ROBOTIC AIR LOGISTICS: A TRANSFORMATIONAL CAPABILITY IN WARFARE

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My logisticians are a humourless lot….they know if my campaign fails, they are the first ones I will slay.

— Alexander the Great

The line between disorder and order lies in logistics.

— Sun Tzu

On December 17, 2011, an epoch-making occurrence took place;[1] it has gone unheralded, but time may show it as a path-breaking event that will revolutionise the use of air power in combat. The first **operational** cargo delivery by an Unmanned Aerial Vehicle (UAV) took place in a combat zone. An unmanned K-MAX helicopter, a Lockheed Martin and Kaman Aerospace venture, transported 3,000 lb of underslung cargo in a two-hour flight to resupply an outpost of the US Marines in Afghanistan. By January 9, 2012, twenty sorties had already been executed in the planned six-month

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1. *Rotor and Wing,* January 4, 2012, available at http://www.aviationtoday.com/rw/military/utility/75495.html, accessed on January 07, 2012.

An unmanned K-MAX helicopter transported 3,000 lb of underslung cargo in a two-hour flight to resupply an outpost of the US Marines in Afghanistan.

operational trial of the robotic helicopter.[2] Neil Armstrong may well have said, "A small hop for a helicopter, but a giant step for combat air power."

Well, what's so great about this? Actually, the earliest unmanned devices were balloons filled with explosives, used by Austria way back in 1849 to attack Venice.[3] Unmanned aircraft first flew almost a century ago in World War I and development of drones continued post World War II feverishly, as the Americans were aware of the dangers to their spy planes being targeted by the Soviets – their fears came true in 1962 when Gary Powers' U-2 was shot down. The Israelis showed great tactical use of their drones in the 1982 Bekaa Valley action, which was the first integrated Electronic Warfare (EW) campaign built on blinding the enemy air defence – the 82:1 kill ratio points to their success. And, there are a dime a dozen drones flying in the world's skies, with the ones in the Af-Pak region making news daily. So, where lies the uniqueness about the Afghanistan K-MAX unmanned robotic supply mission?

This paper will examine the impact that robotic air delivery would have on the logistics of the ground battle.

IMPORTANCE OF LOGISTICS

Logistics is a function of command – if treated only as a support arm, the repercussions could be many. Supply of troops is a charge that all commanders hold dear**;** it is one of the primary tasks, as no operational plan can go through successfully without a suitably intermeshed logistics approach. It is the commander's intent that determines troop movements as per a strategy devised by him. The fog of war makes the best of plans go

2. *The Times of India* (New Delhi), January 9, 2012.
3. Dr Christina J. M. Goulter, "The Development of UAVS and UCAVs: The Early Years" in Owen Barnes, ed. *Air Power UAVs: The Wider Context* (Royal Air Force Dte of Defence Studies), available at http://www.airpowerstudies.co.uk/UAV-Book.pdf p. 14, accessed on January 5, 2012.

awry, throwing schedules out of sequence and generating unwanted and undesired trajectories of personnel and equipment trails. A good commander is one who is *au fait* with the happenings and who maintains his logistics in sync with the operational ground realities**;** if it is the converse, i.e., if he has to maintain his operations as per the logistics schedule and availability, then it is an indication of a comedown and incorrect logistics planning. The campaign plans must fully integrate operational and logistic capabilities**.** The logistic stream, thus, has to stay wedded to a commander's operational requirements, as a mismatch may result in the loss of combat force and consequently, its morale.

Logistics functions comprise three basic steps, viz, production or procurement, strategic allocation of materials and, lastly, inter or intra theatre logistics;[4] the third step implies positioning the allotted material and/or equipment at the right place, at the right time and in the desired quantity.

