disconnections; the F-35 is a very stable airplane.



FIGURE 7 NINJA GREETED BY ITALIAN AIR FORCE GENERAL UPON ARRIVAL AT PAX RIVER FEBRUARY 5 2016

Question: This is the first F-35 built on a new assembly line.

Did that come into play in your calculations in flying the aircraft?

Answer: We did 15 flight hours with AL-1 prior to crossing the Atlantic and we had no issues, and I mean NO issues.

It is the first F-35 built outside the United States.

Our workers at the FACO worked as a team as a team to get this result.

We are building for our own air force and wings for other air forces.

We flew the jet 5 times back to back to back to back prior to coming. I don't think that has ever been done before as well.

Question: How many flight hours do you have on the F-35?

Answer: About 50 real flight hours.

I was formerly a Tornado pilot in the reconnaissance role.

And then became a test pilot.

Question: After the testing here, what is next for the jet?

Answer: We will take the first two aircraft to Luke AFB.

Then in a few months will bring additional aircraft to Luke.

This summer we will ferry number 4 and 5 to give us a full complement of five at Luke.

All the student pilots at Luke fly the aircraft in the fleet whether US, Australian, Norwegian or Italian.

And the training allows us to learn common TTPs from the ground up.

We are building a fifth generation approach from the ground up.

Question: When you sit in the F-35 cockpit and flew across the Atlantic how did the various systems assist you in the flight?

Answer: The great thing about the F-35 is that the human-machine interface (HMI) is so good and so built around the pilot that you don't have to learn how it works.

You just use it.

You can configure the screens to configure for the mission.

The aircraft is built to understand; you are building a strategy, not focusing on managing the sensors or really focused on the flying function.

I was able to see the aircraft surrounding me through the clouds, such as keeping distance with my tankers, by using my helmet and the Distributed Aperture System and see the C-130s below me below the clouds.

Question: Did you have any problems with your helmet?

Answer: No. I used the Gen II helmet and the Gen III has improved the helmet, but my helmet worked flawlessly during the flight. I was able to fulfill the mission and I am here.

Question: How different is flying the Tornado compared to the F-35?

Answer: How can answer and be polite? There is no comparison. Recently, I flew the Tornado after learning to fly the F-35. It was a real shock to go back in time.

I had to move my head and focus on the switches and sensors – you have to manage the aircraft to fly.

The F-35 is totally different.

Question: What is it like to cross the Atlantic with DAS?

Answer: It is IR so much of its functionality is used during the night not the day, although you do look through your legs and could see buildings, intersections, and various landmarks while flying.

Question: Many more people saw Lindbergh land at Le Bourget in 1927 than are here today.

There are four reporters here to witness your arrival, and let make no mistake about it, this is an historic day in which an Italian flew the first F-35A with an Italian assembled aircraft, rather than the USAF having done so.

How does that feel from an Italian point of view?

Answer: It feels great. It is a different mindset. We are working at a different level than we have done in the past.

It must be weird from your point of view to have an Italian fly the first F-35 across the Atlantic. We are making history. We are building it; we are flying it; we are maintaining it.

We talk about facts. I am a pilot.

We have flown all these flight hours with no problems; we are living a new reality.

Second Line of Defense

The aircraft is extremely reliable.

We are close to 50,000 flight hours with aircraft.

That is a fact.

We had a no gripe, no maintenance discrepancies during flight as well.

Question: When the Marines we barred from flying from Pax River to the Farnborough air show in 2014, how did this affect your preparation and thinking?

Answer: I certainly realized that I was going to be first and felt that pressure.

But with regard to the flight I talked with the Marines about their flight – they went from Yuma to Pax – and their flight plan to come over.

They were very helpful.

Semper Fidelis is what I have to say about that.

Question: How was the airplane ergonomically?

Answer: I did not think about it until you asked the question

The seat is very comfortable.

You can stretch your legs in front of you.

The helmet was comfortable, and the seat was very supportable and comfortable.

With this helmet I do not have to turn my head, which makes it easier as well for the pilot.

Question: When did you learn that you would do this flight?

Answer: We started working this about six months ago and worked various scenarios for the flight including divert requirements if needed.

But the aircraft holds so much fuel that there is an additional safety factor built in. After 30 minutes after take off from the Azores I could reach the coast of Canada flying high. If I needed to fly lower, I would need a refueling.

We also brought our tankers to Edwards last year to do refueling of the F-35 and worked through various procedures and operating conditions.

Question: This plane is designed to drop bombs and fire missiles.

What you can see going forward with regard to training with regard to weapons?

Answer: It is a lot easier than you think.

This is one of the first aircraft that you can take off and after about two flights dropping bombs, and firing weapons.

Your mission systems are so good that you can start operating weapons very early in your training and operations.

We have to air-to-air pilots working with air-to-ground pilots and merging the cultures.

You are not focusing on your sensors; you are focusing on the end objective of your mission.

The big difference with this aircraft is situational awareness.

You see everything, and I mean on the surface and on the ground and you command attack, defense and electronic warfare functions within the aircraft.

The HMI is processing this and allowing you to be more strategic in your role.

You have different screens and different set ups that we are using as we fly the aircraft, and over time we can help the pilots standardize ways to usual the two screens optimally.

During my flight, I mostly used the two screens in the following way:

Half a screen provided a long-range view to look further; the second half showed the formation.

And the second screen contained my targeting Pod in one half and DAS in the other.

I hand flew because I wanted to play with the screens and figure out how to make best use of the systems during flight.

Question: How is the F-35 a game changer for the Italian Air Force?

Answer: The F-35 gives us much greater global reach.

We have so much gas in the aircraft and it is so fuel efficient, it gives us options in the various scenarios we are likely to face in our area of operations.

(Note: Ninja landed in Pax River on February 5, 2016)

THE MARINES AND THE ROYAL AIR FORCE ABOARD THE USS WASP

The continuous sorties of F-35Bs aboard on the USS Wasp on May 26, 2015 witnessed by visitors from the foreign and the U.S. press was almost numbing.

There were six F-35Bs aboard the ship, 4 from the Green Knights squadron at Yuma and 2 from the Warlords at Beaufort. We saw several sorties of F-35Bs aboard the ship conducted by pilots from both squadrons.

The first USMC squadron is now operational and being effectively integrated with the other elements of the Marine Air Ground Task Force while operating from Yuma USMC Air Station.

We saw aboard the ship maintainers from three squadrons, the Green Knights (Yuma), the Warlords (Beaufort) and VMX-22 (New River), the squadron that prepared the Osprey for its IOC in 2007 and is continuing its work with F-35B integration.

In addition to the USMC squadrons, the USN has worked hard on modifying the ship to operate the new USMC aviation assets. The XO of the ship, Captain Andrew “Mongo” Smith, highlighted that the ability of a 25 year old ship to become part of “fifth generation enabled combat operations” and its ability to operate the F-35 showed the flexibility of the ship and the USN-USMC team.

Second Line of Defense

After witnessing the initial sorties on May 26, 2015, a panel was held at the end of the visit with several Marine Corps and Navy participants in OT-1. The material presented provided a good overview on the tests and the progress to date.

The participants in the panel were as follows:

- Captain Andrew Smith, USN, USS Wasp Executive Officer, ESG 2;
- Major Richard Rusnok, USMC, VMX-22 F-35B Det Officer-in-Charge, F-35 Detachment, Edwards AFB and the lead planner for OT-1;
- Major Aric Liberman, USMC, VMFA-121 Special Projects Officer, Yuma, Arizona;
- Major Brendan Walsh, USMC, FMFA-121 Operations Officer, Yuma, Arizona;
- Major Paul Hoist, USMC, VMFA-501, Director of Safety and Standardization, Beaufort, SC;
- SSgt William Sullivan, USMC, VMX-22 Airframes Division Chief, F-35 Detachment Edwards AFB;
- Lt. Cdr. Neil Mathieson, Royal Navy, UK F-35B Ship Air Integration Lead, UK MOD< Abbeywood, Bristol,
- Lt. Cdr. Beth Kitchen, Royal Navy, OT-1 Evolutions Lead, VFMA-501, Beaufort, SC
- Also joining was Major Mike "Gravy" Roundtree, who discussed maintenance issues as the maintainers were working on the planes for the afternoon sorties and exercises.
-

Captain Smith, the XO of the ship, provided an overview on activities aboard the USS WASP.

"The primary purpose of this event was to take what we've done with the F-35 in developmental testing and handing the effort now to the operators. DT1 and DT2 were very data driven exercises, where we went out and tried to exercise the aircraft in order to get test points.

What we're trying to do now is to develop the tactics, techniques, and procedures of operating this aircraft at sea effectively and efficiently. From the perspective of planning this event, we have taken five different squadrons and multiple other organizations, technical experts across the joint program office, industry operational test team, we brought them out as well.

And the idea was to take six aircraft, which is the same size as the Marine expeditionary unit, which would be a normally deployed six-plane detachment which is part of that rotation, and take them out here and exercise them aboard the ship. We can then learn how to make this aircraft function as a normal deployed aircraft outside of the normal test, developmental test environment.

Our primary focus here has been upon supportability. That was one of our major emphases. If you look at what General Davis and his team put together as priorities for what they wanted us to look at while we're out here, the vast majority of those were focused on supportability.

LT CDR Kitchen together along with the other maintenance officers, put together an extensive list of items that we wanted to make sure that were functional at sea.

That goes from the mundane like changing a tire to the complex, like changing an engine. Doing those evolutions at sea is a different animal.

You've got chains, you've got deck motion, you've got all those space constraints that you saw down in the hangar deck that you don't have ashore. We want to make sure that any differences that we saw from support ashore to afloat were properly documented and we make those changes with the ultimate goal of making the deployment for the very first squadron that's going to go to sea as easy as possible.

From the effectiveness side of the equation, it was getting ten pilots out here and used to operating around the ship, and getting the ship used to operating 35's on board, getting the deck crew used to moving an aircraft that is much larger than what they're used to operating with on this somewhat smaller deck than what we would see on a normal big-deck aircraft carrier.

Functioning as a team, and that's really what we've done over the first week.

And I think based on what we saw this morning, you could see how efficient the operations have become just over that one-week time span."

Question: How have you done with regard to supportability of the aircraft on board the ship?

Lt. Cdr. Kitchen: I'll start by touching on the main solutions that we've conducted.

A large proportion of those main solutions that we've conducted have not directly been required as a part of the service of the aircraft themselves. We have gone over and above basic maintenance requirements.

Among those things we have done over an above any basic maintenance requirements include: conducting demonstrations for installation removal of the engine, the lift back, and the integrated compartment, the canopy, and the ejection seat..... At sea, we obviously have a moving deck. We have looked at how we tie down the aircraft from very calm sea states up to heaviest possible sea states.



FIGURE 8 THREE OF THE PARTICIPANTS IN THE PANEL HELD ONBOARD THE USS WASP DURING THE DT-2 TRIALS. CREDIT: SECOND LINE OF DEFENSE

And these have taken a huge amount of time. The good news is that we have gone through all of these evolutions, we have identified lessons, and majority evolutions we are confident that we can now conduct at sea.

The real difference between DT2 and DT1 and OT is the fact that this first time that Marines have been responsible for conducting maintenance. So part of that verification was not just ensuring that we ensured that the equipment, the tools, the procedures in the ship environment worked but also that we trained the maintainers correctly. And that's why this detachment has been hugely a success not just from a flying perspective but a maintenance one as well.

Question: With regard to the UK personnel, it is clear that you view the USS Wasp operational trials as an important input to the preparation for operations aboard your own new carrier, HMS Queen Elizabeth.

Second Line of Defense

Could you comment on how you are leveraging the working relationship with the USN and USMC to get ready for your own carrier, one which is specifically built for the F-35B?

Lt. Cdr. Kitchen: UK personnel have been working with the Marine Corps now for about two and a half years. I personally have been here in the States for a year working with the Marine Corps at Marine Corps Air Base Beaufort.

Our programs are aligned and they're working in partnership in order to develop the capability of the 35B. In terms of this ship deployment, we've got other UK maintainers who have been a part of the detachment. We've got personnel who are working within the power line with the avionics department as well as any maintenance control.

And they are able to contribute to the maintenance effort in exactly the same way as the Marines are. They are trained in the same way in the schoolhouse down at Eglin. But the Marines also they are learning to look at how the UK conducts maintenance and how that can possibly be involved in the future.

Lt. Cdr. Neil Mathieson: As I mentioned during introductions, myself and the team from the UK are here observing OT and taking a lessons from the Marine Corps and the US Navy back to the Queen Elizabeth. And the great news is we have seen a lot this week and validated a lot of our assumptions.

As you said, Queen Elizabeth has been specifically designed around about the thirty of the F-35Bs. So a lot of the infrastructure, the support issues, how the deck is operated, a lot of what we have seen this week has validated all of our assumptions, all design assumptions we have for the ship and puts us in a very good place.

And obviously the partnership with the Marine Corps is crucial to all of that and it has been a fantastic opportunity for us to come over and see what the USN and USMC have been doing.

Question: When you start getting B-35Bs in Britain?

Lt. Cdr. Neil Mathieson: We already are getting them. Our first squadron is being set up alongside VMFA-501 at Beaufort. In 2018, that squadron will "lift and shift" from Beaufort and stand up as 617 Squadron in the UK. Our presence at Beaufort will grow to approximately 250 at Beaufort.

Question: What has the British team learned from these trials that requires more work?

What about the deck, for example?

Lt. Cdr. Neil Mathieson: The US and Royal Navies are certainly aware of the impact of the impact of F-35B jet launch on the deck. You will have seen on the flight deck something with a slightly different color coating. That is a product that working with the Naval Research Lab as a research program with regard to high temperature deck coatings.

The UK is working hand in glove with N95 to understand that deck coating improvements and take it across with application on Queen Elizabeth. Commercial issues are involved as well as there is a company in the UK that does this work as well as a company in the US that does the work.

And it's really a research program just right now where we are measuring temperatures in the deck structure and learning if that product is going to be good enough to coat with. So that's one area we are learning every single day.

And actually one of many that we've seen throughout the week where we see an issue, we're working the issue and we're confident that there will be a solution by the end of the day.

Lt. Cdr. Kitchen: I can cover maintenance supervision lessons.

I think from my perspective this has been a very positive detachment.

Because what we've actually demonstrated is almost all of the maintenance evolutions that have been attempted we are now confident we can now conduct at sea. There have been lessons identified where some of the equipment doesn't necessarily interact with the ship's facilities.

But these are all things that can be easily rectified. For example, we wouldn't be able to conduct a lift fan movement installation today only because we need an additional shackle that interfaces between the ship's overhead crane and our lifting equipment.

This is a very simple piece of equipment to source and with this detachment it can be resolved. It's the same with a number of issues like that.

So, from a program perspective this has been successful.

A lot of observations will be sent back to the joint planning office and there are people who will be taking those lessons.

I'm not going to be requesting many procedural changes to joint technical documentation. The tools that maintainers use though, I'll allow SSG Sullivan to elaborate in a second, all seem to be fit for its purpose.

Even things like the automated logistic information system have gone exceptionally well here. We haven't struggled with connectivity. None of the maintainers have reported that it has been any slower than it is on shore. Which is a huge positive step for us.

Every detachment will have lessons to learn so we can evolve and make everything better and quicker. And those are things that we are going to be taking back.

But the headline news is we are confident that we can maintain these aircraft at sea for periods of time.....

Question: What about flying the aircraft on and off the ship? How did that go?

Captain Andrew Smith: The aircraft itself flies fantastically. It's an incredibly smooth flying airplane that is much easier to fly from a pilot perspective than the Harrier was, especially around the ship and the ship environment. The training we did for this detachment was much less than the training we did in a Harrier fleet to get to a ship.

And that's just a testament to the ease of the airplane to fly, the pilot vehicle interface, as well as the simulators that we have on shore that allow us to recreate to a high degree of detail the ship environment.

We took pilots from across the spectrum. From East Coast, West Coast, Harrier, Hornet, two-seat, single seat, ship experience, no ship experience since flight school and we put them on this deck very easily in a very short amount of time with a short amount of adapting to the ship environment.

And you saw the results today.

It is a testament to the ease of the airplane, to its design specifications to how they execute those design specifications, and how easy it is for us to just adapt to flying the airplane.

Second Line of Defense

The ship boarding rate is as high if not higher than the Harrier right now.....

Question: What is a boarding rate?

Captain Andrew Smith: That's the ability of the airplane to get aboard the ship without having to divert ashore. It's something we're very concerned with because we're always trying to maintain the ability to divert in case of a problem. Well, we haven't had any problems.

Question: What is the difference between flying the Harrier and the F-35B with regard to operating on this ship?

Captain Andrew Smith: The takeoff and landing portion of the F35 is seamless with the ship.

It is much easier to execute from the pilot perspective as well as the single officer perspective up in the tower.

We were able to, in a very short period of time, smooth out all of our process with the ship, have a team of three organizations come together, fly together for the first time, set up standard operating procedures (SOP) and function around the ship in a seamless manner.

And most of that is due to the fact that the jet takes care of a lot of the task loading that was resident in the Harrier and is not resident in this airplane.

So now we are able to pay attention to flying around the ship, and being a good steward of the aircraft and the ship at the same time, and bringing aboard exactly on time, exactly on the fuel safe that I'm looking to be aboard by....

Question: What is the biggest surprise for you about this aircraft aboard the ship?

Captain Andrew Smith; I think for many it's the situational awareness it gives you.

The other day I took off and all the combat systems that are supposed to be working in the configuration were working and in the shipboard environment which is a very challenging environment. And I was just very impressive to me to launch off of the ship, have everything working that should be working, and then complete a tactical mission with a couple other 35's. And it's awesome to see that in the shipboard environment.....

Question: Recently, during a visit to USMC Air station Beaufort it is clear that you are already putting a great deal of effort into integration with legacy aircraft (F-18s at the base) and with the USAF in the Georgia Air National Guard is kind of a missing factor in evolving your capabilities. Could you comment on that?

Major Mike Roundtree: That's a testament of not just the airplane but the people the Marine Corps has chosen to put into this program that the moment we've gotten the aircraft or gotten block upgraded hardware or software, the first thing we do is look to see how we can use this airplane tactically and strategically.

We develop the syllabus, we develop the training programs, and we go out and do it. On the East Coast out of Beaufort we're fortunate enough to have a large base in Savannah where we can integrate large exercises many times a year with F22, F16, F18, F15 and do large force exercises.

We use that opportunity to train our pilots. As well as to push the boundaries of the airplane in an inter-connectivity type of way.

That's all part of the development, the tactics, and our desire to develop this airplane fully from the beginning and look towards the future, future capabilities, and also start developing those tactics to try to get ahead of the curve.

And Lt. Cdr. Kitchen put on the finishing touch to the panel with this comment:

The F-35 can be surrounded by myth and legend. But it is a real testimony to the capabilities of the maintainers of the Royal Navy, the Royal Air Force and the USMC to adapt to the new technological challenges. Their knowledge of aircraft systems is now being applied to a new air system and taking steps forward into the unknown.

It is a testament to the professionalism of these maintainers that they are just getting on with the job of making this aircraft work. Every single person involved in this detachment are passionate about this aircraft and not just because it is a sexy looking aircraft but want to see it working in every operational environment.

THE F-35 GLOBAL ENTERPRISE: THE IMPACT OF A GLOBAL FLEET

The F-35 is a 21st century air system and was established to manufacture a global product in significant numbers to enable a global fleet, of unprecedented reach and impact.

The F-35 represents a new approach to the development, production, system and sustainment of a fleet of combat aircraft. Additionally, the F-35 takes an innovative approach to collaborative upgrades over the airframe and global fleet's life cycle.

It is clear that the F-35 global enterprise is a unique enabler of the entire re-set of U.S. and allied airpower. Yet this crucial and even central reality is hardly recognized in the mounds or should one say piles of commentary on the F-35 program.

Allies are not simply "partners" in the program they are the enablers of 21st century air combat development and approaches. Allies are not simply "following" the US lead; they are innovating on their own and will infuse the F-35 global enterprise with the spirit of innovation and invention, not mortgaged by the "sequestration" somnolent evident in Washington.

The F-35 as a global enterprise is clearly a foundational force or forcing function force for other developments. It is not simply a means to an end (modernizing the tactical aircraft fleet) but a forcing function force for fundamental change in approaches to 21st century defense forces.

There are several key aspects of the F-35 global enterprise, which are significant for allies as well as Americans.

It will be in production for a long time, which means that allies can buy with confidence that the system will be there when they need it. There are currently three final assembly lines and a significant global network of suppliers to the program.

The weapons, which will be fitted onto the F-35 or operated by the F-35 in a sensor shooter relationship, will be developed globally. This is historically unprecedented and allows global partners to build for themselves and for the global consortium.

As a software upgradeable aircraft, users reflecting collaborative combat experience will do the code rewrite. This is already happening with the Wedgetail in Australia, which is a launch point for the use of new software upgradeable aircraft.

Second Line of Defense

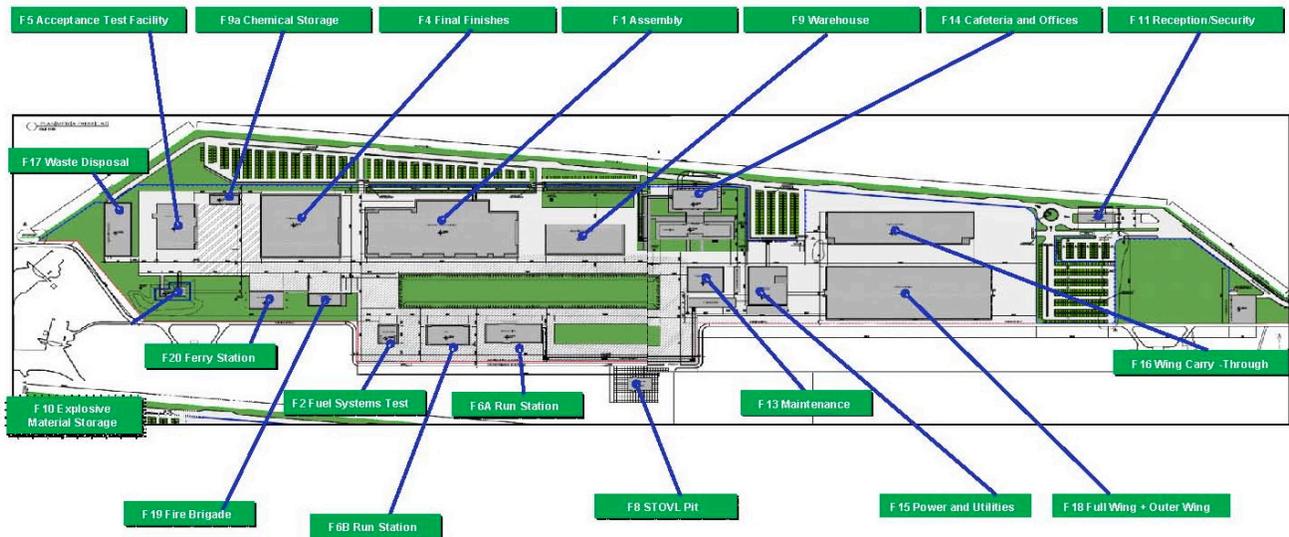


FIGURE 9 CAMERI F-35 SITE GRAPHIC

The program has built in a global sustainment capability from the ground up, which allows for the clear possibility of shaping a very different approach to global sustainment. Programs developed first for the US, which then add global customers, face a significant parts and support problem because there was never a thought of building in a global sustainment approach.

The Italians have already built a regional sustainment center in Italy for Europe and Med operations. And operationally, a global fleet will provide significant opportunities for innovation by the U.S. and its partners in building out a new combat approach around distributed operations.

There are 9 key elements built into the aircraft were identified as defining the baseline aircraft which are leveraged to help shape a global enterprise.

- A new cockpit and helmet which enable the pilot to function as a tactical decision maker;
- A fusion engine which brings together and integrates the core combat systems on the F-35;
- The fusion engines are designed to share information across the combat enterprise, or put in other terms each plane is synergy enabled;
- The plane is built as a weapon system built on a foundational architecture of chip and software upgradeability;
- The software is built to shape a manageable workload for the pilot;
- Stealth is built into the aircraft and is a core enabler for the entire aircraft;
- As a flying combat system, the F-35's advanced agility is a key enabler of combat operations;
- The power plant of the F-35 enables a long term growth strategy for the fusion engine. Unlike unmanned aircraft, where the power plant is devoted to flying the aircraft resulting in less than optimal sensor and weapons loading, the F-35 has significant growth possibilities;
- The F-35 can fire a full gamut of legacy weapons but lays the foundation for the next generation of weapons as well.

The key point is that these 9 key elements are the same for all three variants of the aircraft, and are common throughout the three U.S. military services buying the aircraft as well as allies buying those aircraft as well.

The impact of commonality across a fleet of aircraft is rarely discussed in terms of its tactical and strategic impact. But it is significant.

Take the case of the common cockpit.

The absence of commonality and its impact was seen in the Libyan operation in 2011. The countries involved could not even agree on what to call the operation.