Historically speaking, in the centuries gone by, war campaigns saw the victors foraging and pillaging the vanquished countryside to feed their troops. Alexander's army's great 11,250-miles march in eight years to the river Beas in India was, for the most part, fed through such methods[5] and this practice actually continued till World War II when both sides lived off the land, as it were, as the logistic lines got extended;[6] non-provisioning or interruption in availability led to operational setbacks. The most famous example of an operation getting delayed is the one of Patton having had to slow down his Third Army in 1944 in its drive through France due the fuel logistics chain not having kept pace with his furious advance. Patton is reported to have remarked, "At the present time, our chief difficulty is not the Germans, but gasoline. If they would give me enough gas, I could go all the way to Berlin!" In the event, he had to stop all movement for a week which paid put

4. Chris Madsen, "Strategy, Fleet Logistics, and the Lethbridge Mission to the Pacific and Indian Oceans 1943-1944," *Journal of Strategic Studies*, vol 31, no 6, December 2008, p. 951.
5. Maj Gen Julian Thompson, *The Lifeblood in War: Logistics in Armed Conflict* (London: Brassey's (UK), 1991), p 16. Also see Donald W. Engel, *Alexander the Great and the Logistics of the Macedonian Army* (Berkeley USA: University of California), p. 120.
6. Paul Kennedy, *The Rise and Fall of the Great Powers* (London: Unwin Hyman Ltd, 1988), pp. 308-309, 362.

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to his plans of being the first to reach there.[7] Distance, timeliness, and quantity are the perennial concerns of logistics**;** put in other words, how far, by when, and how much.[8]

LOGISTICS MOVEMENT

Post procurement and allotment, the final step is the positioning of the load at the required locations (how far, by when and how much). The cheapest and most efficient way is by road or rail and when cartage volumes are considered, no other means come anywhere near the intrinsic advantage that this surface mode has. This paper will consider the effect of robotic air delivery on logistic provisioning in forward operational areas only.

In operations, an advancing force, as it moves away from its holding point or concentration area, gets into a position of disadvantage in terms of assurance of logistics. This is because its supply line starts getting extended, just as it happened in the case of Patton in his drive through France. When viewed from the side of the defender, availability of supplies becomes problematic when a siege like situation develops due to disruption of the supply lines by the attacker – the sieges of Dien Bien Phu and Stalingrad are examples. The recourse left is to supply the units/garrisons by air. This is easier said than done and one only needs to go back in the history of air power to get the full import of this statement. The Germans, in the Battle of Stalingrad in World War II, lost 488 aircraft and 1,000 aircrew in their attempt to supply their men surrounded by the Russians. In Indo-China, the French lost 62 aircraft in their endeavour to support their troops in the May 1954 siege of Dien Bien Phu.[9] More importantly, both the countries lost the battles and

7. Daniel G. Grassi, "Refuel on the Move: Resupplying Patton's Third Army," *US Quartermaster Professional Bulletin,* Summer 1993, available at http://www.qmfound.com/pol.htm, accessed on 11 Jan 12.
8. Madsen, n. 4, p. 952.
9. Dr. David K. Vaughan and Maj James H. Donoho, "From Stalingrad to Khe Sanh**:** Factors in the Successful Use of Tactical Airlift to Support Isolated Land Battle Areas," *Air & Space Power Journal* - Chronicles Online Journal: available at http://www.airpower.au.af.mil/airchronicles/cc/vaughan.html, accessed on January 21, 2012.

due to loss of national morale, the two events became turning points in the two conflicts. In Vietnam, of the 5,000 plus helicopters lost by the Americans[10] many were on routine errands like taking hot *chow* (food) for the troops on the front lines – this was a morale aspect being addressed, but the loss of the helicopters and aircrew on such routine logistics sorties was not a small price to pay.

The positioning of logistics has hitherto been by surface means and, after man took to the air, fixed-wing aircraft and helicopters have been added as another mode. Thus, a prime method of strangulating an opponent or taking the momentum out of his manoeuvres is by denying him his logistics. Denial of logistic supplies is possible by interdicting an opponent's supply lines so as to raise the costs for him in terms of the supplies and human lives in his endeavour. Thus, in conventional war, where the supply lines are generally defined and located in territory under the control of the opponent, it requires overt offensive action by interdiction**;** the situation, however, is different where the opponent is a non-state actor and the conflict is in the domain of Irregular Warfare (IW). It is not why the conflict is being contested but *how* it is being fought and the scene of action is on one's own soil and not that of the opponent; disrupting supply lines of the state becomes an important activity for the insurgent as it gives the following dividends:

- Ties down a large number of human and material assets of the state as it attempts to protect its supply routes.
- Causes supply losses and brings in an element of uncertainty in the minds of the state forces about the efficiency and determination of the insurgents.
- Propaganda value by hyping the state of morale of the insurgent movement.

10. Jacob Wise and Desmond Young, "Helicopters: The Tactical Innovation of the Vietnam War" in Eau Claire, ed., *Vietnam: A Historical Geography* (University of Wisconsin, 2010), available at http://www.uwec.edu/webprojects/geog445/helicrash_byyeear.html, accessed on February 4, 2012.

Road convoys in insurgency prone areas have become very lucrative targets for Improvised Explosive Devices (IEDs), roadside bombs and ambushes.

Future armed conflicts have been predicted to be of the low intensity type in which insurgency will dominate.[11] Counter-insurgency warfare calls for establishing control over an area where the writ of the state has been challenged by group(s) inimical to the state. This challenge is not peaceful but takes recourse to armed action against the state. To maintain or reestablish control in the area, the presence of the different arms of the government is necessary. Thus, there are outposts of government armed forces that have to be supported logistically from some secure base at the rear[12].

Road convoys in insurgency prone areas have become very lucrative targets for Improvised Explosive Devices (IEDs), roadside bombs and ambushes. While no official details are available regarding deaths due to IEDs in India, this weapon of the insurgent has been a low cost foil to technology intensive weapons of the modern world. *The Washington Post* reported that by 2007, "….IEDs have caused nearly two-thirds of the 3,100 American combat deaths in Iraq, and an even higher proportion of battle wounds….. they have also resulted in an estimated 11,000 Iraqi civilian casualties and more than 600 deaths among Iraqi security forces."[13] The latest figures put the Americans having lost 3,008 soldiers to such attacks in Iraq and Afghanistan.[14] Casualty sensitivity is high in the modern world and tolerance of the civic society to bear such losses of soldiers is low and continuing to go down. This has resulted in road convoys for certain missions and operational areas being replaced by aerial lifts, mostly by helicopters. The

11. Thomas G. Weiss, *What's Wrong with the United Nations and How to Fix It* (Cambridge, UK: Polity Press, 2008), pp. 27-28.
12. In India, the Air Force has the additional charge of air maintaining many remote Army border posts because of their inaccessibility due to absence of roads, weather or due to their peculiar location on the border.
13. Rick Atkinson, *The Washington Post*, September 30, 2007, available at http://www.washingtonpost.com/wp-dyn/content/article/2007/09/29/AR2007092900750_pf.html, accessed on January 30, 2012.
14. DoD Personnel and Military Casualty Statistics from October 7, 2001, till January 03, 2012, available at http://siadapp.dmdc.osd.mil/personnel/CASUALTY/gwot_reason.pdf.

opposition has got smarter and has started targeting helicopters using small arms and Recoilless Portable Guns (RPGs), with disastrous consequences.[15] One major reason for the withdrawal by the Russians from Afghanistan in 1989 was the loss of tactical supremacy afforded by the once 'invincible' helicopter gunship. The US supplied Stingers took a heavy toll of the Mi-24s and Mi-25s, forcing the Russians to fly higher, resulting in a higher success rate of ambushes of road convoys. The downing of an American Chinook recently (December 2011) in Afghanistan, causing the loss of 30+ lives, made headlines, as 22 of the fatalities were from the same Navy Seals unit that took part in the Osama bin Laden raid in Pakistan. Earlier, in 1996, the Indian Air Force lost an Mi-17 in the Siachen Glacier area after being hit by a missile while on a logistic resupply mission to an Army post in the Siachen Glacier.[16] And within the country itself, the Flight Engineer of an Indian Air Force Mi-17 helicopter was killed in November 2008 when it was fired upon by left wing extremists in the Chattisgarh area.[17] The RPG has brought in an element of helplessness in the cat and mouse game between the helicopter and the insurgent – as yet, no solution has been found to the almost fatal consequences to a helicopter if an accurately aimed RPG hits it at a vital spot.[18] Thus, the relative safety of vertical separation from hostile ground forces afforded to a helicopter has been eroded and begs a solution as, besides loss of lives, the propaganda advantage that accrues to the insurgents is disproportionately high.