- NATO-“Operation Unified Protector”
- Belgium-“Operation Odyssey Dawn” and/or “Operation Freedom Falcon”
- Canada-“Operation Mobile”
- France-“Operation Harmattan”
- UK-“Operation Ellamy”
- Spain- “Operation Odisea al Amanecer”
- US-Italy, Denmark, Norway- “Operation Odyssey Dawn.”
-

Now the Air-order-of Battle by aircraft Type/Model/Series of fixed wing Fighter/Attack aircraft

- Various block's of F-16 (USAF, Royal Danish AF, Belgian, Royal Netherlands AF, Italy, Royal Norwegian AF, Turkey), US-F-15, A-10, AV-8, EA-18, B-2,
- Canada-CF-18
- French Air Force-Mirage (2000-5, 2000D), Rafael, Mirage F-1, Super Etendard
- Italy-Tornado ECRs, Eurofighter, AV-8B
- Spain-F/A-18
- Sweden-JAS-39 Gripen
- UAE-F-16 and Mirage 2000
- United Kingdom-Tornado, Typhoon
- Considerable effort also went into Aerial, Refueling, AWACS, and Maritime Patrol.
- Finally, helicopters were extremely active and effective.

So a good Libyan War lesson learned is simple—current modern war, especially war in the air requires considerable planning, and high-level coordination, and extensive high end airborne assets for command and control to be effective.

Now imagine all combat pilots, from all allied countries having the same intelligence and situational awareness about the Battle Space in their individual cockpit. It gets even better — all pilots will have uniformly understood symbols and cockpit display icons that are not language specific. Much like the emerging universal road and other signage that are understood regardless of language.

The F-35 “C5ISR-D” (D is for Decision) Common Combat capabilities in the individual cockpit has the potential to revolutionize the ability of an alliance fighting force.

All Fighter Pilots flying the F-35 across U.S. services and allied Air Forces will concurrently operate from the same base line of evolving battle intelligence. The possibilities for new combat tactics for a decentralized yet unified air campaign are only limited by the operator's imagination.

The commonality inherent in the aircraft will be a baseline from which fleet understanding and concepts can be developed. Such commonality is being shaped right now at Eglin Air Force Base and the F-35 training center, Luke AFB for the pilots of F-35As, and at Beaufort USMC Air Station for the pilots of the F-35Bs.

Second Line of Defense

The training at the centers is for the maintainers and pilots. And that commonality can over time be leveraged as well to re-shape thinking about the role of logistics in combat capabilities as well. Again this is an inherent potential that needs to be realized in organizational practice, and does not happen by itself.

F-35 as Allied Pacific Lynchpin

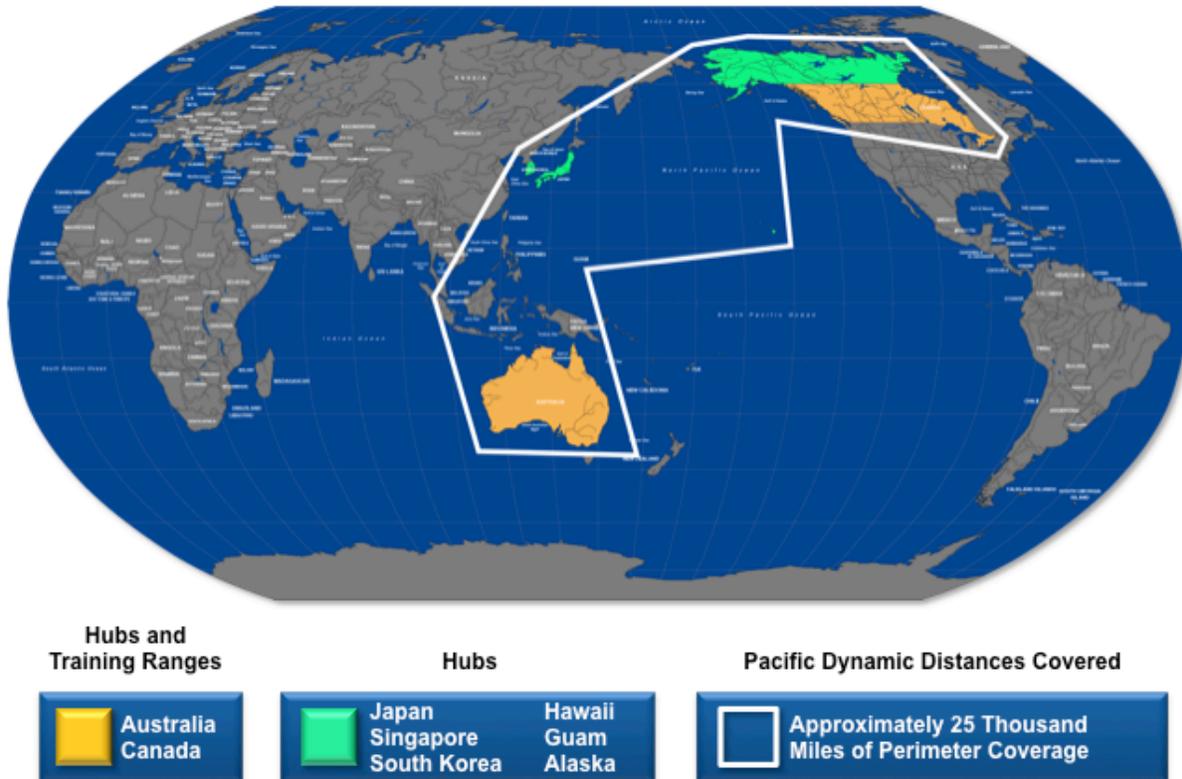


FIGURE 10 POTENTIAL LOGISTICS SHARING ACROSS THE PACIFIC FOR US AND ALLIED F-35 FLEET.

As Ninja, the Italian pilot who crossed the Atlantic and who learned to fly the F-35 at Luke AFB commented with regard to the impact of learning the aircraft from the ground up in a coalition-training environment:

“All the student pilots at Luke fly the aircraft in the fleet whether US, Australian, Norwegian or Italian.

And the training allows us to learn common TTPs from the ground up.

We are building a fifth generation approach from the ground up.”

The approach to sustainability for the F-35 is built upon a new digital foundation. It is designed more akin to new commercial aircraft – like the 787, A380, or A350 – than legacy combat aircraft. Again, the digital revolution can lead to significant change in maintenance practices but only if it is accompanied by organizational change in how maintenance organizations operate.

The F-35 is the first combat aircraft to be built in numbers in the new digital age. The plane speaks a universal language. Because the F-35 was born at a time when DOD was keenly focused on implementing

Unique Item Identification (UID) and Radio Frequency Identification (RFID) technologies, the plane was built from the start with modern logistics tool sets in mind.

In effect, this means that the aircraft speaks a universal or global logistics language.

This common language and the digital management, which is enabled by this language, allows for the F-35 fleet to be managed globally in an historically unprecedented manner.

The digital foundation for the maintenance of the F-35 is not about the platform; it is about the fleet. The consequences of such an approach allows not only for significant cost savings over time but a significant change in the overall capabilities and approach to deployments.

New platforms are built with a significant amount of attention to how to enhance their ability to be maintained over time. When platforms were built thirty years ago, logistics support was an afterthought. No it is a core element of determining successful outcomes to the manufacturing process.

Sustainability is a combination of logistics and maintainability considerations combined. Designing a more sustainable product, which can operate fleet wide, should be one of the very core procurement principles.

Savings will come from pooling resources, something that cannot happen if you buy a gaggle of aircraft, rather than operating a common fleet. Just ask Fed Ex what commonality for their fleet delivers in terms of performance and savings.

At the heart of the advantages of the F-35 considered, as a fleet is the question of development costs and approaches. For example, the selection by Norway of the F-35 highlighted the significance of Joint Strike Missile integration. A key element of the F-35 decision by Norway was the acceptance of the integration of a new Kongsberg missile onto the F-35 itself. What this means is that the integration of the missile on the Norwegian F-35A makes it available to every other nation's F-35A without further testing or software integration required. In other words, rather than integrating their missile on a few Norwegian aircraft, the Norwegians have built a missile available to any of the coalition partners who wish to buy it.

It is very likely, for example, that Asian partners in the F-35 will find this capability to be extremely interesting and important. And so Kongsberg's global reach is embedded in the global reach of the F-35 itself.

All of this is facilitated by the nature of the software upgradeability built into the aircraft itself, which allows for a different approach to fleet upgrades and evolution.

Given the significant commonality among the three types of F-35s, logistics and support hubs can be built throughout the globe in the partner countries. The differences among naval air and air force air are significantly blurred by the commonality of the F-35s.

This means that specific support for the As, Bs, and Cs could be generated. Based on the earnings from a logistics hub, the partners will also be able to pay for a significant part of their own fleet modernization. And a hub is not a permanent base. As an on-call service facility, the various allies can draw upon support when they are working with the partner's regional security missions.

By having a diversity of supply HUBS throughout the APR, not only would partner countries have capability but the U.S. would not have to concentrate its supplies in simply its own bases. So potential adversaries wishing to cripple a particular nation would now have to consider the entire global basing of the F-35s as a problem.

Second Line of Defense

Never has a logistic system been such an essential part of DETERRENCE than the F-35 global fleet approach and is part of a deterrence in depth strategy for the U.S. and its allies in the years ahead. When Russia looks at Canada across the Arctic the strategic depth of an F-35 fleet deployed to Alaska, Japan, Norway, the UK and elsewhere would be part of any Canadian deterrence strategy.

THE F-35 GLOBAL ENTERPRISE AND SUSTAINABILITY: THE PERSPECTIVE OF THE ROYAL AUSTRALIAN AIR FORCE AND THE ROYAL AIR FORCE

The Royal Australian Air Force (RAAF) is shaping a transformation strategy, which they call Plan Jericho. In anticipation of the coming of the F-35, the RAAF is looking to shape a 21st century joint force built around the F-35.

The Plan Jericho approach is about shaping a more integrated force built on 21st century situational awareness and decision-making systems. It is a work in progress for the Royal Australian Air Force and the Australian Defence Force.

It is clearly not just about platforms, but how you re-shape the concepts of operations, and transform to a more integrated force. Clearly required is also a transformation of training and logistics, key elements of what professionals pay attention to but do not get the focus of attention which platform acquisition itself receives.

In an interview with the Air Commander of Australia, Air Vice Marshal Turnbull., highlighted their importance:

“Question: You are clearly shaping a 21st century expeditionary force, how do you deal with the challenge of shaping a logistics system, which can enable it?”

Air Vice Marshal Turnbull: Logistics is not an exciting subject but it is essential to any operational success.

We must make sure that it's not so much a specific force, but it's our ability to project a force within an appropriate timeframe wherever we may want it effectively.

As we develop capability we have to maintain a keen eye on the fact it needs to be designed to be moved quickly and efficiently from wherever we garrison to wherever we operate.

A deployable mindset is the key to keep people innovating in the right way. For our logistics to be able to service our requirements anywhere in the world in a reasonable timeframe is a key focus for our transformation efforts.”

Leveraging the F-35 global enterprise is seen as a key element of the effort, and with it shaping a sustainment approach, which can fully work with that enterprise.

In an interview with Air Vice Marshal (retired) John Blackburn, who has been associated with the effort from its beginning last year, the sustainment aspect of the effort was highlighted.

“What we've seen in the past is that the logistics part has been underemphasized. We've always emphasized the platform and the logistics element is the poor cousin that follows in its trail.

For example, how are we going to provide situational awareness, common information systems across the whole logistics base. What we're seeing now with global supply chains, and using the JSF as an example, is you're actually looking at supporting your platform with a global supply chain, which is actually shared with all the other partner nations.

There are two key issues, which need to be addressed.

First, one needs to optimize delivery through a global supply chain vertically, if you want to put it that way. And then for the national force, you're going to look horizontally across each of those supply chains, and so how does the joint logistics area manage that?

Do you order supplies only through that vertical global supply chain or do you rationalize across your force and your force holdings by the national joint supply chain?

We have to understand that you are going to end up optimizing platforms to the global supply chain such as the JSF for very good reasons. How that integrates and interfaces in a country-by-country case into a cross capability logistics system, I don't think is understood as yet.

This is a critical issue to understand so that we can deploy as effectively as possible, and operate across a range of capabilities in a more complex logistics environment in the future.

Addressing both the national and global F-35 approaches are important because they are at the cutting edge of an approach which may well be repeated with regard to other systems to be supported globally in the future by US and allied militaries.

In other words, the F-35 system is a pathfinder effort for squaring the circle between a global supply chain and supply chains for a transformed joint force towards which Australia is clearly working."

Question: To put it into your words, the challenge is squaring the dynamics of a global vertical supply chain with a nationally based ability to supply your force?

Air Vice Marshal (Retired) Blackburn: "The challenge you face now is a far more complicated logistics information system that needs to not only work in that vertical axis but in the horizontal axis country-by-country, and then you have to make some hard decisions because you're not a just-in-time civil supply system. You need a resilient supply base, and not just depend on just-in-time deliveries from a global supply chain.

Cost is a critical factor as well.

If I quote from the Australian Strategic Policy Institute defense budget report of this year, they are projecting a 5.2 percent real growth per annum – real growth – in sustainment costs. When you look at the scale of that operating cost for a force like ours, that's something that's got to have to be managed very carefully to make sure that our force remains affordable.

I think the sustainable logistics part is going to be a very, very important factor in supporting a transformation effort."

Question: What are your thoughts on the cross-cutting of the training and logistics challenges for transformation?

Air Vice Marshal (Retired) Blackburn: "They are cross-cutting. It is important in the training of pilots to operate for the joint force to understand that an airplane without sustaining capability is a museum piece. It's nice to look at but not much use.

We have to educate our people from day one. There's a bigger world out there, and yes in the first part of your career, you focus on your specific skillsets, in being a pilot, an air combat officer, or logistician, or an air traffic controller or a battle manager for example. But, if you don't understand how it works as a system, then you're not going to be much use as you progress in your career.

Second Line of Defense

I would argue that day one in any of our military courses, you start to get the students to understand they're part of a larger system. The critical learning point is that it is not just the platform; it's the total system that matters."

A similar perspective is emerging for the Royal Air Force as well.

In an interview with Group Captain Ian Townsend, a key officer involved in working the F-35 introduction into service for the RAF, the importance of the global enterprise was highlighted as well.

Question: You are working the task of bringing the F-35B to the UK in 2018 and preparing for its integration with the Queen Elizabeth. What role does your engagement with the Marines at Beaufort play in this process?

Group Captain Townsend: "We have a pooling implementation agreement or PIA with the Marines.

The PIA formalizes how we're going to work alongside them. We currently have 14 maintainers at MCAS Beaufort but, by the end of 2018, we'll have about 242 maintainers.

They are all operating under the U.S. Marine Corps regulations and will be ready to come back to the U.K. and operate F-35 independently in late 2018."

Question: And concurrently, you are building your own infrastructure in the UK to then support your F-35s in the UK?

Group Captain Townsend: "That is correct. It is a massive effort to put in place the UK infrastructure but we are learning significant lessons from other F35 partner nations.

We are conducting developmental test flying, operational test flying and frontline flying all at the same time, something we call concurrency. We've never done that before. If we hadn't taken that approach, none of the F-35 operators would be where we are right now.

The Marine Corps wouldn't be IOC, if they haven't taken that approach.

And we certainly wouldn't be thinking about IOC in 2018 if we hadn't taken that concurrency approach.

Working alongside the Marines not only allows exposure to F35 operations through the maintenance department, but our pilots are also working alongside their Marines equivalents. We're training to the 501 Operational Conversion Syllabus, so we will now know exactly what the Marines are trained to go and do, which I think will make us better partners in the future as well."

Question: And by then, the Queen Elizabeth will be doing sea trials and getting ready to accept you?

Group Captain Townsend: "That is the target. The first period of developmental testing onboard the Queen Elizabeth happens at the end of 2018. We have a second period in the mid-part of 2019, and then we will conduct continuation training on the ship before she achieves operational capability at the end of 2020."

Question: One misunderstanding often is that the Royal Navy is seen to be flying the F-35B where it is really the RAF. And the RAF is flying both the upgraded Typhoon and F-35B and working through their integration.

How would you describe the importance of the RAF working both processes concurrently?

Group Captain Townsend: "I think this plays very nicely into the fact that the Royal Air Force is the air-minded service. We focus solely on being the expert deliverers of air power.

However, being a joint force, we have the additional benefit of having Fleet Air Arm pilots embedded within the U.K. Lightning Force. So there is no Royal Air Force Lightning Force.

There is no Royal Navy Lightning Force.

We are just one force.

And we're bringing together the expertise of both elements of light blue and dark blue uniforms to provide the very best effect for carrier strike in the future."

Question: It was clear looking at reactions to the USS Wasp sea trials, that the core point of the integration of the ship with the airplane was largely missed. The Queen Elizabeth is a ship designed for the F-35B and the F-35B will provide unique capabilities, which the ship can capitalize on in shaping its concept of operations.

How would you describe this synergistic process?

Group Captain Townsend: "As an airman, I like anything that enhances my ability to deliver air power, and the ship certainly does that. The ship has been tailor-made from first principles to deliver F-35 operational output. The ship is part of the F35 air system.

I think this is the key change to where we were in Joint Force Harrier where the ship was really just a delivery vehicle. The ship was just a runway.

The Queen Elizabeth class aircraft carriers are much more than that. They are right at the heart of the air system's capability fundamentally enabling and supporting what the air vehicle is doing three, or four, or five hundred miles away from the ship. And that wasn't quite the same in Joint Force Harrier with the invincible class CVS carriers.

So it's very different for us.

Everyone involved in embarked F-35 operations needs to understand what the air vehicle is going off to do because everybody on the ship is much closer to that end delivery of effect. This is a very different concept of operations from 15 years ago.

When I launched from the CVS in 2005 to fly an operational mission in Afghanistan, once I left the deck, I was gone.

The next contact I would have with the ship was when I called for recovery, several hours later.

Whilst I was airborne the ship and I became very separate operational platforms. When a UK Lightning launches from the QUEEN ELIZABETH, the information link between the air vehicle and the ship now means that they remain connected during the operation greatly enhancing operational capability.

In terms of being an information node or a C2 node, we're in a much different place now. And I think that's really quite interesting for us as air commanders in terms of our ability to control what is going on forward with the airplanes.

Second Line of Defense

I also think from a pilot's perspective, being on the deck in my F-35, being able to see in my cockpit what is going on in the battle space, because my brothers in their F-35s already in the operational battlespace have sent information back to me, I think that's really exciting as well.



FIGURE 11 THE SKI JUMP ON THE QUEEN ELIZABETH CARRIER AS SEEN DURING A VISIT TO THE CARRIER IN SCOTLAND IN MARCH 2015 BY SECOND LINE OF DEFENSE.

We are no longer launching into the unknown.

We can see what's happening.

We understand what we're going off to go and do, but we can see the real-time situation in the battle space before we launch off the deck. A significant operational benefit."

Question: The impact of the global fleet of F-35s is significant as well in shaping enhanced capability for the Queen Elizabeth-F-35 enabled air system as well.

How do you see the impact of the F-35 global enterprise on the RAF?

Group Captain Townsend: "There are many benefits. Not just in terms of training alongside each other and seeing the TTP developments, but practically when you're in the battle space, how much information can you get from all of these different F-35 partners that are out there.

Broadening that question a little bit further, being part of the global platform and global sustainment, what are the opportunities there about not having to take all logistics with you?

What can you do to leverage off an Italian ship that's nearby that might have the particular part that you need but you might not have it because you haven't had to take anything forwards.

There's an awful lot of questions being raised and a lot of opportunities available about being part of this global platform.

Again, this is something that we in the U.K. have never done before and there are a number of lessons ahead."

Question: I believe that any new platform needs a decade to put its legs under it. But the basic point is that we're moving in a different direction from the beginning, rather than spinning our wheels with historic patterns.

And your perspective is the need to get on with it, more or less?

Group Captain Townsend: "I think that's absolutely right and inevitable. But at least, the foundation has been set. The partners involved in the global platform understand each other's business, from the outset, in a way that we haven't really seen ever before.

I think the closest equivalent you could come to would be the F-16 program that was widely sold across the world, but every nation did F-16 differently.

There were different support solutions for every F-16 operating nation.

By and large, anyone operating F-35 is going to be doing it in broadly the same way with the same sort of broad sustainment solution.

That's part of the global program.

That's what makes it an attractive option for everyone that's involved."

THE F-35 AND THE EVOLVING STRATEGIC ENVIRONMENT

The F-35 is a first generation information age air combat asset. It is a foundational capability to empower the security and defense forces which need to operate flexibility and rapidly across an area of interest, for combat or deterrence.

Lt. General Preziosa, the recently retired head of the Italian Air Force provided a clear link between how he saw the F-35 as an information age combat asset and the changing global environment. In an interview conducted in Rome at his office in 2013, but several points enhanced in follow up interviews in 2014 and 2015 he underscored the nature of global change which called for an information warfare combat asset.

He saw the period through World War II to end of the first decade of the 21st century as having more in common than different. He saw this as a period, which saw significant disruption and then growth built around building up continental focused growth and development. Global regions grew and financial systems largely supported those regions in their growth and development.

Airpower has been largely linear in its development during this period, in which new planes have been added, but they have essentially replicated what we asked planes in World War II to do. Bombers and fighters have over time gotten better, but essentially they work in a linear strike and defense pattern in shaping an approach towards longer-range operations.

With the information age, he sees a different type of development, globalization in which the focus is upon inter-continental growth and development. In this phase, we have to meet the challenge of new growth and development models, shape new financial systems and deal with new defense and security challenges.

"Partnerships are changing; continents are working to get closer and to work more effectively with one another. But there is a governability shortfall in managing the new challenges, and in such areas of shortfall the problems appear. There are continuing conflicts within and among continents but there are also new patches of emerging challenges within the seams of the global system whereby terrorists, organized crime or forces of instability grow and disrupt."

Second Line of Defense



FIGURE 12 LT. GENERAL PREZIOSA IN HIS OFFICE IN ROME AFTER THE FIRST OF HIS SECOND LINE OF DEFENSE INTERVIEWS. 2013. CREDIT: SECOND LINE OF DEFENSE

With the range and distance of erupting threats, and the need for global cooperation or coalitions to deal with them, airpower needs to be modified. “We now need to have assets which operate in a distributed manner with coalitions engaged to deal rapidly with problems. The advantage of airpower is its reach, speed and mobility. The challenge is to coalesce capabilities to put resources rapidly up against threats and challenges early enough to deal with them.”

More by chance, than by design, the F-35 is entering the global scene at this moment in global history.

“This is an information warfare airplane which can share data across a fleet of global players. The reach of the F-35 means that my planes operating in the Western Mediterranean can receive data from throughout the region. And it is a plane with coalition designed into the aircraft.”

The plane is an information warfare aircraft, or an aircraft built to operate very differently from legacy aircraft. “Command and control capabilities are built into every cockpit of the F-35; the challenge will be to leverage those capabilities and the distributed decision making capabilities inherent in a fleet of F-35s.”

He underscored that a strategic shift towards pockets of defense and security challenges around the European, African, Mediterranean and Middle East regions meant that Europe, the United States and others needed to shape collaborative approaches to insert airpower when appropriate rapidly. And the F-35 as a key distributed force asset was the right match for meeting distributed challenges.

“The fusion system built into every cockpit will allow shared coalition decision making that is required for the kinds of multi-national operations which are becoming the norm. We are not fighting in mass; we are applying tools rapidly and directly to discrete problems and challenges. This is not yesterday’s aircraft being applied to the challenges of the next 30 years; it is about reshaping concepts of operations for coalitions meeting the evolving new challenges and operational requirements.”

The human-machine interface allows the plane to provide for enhanced decision making capabilities in the cockpit as the famous Observe-Orient-Decide and Act loop of John Boyd sees the OO be largely done by machines and the pilots focusing on the Decide and Act function.

The F-35 is an ISR, C2, Electronic Warfare asset that can see around itself with 360-degree precision at significant distance. Operating as a wolfpack, it can cover a significant swath of territory, and can work among the F-35 fleet, or engage with other assets to provide the kind of ISR and targeting coverage crucial for extended operational space.

It is an interconnected combat asset, which can operate effectively with other F-35s – of all of the F-35s of the allies engaged in the mission – or work with other combat assets, to provide for protection, or offensive support as needed.

It is about providing for fifth-generation enabled combat capabilities. And rather than focus on stealth, the practitioners of fifth generated enabled forces are already reshaping concepts of operations.

For example, at the Trilateral Exercise held at Langley AFB with the British Typhoons, the French Rafales, and the F-22s, Air Combat Commander “Hawk” Carlisle highlighted one of the impacts of fifth generation enablement – reshaping how the entire combat force operated.

If the exercise had been held 12 years ago, not only would the planes have been different but so would the AWACS role. The AWACS would have worked with the fighters to sort out combat space and lanes of operation in a hub spoke manner.

With the F-22 and the coming F-35, horizontal communication among the air combat force is facilitated so that the planes at the point of attack can provide a much more dynamic targeting capability against the adversary with push back to AWACS as important as directed air operations from the AWACS.

As General Hawk Carlisle put it:

“The exercise was not about shaping a lowest common denominator coalition force but one able to fight more effectively at the higher end as a dominant air combat force.

The pilots learning to work together to execute evolving capabilities are crucial to mission success in contested air space.”

The centrality of fifth generation or what we are calling a first generation information warfare air combat asset was highlighted by the RAF at the Trilateral Exercise.

One British pilot on the exercise described modern air warfare as an information war. “Whoever can gather, process and exploit the most information in the quickest time will win the information war and ultimately the fight. With fifth generation aircraft being able to instantly share data with their fourth generation cousins, the Typhoon can become and an even more effective and capable jet fighter.”

It can be deployed to a crisis, or engage in the defense of national territory, but not simply as and of itself asset but one which provides significant interlocking coverage, protection and striking power as well.