So, what was the solution to this low cost but potent threat to an indispensable means of logistic delivery? The solution lay in analysing the three aspects in the loss of a helicopter or aircraft to ground fire, viz, loss of aircrew, loss of the aerial vehicle and supplies and propaganda gain

15. An officer writing in *Marine Corps Gazette*, recently put it (the ability of the insurgents to adapt to counter-measures) as, "The Flintstones are adapting faster than the Jetsons." *The Washington Post*, September 30, 2007.
16. See http://www.bharat-rakshak.com/IAF/Personnel/Martyrs/198-4-99-Siachen.html
17. Many more such incidents of firing on helicopters have since taken place and reported widely in the press, luckily with only some damage to the helicopters and no casualties; for example, see http://articles.timesofindia.indiatimes.com/2011-12-26/india/30558392_1_iaf-chopper-naxal-fire-jagdalpur
18. Col David Eshel , "Deadly Scourge of the US Helicopter Pilots in Iraq", available at http://defense- update.com/newscast/0207/analysis/analysis-100207.htm , accessed January 30, 2012.

With advances in robotic technology, data transfer rates and automation in flying bodies, a concept of unmanned delivery of logistics supplies was mooted by the United States Marine Corps.

by the adversary. Any reduction in any of these variables would benefit the commander, besides saving lives, an aspect that outweighs everything else and is considered paramount.

THE 3-DS

Provisioning of logistics supplies can be categorised as part of tasks that form 'the three Ds' – jobs that are 'dull, dirty and/or dangerous'. Dull assignments are those that require routine functions, dirty jobs are performed in harsh environmental conditions, while dangerous missions involve tasks in which humans could suffer physical harm.[19] Robots have proven most efficient and cost-effective in such 3 D combat tasks. With advances in robotic technology, data transfer rates and automation in flying bodies, a concept of unmanned delivery of logistics supplies was mooted by the United States Marine Corps in the last decade of the 20th century. Kaman Aerospace was awarded a $4.2 million contract in June 1999 to design, build and install a remote piloting package in a K-MAX helicopter as part of the Marine Corps' programme christened Broad-area Unmanned Responsive Resupply Operations or BURRO. The objective of the BURRO concept was to demonstrate the feasibility of using an unmanned vertical take-off and landing platform to deliver supplies to widely dispersed troop locations in a battle zone.[20] This capability was to conduct sea-based autonomous resupply in support of the Marine Corps' Operational Manoeuvre from the Sea (OMFTS) war-fighting concept, and the enabling concept, Ship-to-Ship Manoeuvre (STOM).[21] The acronym BURRO was targeted at the hardy **burro**, a small donkey used primarily as a pack animal.

19. James Jay Carafano and Andrew Gugel, "The Pentagon Robots: Arming the Future", *Backgrounder*, no 2093, (The Heritage Foundation, 2007) available at http://www.heritage.org/research/reports/2007/12/the-pentagons-robots-arming-the-future, accessed on January 25, 2012.
20. Details at Kaman Aerospace website http://www.kaman.com/news/u-s-marine-corps-awards-follow-on-contract-to-kaman-for-development-work-on-remotely-piloted-k-max-s/ accessed on January 22, 2012.
21. "Unmanned Aerial Vehicle Roadmap 2000-2025", US DoD document issued from the Office of the Secretary of Defence, Washington, April 6, 2001, p. A 17.

Fig 1

http://www.uasvision.com/2011/10/07/us-marines-take-k-max-to-afghanistan/

The BURRO programme, within a year, was drawing attention in UAV literature[22] and its progress was keenly followed. In less than a year, in May 2000, Kaman was given a follow-on order of a $2.7 million contract by the Marine Corps War-fighting Lab for further development in terms of advanced capabilities that included coupled navigation culminating in a fully automated BURRO, which could navigate a pre-programmed

22. Air Vice Mshl R.A. Mason, "The Development of UAVS and UCAVs: The Early Years" in Barnes, ed., n. 3, available at http://www.airpowerstudies.co.uk/UAV-Book.pdf, accessed on January 05, 2012. AVM Mason writes, "In April 2009, the US Marine Corps was reported to be seeking an unmanned cargo aircraft for resupply of forward operating bases." p. 118.

course without human intervention, while carrying an external load. The ultimate goal of the BURRO was an automated cargo delivery system capable of safely delivering supplies to a precise location. The aircraft's enhanced capabilities were to be demonstrated, which would include a 6,000 pound payload capacity, long-range (50 mile) data link, and auto-take-off/auto land capability. Ease of operations was a major criterion and the company claimed that that the system would not require a rated pilot.[23]