The evolving strategic environment clearly is one where flexibility and agility are crucial for the combat assets of a nation, and the need to operate in coalitions in most circumstances. The ability to provide agile and scalable force is a key element for information age combat assets crucial to shape evolving concepts of operations to deal with evolving or pop-up threat scenarios.

For example, the Russians after their seizure of Crimea have clearly threatened the Baltic states. How would an F-35 enabled defense force deal with the Russian threat to the Baltic states?

Second Line of Defense

Deterrence is not just about arming and occupying the Baltic states in ADVANCE of the Russians doing something and given the geography such actions seem unlikely at best. As a landpower with significant Baltic sea assets, it is difficult to imagine the Russians providing a long period of warning for the USAF to deliver significant US Army forces to the Baltic states to deter Russian attack. This is not a US Army led operation in any real sense.

And building up outside forces on the ground in the Baltics takes time and could set off Russian actions which one might well wish not to see happen. This latter point is crucial to Balts as well who would not like to be viewed by the Russians as an armed camp on their borders in times of crisis, and not only the Russians living in Russia, but those in the Baltic republics themselves.

Credible defense starts with what NATO can ask of the Baltic states themselves.

In the 1980s, there was a movement in Western Europe which called for “defensive defense,” which clearly applies to the Balts. Greater cooperation among the three states, and shaping convergence of systems so that resupply can be facilitated is a good baseline.

Add to that deployments of defensive missile systems designed for short to mid-range operations, and the ground work would be created for a stronger DEFENSIVE capability which would slow any Russian advance down and facilitate the kind of air and naval intervention by NATO which would mesh very nicely with the defensive capabilities of the Baltic states.

What the core Nordic states (Sweden, Denmark, Norway and Finland) can do is create a more integrated air and naval defense. If the Russians believed that the Nordics most affected by a Baltic action could trigger what other NATO nations can do, there is little incentive for them to do so.

This means leveraging the Baltic Air Patrol to shape a Northern region wide integrated air operations capability that the US, France, Germany and the UK can work with and plug into rapidly. It is about modular, scalable force with significant reachback that would kill a Russian force in its tracks, and be so viewed from the outset by the Russians.

And because it is not based in the Baltics, but the air controllers could well be, it is part of the overall defensive defense approach. Naval forces are crucial as well, not only to deal with Russian naval forces, but to support the Baltic operation as well. Modern amphibious forces are among the most useful assets to provide engagement capabilities, ranging from resupply, to air operations, to insertion forces at key choke points.

By not being based on Baltic territory, these forces are part of the overall defensive defense approach, and not credibly part of a forward deployed dagger at the heart of Russia argument that the Russian leadership will try to use if significant NATO forces were to be forward deployed upon Baltic territory itself.

Shaping an effective defensive template, leveraging collaborative Baltic efforts, with enhanced integrated air and naval forces will only get better as Western naval and air transformation occurs in the period ahead.

There are a number of key developments underway which can reinforce such a template. The first is the Dane's acquiring the missiles to go with the sensors aboard their frigates and to position their frigates to provide area wide defensive capabilities which can be leveraged in the crisis.

The second is the acquisition of the F-35 by key states in the region whose integrated fleet can lay down a sensor grid with kinetic and non-kinetic capabilities, which can operate rapidly over the Baltic states by simply extending the airpower integration already envisaged in the defense of the region.

The Norwegians, the Dutch, and possibly the Danes and the Finns will all have F-35s and a completely integrated force which can rapidly be inserted without waiting for slower paced forces has to be taken seriously by Russia. There is no time gap within which the Russians can wedge their forces, for Norway and Denmark are not likely to stand by and watch the Russians do what they want in the Baltics. With the integrated F-35 fleet, they would need to wait on slower paced NATO deliberations to deploy significant force useable immediately in Baltic defenses.

The third is the coming UK carrier, which can provide a local core intervention capability to plug into the F-35 forces in the region and to add amphibious assault capability.

The fourth is that the USN-USMC team coming with F-35B and Osprey enabled assault forces can plug in rapidly as well.

The fifth is the evolving integration of air and naval systems. The long reach of Aegis enabled by F-35/Aegis integration can add a significant offensive/defensive capability to any reinforcement force, and the Norwegians are a local force that will have such a capability.

By leveraging current capabilities and reshaping the template for Baltic defense, the coming modernization efforts will only enhance the viability of the template and significantly enhance credible deterrence, rather than doing what RT referred to scornfully as “US troops drills in Baltic states is more a political than military show.”

A key advantage of the approach is that it is led by the Nordics and gets away from the Russian game of making this always about the US and the “US-led” Alliance.

Putin and his ilk can play this game, but European led capabilities are crucial to reshaping Russian expectations about how non-Americans view their aggression as well.

Another example might have been how an F-35 enabled allied force could have been part of dealing with the Malaysian airliner crisis in Ukraine.

How might have the US and allies have responded to assist the Ukrainian government and to stop the Russians from playing a deadly game by involving themselves in shooting down a civilian airliner over Ukrainian territory?

The multi-mission capabilities of the aircraft means that a small footprint can bring diversified lethality to the fight. An F-35 squadron can carry inherent within it an electronic attack force, a missile defense tracking capability, a mapping capability for the ground forces, ISR and C2 capabilities for the deployed force and do so in a compact deployment package.

In addition, an F-35 fleet can empower Air Defense Artillery (ADA), whether Aegis afloat or Patriots and THAAD Batteries, the concept of establishing air dominance is moving in a synergistic direction. An F-35 EW capability along with its AA and AG capability will introduce innovative tactics in the SEAD mission. Concurrently, the F-35 will empower U.S. and Allied ADA situational awareness. The current engagement of the IDF employment of their Iron Dome in conjunction with aviation attacks is a demonstration of this type of emerging partnership being forged in battle.

To get a similar capability today into the Area of Interest would require a diversified and complex aerial fleet, whose very size would create a political statement, which one might really not want to make.

Second Line of Defense

With an F-35 enabled ground insertion force, a smaller force with significant lethality and flexibility could be deployed until it is no longer needed for it is about air-enabled ground forces. A tiltrotor enabled assault force with top cover from a 360 degree operational F-35 fleet, whether USMC, USN, USAF or allied can allow for the kind of flexibility necessary for 21st century warfare and operational realities.

Lt. Col. Boniface, a key Osprey squadron commander, in forecasting a “tsunami of change” to come, understood without even saying so the evolving nature of warfare, and in this case was talking about the Osprey and the coming of the F-35B:

“I sort of think of it like a game of chess..... If you have ever played chess it sometimes take a while to engage your opponent. We now have the ability to move a knight, bishop, or rook off of this same chessboard and attack 180 degrees towards the rear of our enemy. We can go directly after the king. Yes, it’s not really fair, but I like that fact.”

Our politicians and strategists need to understand the changing nature of warfare and how to engage our assets for strategic advantage. Our adversaries are certainly not waiting around for The West to get smarter.

THE EVOLVING STRATEGIC ENVIRONMENT: THE CASE OF THE ARCTIC

Clearly, the Arctic is a major area of interest for the major Arctic powers as well as global economic powers like Japan and China, who are not one of the five powers with direct claims.

The gradual melting of Arctic ice is creating the beginnings of a very different strategic situation affecting the Pacific states, Russia, the United States, Canada and Europe. The operational geography for trade, exploitation of raw materials, and military forces is becoming altered by that most powerful of forces – nature.

The opening of the Arctic is an event somewhat parallel to the building of the Suez or Panama Canal. The two great canals of the 19th and early 20th centuries changed the face of the United States and of Europe. The new significance of the northern routes could well do the same for Russia.

The impact of the Suez Canal was considerable in changing the 19th century. As one analyst of the geography of transportation has put it: The opening of the Suez Canal in 1869 “brought a new era of European influence in Pacific Asia by reducing the journey from Asia to Europe by about 6,000 kilometers. The region became commercially accessible and colonial trade expanded as a result of increased interactions because of a reduced friction of distance. Great Britain, the maritime power of the time, benefited substantially from this improved access.”^[i]

With regard to the Panama Canal, the East and West coasts of the United States became part of the same country in a fundamental way. And the United States transition to becoming a global power was facilitated by the opening of the “big ditch” as well. The Panama Canal shortens the maritime distances between them by a factor of 13,000 kilometers.

It will take awhile for the full impact of the opening of the Arctic to be realized, but the country whose destiny will be most altered will be Russia, an emerging maritime country. Yes you read that correctly, the great landlocked power, will emerge as an important maritime player and with it different roles for Canada, the United States, Asia and Europe. To get a sense of what is involved one needs to look at a map from the top of the world down.

As the sea lanes in the Arctic-bordered regions become capable of longer periods of transit, the Northern sea routes or the Northwest passage becomes a link at the top of the world which can connect Europe and the Northern Pacific in ways that rival the traditional transit routes Southward through the world's great canals.

But it is not simply about transit. It is about access to raw materials as well.

The Arctic holds significant oil, natural gas, rare earth minerals and other commodities vital to global economic development. Exploitation is challenging and costly; but the long-term trajectory is very clear: the region will be a central economic zone for the global economy.

The two trends – transport and raw material extraction – will become combined. For example, for states like Japan and South Korea, which have no landward reach to raw materials as does China, these states will now have an alternative path to acquire raw materials and have than transited to their factories. Rather than simply relying on the Middle East, for example, South Korea and Japan can work with Russia and others to gain access to Liquid Natural Gas and then have that product transported directly to their ports.

Russia is at the center of these developments.

The Russian European ports can look forward to be directly connected with the Pacific ports and with it the growth of infrastructure, ports, facilities and shipping, along the way.

Russia and Canada Have Longest Maritime and Air Space Areas in Arctic



This transforms the Russian defense and security challenge to one of securing the trade and resource development belt. It also will see a significant upsurge over the next thirty years of traffic, commercial and military, through the area. It will be in Russia's interest to build air and naval assets, which can provide for the various needs for defense and security in the region.

Search and rescue, communications, maritime domain awareness, significant ISR capabilities, bomber coverage, submarine and surface fleet coverage and related efforts will become prioritized.

A new Arctic activism by Russia is clearly underway. But the Arctic is clearly not a pure hard or soft power domain. The area needs significant cooperation to work.

This does not imply that military means are not part of the equation in assisting in core ISR, C2, Search and Rescue and other tasks.

Second Line of Defense

Any time conflict is part of the equation, defense capabilities come into play, and they come into play in reinforcing so-called soft power as well. 21st century military power is clearly interwoven with 21st century security and diplomacy. It is not to be understood primarily as the sledgehammer but as a key contextual element integrated within diplomacy and security efforts to protect national operational sovereignty.

A key task is to shape and craft an Arctic Grid to provide for safety, security and defense in the High North. This is not a task for a year, but for the decade ahead. In an interview, we did with Chris McLean and Richard Bray of Frontline Defence during a visit to Ottawa, we discussed the importance of shaping an Arctic grid.

“Question: If one conceptualizes that a core challenge facing Canadian sovereignty is to provide for security and defense in the context of the Arctic opening, then major acquisitions should be made over time, and build out to that direction.

In effect, the grid covering from Northern Europe to the Northern Pacific and over the Arctic – built with allied collaboration – is clearly a key challenge but also one which could focus Canadian force development and also defense and security investments. It could also guide a way to think about public-private partnerships in the region, and tapping into the ongoing development of various Canadian civilian capabilities that are relevant to the Arctic opening.

Bray: That makes a great deal of sense, and could focus our attention on the ISR and C2 streams, which we need to build out over time.

I’m not convinced we understand what the data from surveillance platforms and other tools will be like, the challenges that such a data stream will present to the operator, or the opportunities it will present to the commander. It’s like being given access to a giant database without the software tools to extract meaning.

As it gathers and sifts more data (and faster), will it be like antilock brakes, allowing you stay 30 feet closer to the vehicle ahead of you? Or will it allow you to complete the mission in a completely different way?

These kinds of assets allow you to get yourself deeper and faster into a situation. So, if the speed of engagement and the amount of data being acquired could quickly become overwhelming without effective software.

The challenge will be to have the data, to verify the data against cyber spoofing, and to integrate enough of the data in order to have the kind of decision-making necessary in a fluid environment.

Bray continued to focus on the grid in a later piece on Front Line Defence.

“A key requirement for Canada will be to shape a grid to cover the full geography, including her Arctic interests. If one conceptualizes that a core challenge facing Canadian sovereignty is to provide for security and defense in the context of the Arctic opening, then major acquisitions should be made over time, and built out to that direction.

In effect, the grid covering from Northern Europe to the Northern Pacific and over the Arctic – built with allied collaboration – is clearly a key challenge but also one which could focus Canadian force development and also defense and security investments. It could also guide a way to think about public-private partnerships in the region, and tapping into the ongoing development of various Canadian civilian capabilities that are relevant to the Arctic opening.”

The shaping of the grid will be done primarily for developmental, safety and security issues. But shaping a grid will lay down a foundation on which appropriate defense systems can operate to protect the sovereignty of key states and their national territories.

Given the importance of the High North, for Russian nuclear operations, the growth in military traffic through the Northern passages, inevitable sovereignty disputes, the high probability the Russians will build flexible forces at the top of the world in order to influence events either in Europe or Asia, defense or military considerations are built into the Arctic opening.

Given the central importance of the kind of cooperation necessary to provide for development, safety and security in the Arctic, the region will not be primarily defined by defense systems, but the Grid will enable them and participate in security missions in any case.

And with the addition of new capabilities, such as fighters, the question will be how do they contribute to and live off the grid while doing their missions? An advantage of an ISR-enabled fighter is obvious: it can live off and contribute to the grid.

Also, training and operational missions will allow the pilots to provide real time information back to military, security and various policy officials about anomalies or threats, which may need to be dealt with. The advantage of a man in the loop generated by fighter operations is to contribute rapidly available information and judgments about what an overall Arctic policy process might need to deal with in the near term.

Some key considerations for an Arctic-enabled fighter would include, being ISR and communications capable with an ability to operate as an airborne command center to support both security and defense operations. Over time, the F-35 will clearly become a potential contributor to this effort. Norway has bought the F-35 and is shaping its fleet with the Arctic in mind. The U.S., Japan, and most probably Denmark are among the allied states that will operate F-35s with Arctic security and defense in mind.

There are two key considerations. The first is the emergence of a 21st century fleet. Pacific allies are buying the F-35 and will be looking to shape integration.

The second is the nature of the combat systems. The F-35 systems make it a C2 and ISR aircraft, notably when the planes are considered as a deployed grid able to cover significant space.

For instance, in the 2011 Northern Edge exercise, its radar mapped the maritime surface of 500 square miles. According to a report released by the Joint Program Office at the time: F-35 combat systems “searched the entire 50,000 square-mile Gulf of Alaska operating area for surface vessels, and accurately detected and tracked them in minimal time.”

Communication linkages are a crucial aspect, not only for combat but for security operations as well. The F-35 can provide support for such linkages as well for reshaping the approach to ensuring Arctic sovereignty.

Because each of the key five stakeholders in the Arctic all have different perspectives as well with regard to even something as simple as “collaboration,” conflict can be built into a cooperative process. But defense in the Arctic is a contextual capability.

To develop the Arctic requires shaping infrastructure for communications and situational awareness in an area with limited “traditional” infrastructure. It is about leveraging air breathing and space systems, and crafting appropriate land based towers and systems, which can create a grid for development and safety operations.

Second Line of Defense

It will be in Russia's interest to build air and naval assets that can provide for the various needs for defense and security in the region. Search and rescue, communications, maritime domain awareness, significant ISR capabilities, bomber coverage, submarine and surface fleet coverage, and related efforts will become prioritized.

This will dramatically change the situation for Canada.

During the Cold War, the North American Aerospace Defense Command (NORAD) was built around close American and Canadian cooperation to defend their territories against various Russian threats, first bombers, then strategic submarines, and then ICBMs. As this threat receded, Canada was able to focus on military operations of "choice" rather than necessity.

The emergence of the Arctic as a strategic zone ends this situation and puts Canada on the front lines. To secure its own claims to resources, and to exploit and protect those capabilities, Canada will itself need to augment its efforts. And along with those efforts will be a need to enhance significantly its relevant security and defense capabilities as Russia is transformed by the Arctic opening and along with it the growing presence of other powers as well.

CONCLUSION: THE NEED FOR CULTURAL INNOVATION OR LESSONS LEARNED FROM DUNKIRK APPLIED TO THE 21ST CENTURY

The F-35 working with robotic elements and with new weapons can empower a distributed operations approach. This approach is being tested out at various centers of innovation within the U.S. military and will be synergistic with allied partners.

Traditional assets, such as the large deck amphibious ship or the large-deck carrier, will be rethought as the new approach and new capabilities are introduced into the force.

Continuing to invest in past approaches and capabilities makes little sense. And ultimately, the fifth-generation aircraft and associated systems can drive significant cultural change.

But there is nothing inevitable here. The United States is at a crucial turning point. In a stringent budgetary environment and with a demand to shape a post-Afghan military, the crucial requirement is to invest in the future not the past.

But it is not just about airframes or stuffing as much as you can in legacy aircraft. The new aircraft represent a sea change with significant savings in terms of fleet costs and overall capability at the same time.

The sustainability of the new aircraft is in a world significantly different from legacy aircraft. Digital maintenance is part of the revolution in sustainability. The sustainability revolution enables a significant increase in the sortie generation rates for the new combat aircraft. And in addition to this core capability, there is a significant transition in combat approaches facilitated by the new aircraft.

The aircraft can shape disruptive change by enabling distributed operations. The shift is from linear to simultaneous operations; it is a shift from fighters needing reachback to large aircraft command and control and ISR platforms to 360-degree dominance by deployed decision makers operating not in a network but a honeycomb.

These lessons have been recently highlighted in the Trilateral Exercise held at Langley AFB in December 2015.

If this exercise was held 12 years ago, not only would the planes have been different but so would the AWACS role. The AWACS would have worked with the fighters to sort out combat space and lanes of operation in a hub spoke manner.

With the F-22 and the coming F-35, horizontal communication among the air combat force is facilitated so that the planes at the point of attack can provide a much more dynamic targeting capability against the adversary with push back to AWACS as important as directed air operations from the AWACS.

As General Hawk Carlisle put it:

“The exercise was not about shaping a lowest common denominator coalition force but one able to fight more effectively at the higher end as a dominant air combat force.

The pilots learning to work together to execute evolving capabilities are crucial to mission success in contested air space.”

Modernization of assets, enhanced capabilities to work together and shaping innovative concepts of operations were seen as key tools for the U.S. and the allies to operate in the expanded battlespace in order to prevail.....

And as the RAF highlighted:

“Whoever can gather, process and exploit the most information in the quickest time will win the information war and ultimately the fight.

With fifth generation aircraft being able to instantly share data with their fourth generation cousins, the Typhoon can become and an even more effective and capable jet fighter.”

Fifth-generation aircraft both generate disruptive change and live off of disruptive change. Taking a fleet approach, rather than simply focusing on the platforms themselves, highlights their potential for disruptive change. Properly connected or interoperable with one another, the new aircraft can work together to operate like a marauding motorcycle gang in an adversary's battlespace.

Rather than operating as a linear force, the marauding motorcycle gang creates chaos within the OODA loop of the adversary. In fact, the F-35 is really about shifting from the OODA loop with the machine-man interface doing much of the OO and focusing attention on the DA.

By having an onboard combat systems enterprise able to respond in real time to the impacts that the aircraft are creating in the battlespace, they can respond to the fractual consequences of the battle itself.

Rather than going in with a preset battle plan, the new aircraft can work together to disrupt, destroy, and defeat adversary forces within the battlespace. It is about on-the-fly (literally) combat system processing power that enables the pilots to act like members of a marauding motorcycle gang.

The fifth-generation aircraft enable the pilots to become key decision makers within the battlespace and, if properly interconnected, shape a distributed operations approach to battle management and execution.

They are key elements of C4ISR D, which is deployed decision making rather than data collection sent back to decision makers for less timely actions. C5ISR D is the core capability that 21st-century military forces need for strategic advantage.

For the United States and its allies to work more effectively in the new setting of regional networking, a key requirement will be effective and assured combined command, control, and communications, linked by

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advanced computing capabilities to global, regional, and local intelligence, reconnaissance, and surveillance assets (C5ISR).

The services will need to ensure that there is broad synergy among U.S. global forces fully exploiting new military technologies and the more modest capabilities of regional allies and partners.

Indeed, C5ISR is evolving to become C5ISR D, whereby the purpose of C5ISR is to shape effective combined and joint decision-making. The USMC clearly understands and embraces the disruptive capabilities of the fifth-generation aircraft. For the USMC, TAC Air does not simply play a close air support role in any traditional sense.

It is an enabler for distributed operations when such operations are essential to either conventional strike or counterinsurgency warfare. USMC aviation has allowed the USMC ground forces to operate with greater confidence in deploying within the civilian population in Iraq. Aviation's roles in both non-kinetic and kinetic operations have allowed the USMC to avoid operating within "green zones" so as to facilitate greater civilian-military relations.

Aviation has also provided an integrated asset working with the ground forces in joint counter-IED operations. And quite obviously, battlefields of the future will require the USMC to operate upon many axes of attack simultaneously. Such an operation is simply impossible without a USMC aviation element.

For the USMC thinks ground in the air and the forces on the ground can rely 24/7 on USMC aviation forces to be with them in the ground fight.

As Lt. Col. "Chip" Berke, the F-22, F-35, F-16 and F-18 Marine Corps former squadron commander, put it in a presentation on airpower at the Copenhagen Airpower conference last year:

As a JTAC the key requirement is that the airplane show up. The A-10 pilots are amazing; the plane will not always be able to show up in the environment in which we operate; the F-35 will. That is the difference for a Marine on the ground.

The F-35 will be a "first-generation flying combat system" that will enable air-ground communication and ISR exchanges unprecedented in military history. The pilot will be a full member of the ground team; the ground commanders will have ears and eyes able to operate in a wide swath of three-dimensional space.

But if other airpower leaders simply mimic the operations of older aircraft with the fifth-generation aircraft, the promise of the new air operations will not be realized.

As Robert Evans, a specialist on C2, formerly a senior USAF officer and most recently with Northrop Grumman put it about the dynamics of change:

If warfighters were to apply the same C2 approach used for traditional airpower to the F-35 they would really be missing the point of what the F-35 fleet can bring to the future fight.

In the future, they might task the F-35 fleet to operate in the battlespace and affect targets that they believe are important to support the commander's strategy, but while those advanced fighters are out there, they can collaborate with other forces in the battlespace to support broader objectives.

The F-35 pilot could be given much broader authorities and wields much greater capabilities, so the tasks could be less specific and more broadly defined by mission type orders, based on the commander's intent. He will have the ability to influence the battlespace not just within his specific package, but working with others in the battlespace against broader objectives.

Collaboration is greatly enhanced, and mutual support is driven to entirely new heights.

The F-35 pilot in the future becomes in some ways, an air battle manager who is really participating in a much more advanced offense, if you will, than did the aircrews of the legacy generation.

And going back to my comment about the convergence of planning and execution, and a warfighter's ability to see and sense in the battlespace ... that's only relevant if you take advantage of it, and the F-35 certainly allows warfighters to take advantage of it.

You don't want to have a fifth-generation Air Force, shackled by a third-generation system of command and control.

The result would be that the United States and its allies will repeat the failures of the French facing the Germans in World War II where they had superior tanks with outmoded tactics and command structures, and with the predictable results.

The new aircraft simply do not function in the way the old do. Indeed, one lesson of Dunkirk needs to be remembered when shaping an innovative military strategy for the Pacific in the 21st century: new capabilities without new concepts of operations will lead to strategic failure.

A military force is truly blessed if the combat leaders at all levels in the chain of command have the proper weapons and also the wisdom to employ them against a reactive enemy. History of combat often shows that their not understanding or exploiting that advantage can offset one army's engagement-winning weapons.

It is true that weaker forces through brilliant leadership can vanquish the more technology-capable and stronger army. Of course, as Napoleon said, he also wanted a general who was lucky, and all combat leaders know how the great unknown of luck can also determine the outcome.

And to add to the mix is another great thinker, Damon Runyon, who once quipped, "The race is not always to the swift nor the battle to the strong, but that's the way to bet."

By all static order-of-battle accounting, the Miracle at Dunkirk should have never been necessary, because the British and French had a number of key elements that could have allowed them to win, including superior tanks to the attacking Germans and rough parity in the air.

But the French and British were defeated; the British Expeditionary Force was evacuated and lived to fight another day on to the eventual V-E Day. So betting on the French and the British was the wrong chip to play on the table of the battlefield.

The Germans Blitzkrieg generals down to the lower ranks were all "making their own luck" by exploiting the French and British approaches with the weapons they had.

The fall of France may have some interesting lessons on CONOPS and decision making against a reactive enemy. And those lessons argue for shaping a transition from legacy air CONOPS to new distributed air operations CONOPS leveraging the F-22 and F-35.

The Germans were a quicker and smarter force that defeated the French and the British. Words echoing from history tell us that story and also can now bring an interesting lesson learned to the current debate on what is becoming known as "distributed air operations."

The shift from "legacy" air operations to distributed air operations is a significant operational and cultural shift. Characterizing the shift from fourth- to fifth-generation aircraft really does not capture the nature of the Second Line of Defense

shift. The legacy aircraft operate in a strike formation, which is linear and runs from Wild Weasels back to the AWACS.

The F-22 and F-35 are part of distributed operational systems in which the decision makers are distributed and a honeycomb structure is created around which ISR, C2, strike, and decision-making can be distributed.

A new style of collaborative operations is shaped but takes away the ability of an adversary to simply eliminate assets like the AWACs and blind the fleet. Distributed operations is the cultural shift associated with the fifth-generation aircraft and investments in new weapons, remotely piloted aircraft, and the crafting of simultaneous rather than sequential operations.

Unfortunately, the debate about fifth-generation aircraft continues as if these are simply aircraft, not nodes driving significant cultural changes in operational capabilities.

In a fascinating book by Hugh Sebag-Montefiore on the courageous men in the British army who fought the Germans to allow the escape from Dunkirk, some of these lessons were highlighted. (Hugh Sebag-Montefiore, *Dunkirk: Fight to the Last Man* (Cambridge, MA: Harvard University Press, 2008).

In writing the book, the author provided significant insight into how the British and French lost to the Germans in the European forests and battlefields. Comments taken from diaries of the survivors provide significant insight into lessons learned by not engaging in the cultural revolution that one's new technology provides.

The British and French had new equipment, which, if properly used and embedded into appropriate concepts of operations, might well have led to a different outcome at the beginning of the war.

And the first lesson here is simply to develop advanced equipment is not even half the job. First and foremost: "The campaign showed that politicians must never, even in peacetime, deprive their armed forces of the equipment they need. Complacently assuming that the equipment can be manufactured once war is declared is demonstrably unwise." (Ibid. xiv).

A second lesson learned is that if you do not adapt your command structure to the technology, you will lose. A theme that the author developed was that although the French had tanks, World War I generals who simply were not able to adapt to the tactics of armored warfare commanded them. These difficulties were aggravated a hundred times by the style of French leadership.

The soldier who should have had most influence on the way in which the first counterattack was mounted was X Corps' commander General Grandsard, who had direct control over the divisions in the Sedan sector. He was a Corps' commander General Grandsard, who had direct control over the divisions in the Sedan sector. He was a general of the old school, who had not understood that French strategy must change in line with Guderian's (the German general in charge of the attack) new mobile tactics. (Ibid, 100).

The author when discussing command style introduced a really key term very relevant to the shift from sequential to simultaneous air operations:

"The need to refer back to Guderian was, however, limited by the entrepreneurial culture he fostered: German officers were expected to make up their own minds on how to achieve the objectives Guderian set and how to act in a crisis" (Ibid, 101.)

A third lesson was the importance of getting inside the enemy's OODA loop. The French command structure was too slow to use information and to act on that information on a timely manner. The German commanders

were allowed significantly greater freedom of action and could act in minutes, whereas the French operated in terms of hours:

“The rapid German response to the threat posed by the counter-attack only serves to underline the slowness of the French . . . In other words, the Germans began their own counter-attack within 10 minutes of identifying their target, whereas it had taken the French more than 12 hours to launch their troops into the attack” (Ibid. 105).

A clear advantage of the new aircraft is their technical capability to get inside the enemy’s OODA loop; but without change in how command structure works, no clear advantage can be realized.

A fourth lesson is the challenge of the enemy exploiting your weaknesses for which he has trained to exploit. The German tankers confronting superior armor in the advanced French tanks were able to exploit weakness in those tanks because of intelligence about the weaknesses and training to exploit those weaknesses.

From the diary of a German survivor with regard to meeting the superior French tanks:

The tanks’ silhouettes were getting larger, and I was scared. Never before had I seen such huge tanks. . . .

My company commander gave clear instructions over the radio describing which targets to aim at, and the enemy tanks were just 200 meters away before he gave the order to fire.

As if they had been hit by lightning, three of the enemy tanks halted, their hatches opened and their crews jump out. But some of the other tanks continued towards us, while some turned. . . .

Presenting their broadsides to us. On the . . . side of the tank there was an oil radiator behind some armor.

At this spot, even our (smaller Panzer 2) tanks’ 20mm guns could penetrate the armor, and the French tanks went up in flames immediately after they were hit there. It was then that our good training made such a difference (Ibid. 101-102).

The Chinese study of the classic U.S. air battle and the perceived value of targeting USAF or USN large battle management systems such as AWACS reminds one of the need to get rid of the AWACS as a lead element in any offensive operations and sequential air battle and to move to distributed capabilities in simultaneous operations.

A fifth lesson is to develop logistical systems that allow one to exploit advantages of new technology.

The superior French tanks were refueled by trucks and dependent upon truck-provided fuel.

The Germans parked a “farm” of fuel containers to which the tanks came for refueling and could thus keep up the speed of the attack:

They (the key French tanks) could not even be expected in their first assembly area at Le Chesne, fifteen miles southwest of Sedan, until 6 am. It would then take around six hours to fill them with petrol, another two to move the five miles to their positions to the Mont Dieu forest, and two more hours to refuel them again. . . .

In contrast, the Germans overcame their refueling difficulties by transporting petrol to the front in cans. Once the cans were in the vicinity of the panzer divisions, all the tanks nearby could be refueled simultaneously on any terrain.

The French, on the other hand, had the petrol brought to the front in lorries, which, not being tracked, could not be used over rough ground. Even when the French armor was refueled on a road, the vehicles’ petrol tanks

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had to be filled up consecutively rather than simultaneously which took much longer than the German method (Ibid. 109-120).

Keeping the old tanker approach in place while you add the new aircraft undercuts the ability of those aircraft to operate in a distributed approach. By moving the tanker line back significantly, one can refuel almost like the German “fuel farm” and not expect the tankers like the French trucks to come to them. Even the difference between simultaneous versus sequential attacks was underscored as crucial to the success of the Germans and the negative impact on French morale.

As one French officer commented, “Simultaneous attacks would have been very difficult for us. But attacking in waves in this manner means they lose their courage after seeing their burning comrades” (Ibid, 107).

In short, the core lesson to learn is to buy appropriate numbers of new equipment and to adapt the operational culture, including the logistics systems, to allow the blue team to exploit their advantages.

Unless one wants outcomes such as the French and British experienced in the forests of Europe against the Germans, it is crucial to accelerate the shift to a new culture and capability built around distributed operations.

The old system of sequential air operations built around legacy aircraft, AWACS, and multiple assets needs to be replaced in a timely manner by a well-resourced distributed operations enterprise.

The current Deputy Commandant of Aviation, Lt. General Davis, when CG of 2nd MAW underscored how important he saw the F-35 as a tool in the hands of what he called the I-Pad generation pilots.

I think it is going to be a fantastic blending of not only perspectives but also attitudes. And what I really look forward to is not the old guys like me, but the very young guys who will fly this fantastic new capability. The older generation may have a harder time unleashing the power and potential of the new gear – the new capabilities. We might say “why don’t you do it this way” when that approach might be exactly the wrong thing to do from a capabilities standpoint.

My sense is the young guys will blend. We’ve already picked the first Prowler pilot to go be an F35 guy. He’s going to do great and he’s going to add perspective and attitude to the tribe down at Eglin getting ready to fly the jet that’s going to make a big impact on the F35 community.

I think it’s going to be the new generation, the newbies that are in the training command right now that are getting ready to go fly the F35, who are going to unleash the capabilities of this jet. They will say, “Hey, this is what the system will give me. Don’t cap me; don’t box me. This is what this thing can do, this is how we can best employ the machine, its agility its sensors to support the guy on the ground, our MEU Commanders and our Combatant Commanders and this is what we should do with it to make it effective.”

(We first published this essay in 2010 and included it in *The Renorming of Airpower* published later that year. We included a revised version in our book on Pacific strategy, and published a revised version earlier this year).

Recently, we discussed fifth generation enabled warfare with a senior naval aviator and during that discussion he emphasized a number of key points with regard to the role of the F-35 in enabling a more effective approach to shaping the sea services capabilities to prevail in the extended battlespace.

- The capabilities of fifth generation aircraft reduce the amount of time necessary to do the OO of the OODA loop with a focus on the decision making part of the loop and a general restructuring of how decisions can be taken from the edge of the battlespace.
- A key focus is upon working new ways to distribute information throughout the battlespace.
- It is about parsing of information as well.
- To focus simply on distribution of information will always be subject the limitations of the platform operating in the battlespace and the key opportunity driven by fifth generation is the enhanced lethality and survivability of other combat assets.
- The F-35 is not a replacement aircraft, and that the U.S. Navy's discussion of 6th generation is not really about a platform but a decade or more of fifth generation warfare learning and a determination of what comes next, less in terms of a generational aircraft iteration and much more in terms of what can and needs to be added to the blue side combat capability going forward.
- The shift from COIN to higher tempo warfare is a key shift. And the usual argument about the spectrum of warfare misses the point that it is about enhanced decision making in a more rapid operational environment regardless of the spectrum on which you are fighting.
- The shift in training is crucial:
 - "We tend to be conservative in our TTPs and are still captured by the replacement platform mentality. We do not want to do TTPs for the F-35B informed by the Harrier; we do not want to do TTPs for the F-35C informed largely by Super Hornet thinking. We need a paradigm shift in the war fighting culture with regard to the F-35."
 - The F-35 is both informing and informed by this shift towards warfighting in the extended battlespace.
 - The reach not range approach is a central part of F-35 enabled operations.
 - The intersection of the coming of the F-35 with the overall evolution of new technologies and concepts of operation is the role of the sea base.
 - A key dynamic going forward will be upon the interaction of the systems operating within that extended battlespace with the software evolution of the F-35 combat systems.

APPENDIX: THE EMERGENCE OF THE Z AXIS

The F-35 is often simply referred to as a tactical aircraft, and a replacement for 4th generation or legacy aircraft. It is really something quite different.

It represents a dramatic shift from the past. For the first time in history, individual F-35 pilots –A, B or C – will have the best database of real time knowledge in the history of combat aviation. And all of this is internal to their cockpit and enabled by advances in computer processing and sensor information fusing.

Each F-35 pilot combined with human sensing (seeing visual cues outside the cockpit) will be enabled by machine driven sensor fusion to allow combat "situational awareness" (SA) better than any other opponent.

Concurrent with their ability to look- see, which is limited by physical realities, the F-35 pilot will be able to "see" using cockpit electronic displays and signals to their helmet allowing them not to just fight with their individual aircraft but be able to network and direct engagements at hundreds of miles in 360 Degrees of 3 dimensional space out to all connected platforms.

A fleet of F-35s will be able to share their fused information display at the speed of light to other aircraft and other platforms, such as ships, subs, satellites, and land based forces, including UAVs and eventually robots. Tactically, "Aegis is my wingman," "SSGN is my fire support" will be developed for conventional warfare.

This enables a "tactical" aircraft to evolve into a key technology for strategic operations and impacts.

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The value and confidence of timely information in combat is everything. One must always remember technology and con-ops are always relative against a reactive enemy. The enemy gets a vote, the game is not simply played by the friendly forces. The enemy will have a reaction and that will define the pace, nature and outcome of the conflict.

The F-35 is known as a 5th generation player in the state-of-the-art for both the Air-to-Air Fighter, and Air-to-Air Attack combat roles.

It also adds an “electronic” or “tron” warfare component to the fight. Electronic Warfare (EW) is a complex subject with many discreet but also connected elements. EW was designed inherently into the F-35 airframe and C5ISR-D Cockpit.

EW can include offensive operations to identify an opponents emissions in order to and fry spoof or jam their systems. In successful “tron” war, often-kinetic kill weapons can be fired. An F-35 can be a single sensor/shooter or off load it’s track to other platforms such as; planes, ships and subs and eventually UCAS-Unmanned Aerial Combat Systems.

The kinetic kill shot is usually a high speed missile designed to HOJ (home on jam). It has been said on the modern battlefield — air, sea or land — if not done correctly, “you emit and you die.”

Defensively in “tron war” there are a lot of other EW issues such as; Electronic Counter Measures, (ECM), Electronic Counter Counter Measures, all things “Cyber War, ” which is a subject unto itself and is extremely complex and not well understood.

Electro Magnetic Pulse concerns (EMP), Infer-Red Sensing (IR) and always protecting “signals in space” of the friendly info being transmitted and as mentioned jamming the bad guys “signals in space,” all are key considerations in Tron Warfare.

What is necessary to succeed in evolving capabilities to fight in the age of Tron Warfare?

In taking a lesson from history, pre-WWII AA&T long lines research found that in order to build and keep operational a U.S. phone system, the AT&T visionaries found that the key to success was the need for “robust and redundant” systems.

Two human Generations, later the F-35, was designed as being both inherently robust and redundant with many sensors and systems built into the airframe structure from initial design forward. All the F-35 systems designed and developed sent “trons” into the aircraft cockpit “Fusion Engine.” Trusted fusion information generated by inherent aircraft systems queued up electronically by threat will send to the cockpit displays, and the pilot’s helmet battle ready instantaneous Situational Awareness.

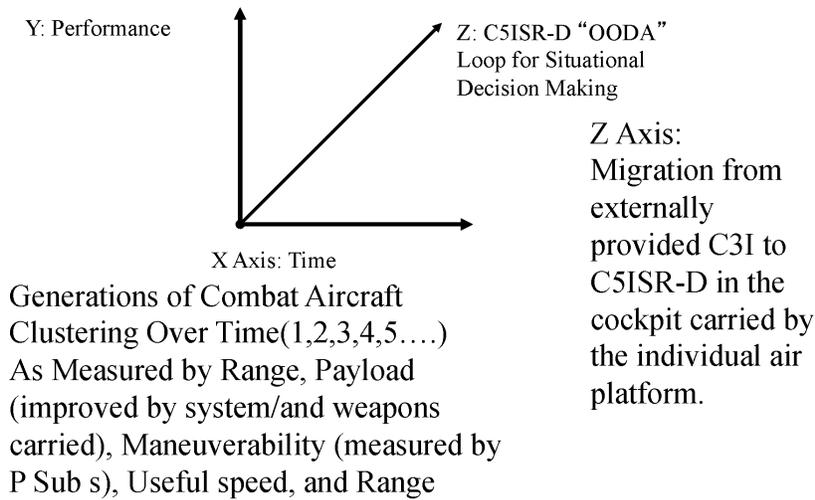
The Z Axis and the “Fusion Engine”

This is the beginning of a combat aircraft design that is building along a new axis—the “Z-axis.” The “Z axis” is a core discriminator. The F-35 aircraft is not a linear performance enhancement from F/A-18 4th Gen; it has a third performance axis “Z.”

The “Z” axis is the pilot’s cockpit C4ISR-D (for decision) loop axis. Starting at the beginning air fleet Command and Control from WWI on it has morphed into C5ISR (useful but getting silly) – Command, Control, Communications, Computers, Combat Systems, Intelligence, Surveillance, and Reconnaissance

Traditionally, in looking at the progression of aircraft a two-dimensional design depiction has been used; the x-axis is time and the y-axis is performance. That graph captures individual airplanes, but they do tend to cluster in generation improvement. Each aircraft clustered in a “generation” is a combination of improvements.

The Z Axis for Combat Aircraft



The aeronautical design “art” of blending together ever improving and evolving technology creates improvements in a linear fashion, if not performance would eventually go asymptotic. The airframe design characteristics blended together prior to F-35 have been constantly improving range, payload (improved by system/and weapons carried), maneuverability (measured by P Sub s), speed, and range (modified by VSTOL—a basing mobility plus factor).

The F-35 is also designed with inherent survivability factors, redundancy and hardening and stealth. Stealth is usually seen as the 5th Gen improvement.

But reducing the F-35 to a linear x-y axis improvement simply misses the point.

The F-35 is now going to take technology into a revolutionary three-dimensional situational awareness capability. This capability establishes a new vector for TacAir aircraft design. This can be measured on a “Z” axis.

Historically, Command and Control (C&C) was external to 1,2,3, 4th and some 5th Generations of TacAir. Now known as C5ISR the goal was still enhancing fleet wide combat performance for all Type/Model/Series (T/M/S) of TacAir.

This is the current modern AWACS (hub and spoke) battle management concept.

But by using a three-dimensional graph, one can understand that the “Z-axis” takes airpower into a totally different domain.

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The shift is from externally provided C5ISR into C5ISR-D for decision into the cockpit. This is the revolutionary step function that breaks the linear progression of previous Generations.

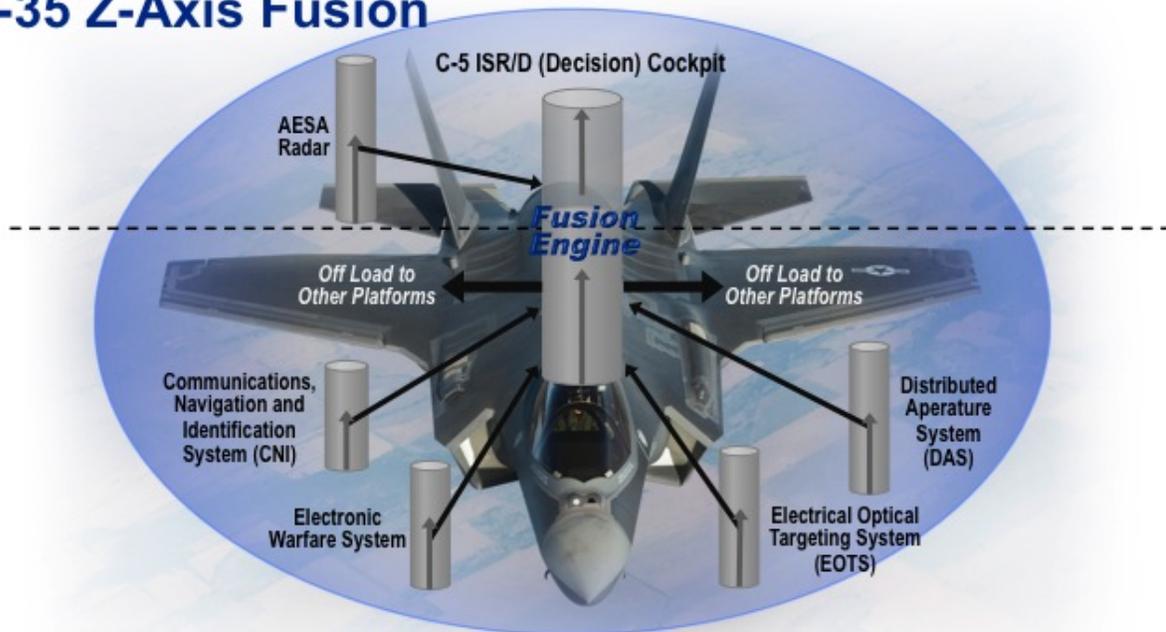
The “Z” axis in which the F-35 is the prototype is the first “C5ISR –D (for decision) cockpit.

A design focus of F-35 is the cockpit, and helmet displays of trusted fused integrated systems. Enabled with that technology the pilot can also be a distributed information decision-maker.

The Fusion Engine

This is the Z axis in action and the enabler is the trusted “fusion engine.”

F-35 Z-Axis Fusion



- F-35 Individual Pilots Internal to Their Cockpit Will Have the Best Real Time Data Base of Knowledge in History
- Each F-35 Will Be Able To Network and Direct Engagements in 360-Degrees of 3-Dimensional Space by Off Loading Tracks to Other Air/Land/Sea/Space Platforms – Including UAVs and Robots
- Fusion Engine Can Drive Unity of Purpose in Focusing World Wide IR&D and R&D on Enhancing C5ISR-D Cockpit Because Each Discreet System Can Be Improved Independently

1

Definitions:

Multi-Function Array (MFA) or the AESA Radar

Distributed Aperture System (DAS)

Electrical Optical Targeting System (EOTS)

Electronic Warfare System.

CNI (Communications, Navigation and Identification System) — connected to the other combat systems via the high-speed data bus is the CNI which is a core and very flexible RF system that enables the aircraft to operate against a variety of threats.

The systems are built upon a physical link, namely a high-speed data bus built upon high-speed fiber optical systems.

The “Z-Axis” is the research vector for robust US and allied IR&D and R&D system upgrades. Each individual sensor is focused on servicing the cockpit “fusion engine.”

This is where the fleet concept of “separate” airframes – As, Bs, and Cs – and across both US and Allied forces yields major breakthroughs and savings. By forging diverse research streams into a common fusion engine, the inherent waste in doing research which then needs later to generate its own platform or is inherently designed for a specific platform with little global reach is obviated.

However, R&D research can go forward also independently on all systems feeding into this trusted fusion engine. This IR&D process can bring value based analysis and engineering on where to put specific emphasis and budget dollars on improving each system for best tactical pay-off.

This dynamic is moving combat system R&D research up the “Z-axis.”

It is an approach to ending stove piping while not closing off the dynamics of change which different systems can provide for future capabilities for the aircraft, the fleet and flying combat systems.

Re-Looking at The Evolution of Capabilities from a Z Axis Perspective

All sensor elements of F-35 T/M/S C5ISR-D cockpit are structured to build three Dimensional War fighting with the concept that “no platform fights alone.”

Ultimately, information will go up and out. This is a fundamental rule for the Intelligence Community and will be a fundamental practice of the F-35 fleet.

This research path can drive 4th to 5th to 6th gen AA &AG weapon research. Currently 5th gen airframes are firing 4th Gen weapons at best.

Fusion engine sensors can drive unity of purpose “aim point” for world wide Defense firms/consortiums.

There is a huge R&D con-ops and training and tactic adjustment required to tie in with legacy systems. Perhaps vectoring the helmet might be cheapest way to promote this type of integration.

The F-35 “Z-Axis” is Symbol driven war fighting and thus language agnostic.

F-35 can network battle management with emerging UCAS systems and robots. UAVs are part of future of aviation NOT the future of aviation. This must be tested at Northern Edge EW exercise.

C5ISR-D Fusion engine is an inherent redundant aircraft and fleet “survivability” factor, as much as war fighting factor. It and can operate internally in the aircraft and off load an attack on one sensor to use the other sensor systems to keep the mission alive. This is cyber war inoculation and can be tested at Northern Edge

“UCAS V Tron warriors” This entire issue MUST be tested and understood. “Cyber” is now being used as a word weapon both pro and con to kill or justify systems and as an organization budget driver as much as a realistic threat. Positing the challenge of protecting everything protects nothing.

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The PLA is modernizing its air and naval forces along a linear command directed “hub and spoke” (AWACS-is their key tell). US Air/Sea Battle can build “honeycomb” technology base/con-ops, which is a winning formula for Allies and US.

Against future hypersonic cruise missiles if F-35 did not exist it would have to be invented. Hypersonic cruise missiles are the biggest emerging realistic threat against the fleet and “others.” (Dr. Mark Lewis former Chief Scientist USAF). With nine minutes of incoming flight, seven minutes can be an eternity at speed of light. The F-35 is a component of focusing energy weapon, “tron” warfare capability and kinetic weapon research relevant to the task and is hence enhanced ship survivability in an operational theater.

The US and its Pacific allies can be their own relative reactive enemy if PLA gets hypersonic cruise missiles. An F-35 lighting up threats 800 miles out and vectoring our killer hypersonic cruise missiles will be a deadly first shot, the one that really counts

In short, the F-35 sensor engine is a key element to fighting “Tron War.” The F-35 seen as a fleet of capability provides an entirely new approach to cognitive learning for the warfighter. Similar to Jean Piaget’s approach to understanding the cognitive learning of the child, the fleet learns as it fights and reaches different levels of competence and capabilities in dealing with the reactive enemy.

This point was driven home in a recent note made by Dean Ebert, a Naval Academy Grad, and former USMC pilot. Dean was one of the key sources of an interview done at the Paris Air Show in 2007 by Doug Barrie and Amy Butler when they were talking with General Trautman, then DCA of the USMC, about the future of Electronic Warfare.

Behavioral aspects of cognition are finding their way into architectures, processing, fusion, and distribution/collaboration of information nodes. Pulling your thread of increased processing power and open architectures — not to mention C4ISR-D and the Z-axis — we are now able to interact with our environment in a more “human” way.

By this I mean that we sense our environment, we understand it, we interact with it based on that understanding, and then as the environment changes we change with it.

Throughout this process, we allow our systems/networks to learn not only what it has sensed and which dials to turn to better interact, but to remember what they HAVE learned... then they can share that with other nodes that may have interests.

You could think of a automated equalizer for a stereo that adapts automatically to a room based on user defined preferences.

Cognitive computing/architectures will be necessary to combat the PLA threat... smaller, disposable “swarms” of sensors, non-kinetic/kinetic attack options will be essential to defeating the numbers of threats while minimizing the risk of our manned systems.

To this end, if JSF with it’s perception of the world, and ability to display/control information is able to direct or at least perceive what the swarms of intelligent sensors are doing, you’ve got yourself a true multiplier.

Each node in the battlespace must be a collaborator... it must be able to share it’s understanding of the environment as well as it’s sensed knowledge, it ALSO must be able to be interacted with... whether asked a question, pass along information, or change its mode of operation/aim point.

We don't need to limit our non-kinetic (EW) options to a power game — EMS finesse is relevant. Also, with just a little imagination you could conceive of numerous ways to prosecute traditional targets from new and interesting angles.

All of this said, it is certain that our interaction with information will shape our ability to deter, engage, and defeat any enemy that may be identified.

All of the original interviews referenced throughout can be found on Second Line of Defense and have been the foundation for articles published in other publications including on *Front Line Defence*, *Breaking Defense*, *Defense News*, *Joint Forces Quarterly*, *India Strategic*, *The Williams Foundation* (Australia), the Centre for Military Studies, the University of Copenhagen, *Jane's Navy International* and have been republished on many websites as well.