The programme was built on the basic K-MAX, which is a single pilot proven external load carrying helicopter used mainly for logging operations. It has 6,000 lb of payload and can carry 4,300 lb at 15,000 ft. Kaman claimed that in Federal Aviation Administration (FAA) approved tests, it pushed all the K-MAX components to the limits by stressing them to full power cycles, 30 times per hour, for the entire life of the components. No other helicopter, let alone any other UAV, has been tested to such extremes, the company said. The K-MAX also has the ability to perform multiple cargo air-drops to different locations using the aircraft's four hook carousel.[24]

PRINCIPLES OF LOGISTICS

For the BURRO to prove its worth and be successful, its output has to be weighed against the principles of logistics. The British Army has five "Principles of Administration" while the Americans have nine; these are logistics intelligence, objective, general logistics, interdependence, simplicity, timeliness, impetus, cost-effectiveness and security.[25] Of these, the last four, viz., timeliness, impetus, cost-effectiveness and security are directly affected by the final step of the logistics functions i.e., the positioning of the load at the required location(s) (how far, by when and how much). Timeliness is self-explanatory in that the required item/equipment should be available at the time required for operations. Impetus implies forward motion or drive

23. n. 20.
24. Ibid.
25. Maj Gen Julian Thompson, *The Lifeblood in War: Logistics in Armed Conflict* (London: Brassey's, 1991), p. 7.

– "the need to support well forward, right into or close behind the fighting units' areas", as the Americans expect. Thus, the items being provisioned should reach as far forward as required by the operational staff, and not require them to continuously wonder whether the supply is fetching up or not.[26] Cost-effectiveness and security are inter-linked, in terms of both financial aspects and human lives. If the logistics train is not secure, then it would result in losses in both these facets, with the impact of loss of life being an unquantifiable entity.

In comes the K-MAX BURRO in such a scenario. It flies as an unmanned pre-programmed autonomous machine or as an unmanned pilotable (from ground) helicopter with the supplies underslung beneath it. The automated K-MAX takes off with the load, goes to the programmed height (out of harm's way from ground threats), flies a designated route, descends to the destination helipad and releases the load when it (the load) touches the surface. The BURRO then takes off for a subsequent area to deliver the remaining load or returns to base to be serviced and refuelled for a subsequent sortie – this cycle can continue many times and would be limited only by bad weather or technical limitations. Since it flies with sophisticated automated equipment, the K-Max BURRO can fly at any time of day or night and the supplies delivered with pinpoint accuracy and almost negligible, if not zero, losses – in automated flying, the instruments get feed from sensors that judge the movement of the vehicle in the atmosphere**;** thus, day or night has no influence on the ability of the vehicle to be controlled in a robotic mode. In times of a hot war, the K-MAX would be a legitimate target, but its loss would not involve any aircrew – a big issue in these times of low casualty sensitivity. With net-centricity and Remote Split Operations (RSO) becoming an everyday affair in the Afghanistan and Iraq Wars,[27] these BURROs can be redirected by a commander to places requiring emergent logistics assistance. Thus, the logistics supply would be timely, of the required amount and positioned with pinpoint accuracy, fulfilling the 'principles of logistics'.

26. Ibid., p. 8.
27. Maj Brad W. Borke, "Global Dynamic Operations", *Air and Space Power Journal*, Spring 2010, (Maxwell Air Force Base), p. 75.

The United States Air Force wrote in an 82-page report titled "Unmanned Aircraft Systems Flight Plan 2009-2047, "that *autonomous* **drone aircraft are key" to increasing effects while potentially reducing cost,** *forward footprint and risk".*

The present mission of the Lockheed Martin Kaman Aerospace team is to run the K-MAX BURRO through a six-month operational trial period in Afghanistan for the US Marines. Is this a one-off UAV plan that has been generated because of Iraq and Afghanistan? No. The United States Air Force wrote in an 82-page report that outlined the future usage of drones, titled "Unmanned Aircraft Systems Flight Plan 2009-2047, "that *autonomous* drone aircraft are key" to increasing effects while potentially reducing cost, *forward footprint and risk* (emphasis added)."[28] The report makes interesting reading as it states that by the year 2047, the computing powers will be such that there will be no human 'in the loop' but he would be 'on the loop', implying that decision-making capability would transfer to the Unmanned Aircraft System (UAS) and humans would be present only in a monitoring role. The report adds that, "Simultaneously, advances in Artificial Intelligence (AI) will enable systems to make combat decisions and act within legal and policy constraints without necessarily requiring human input."[29] Thus, as the BURRO K-MAX technology matures, the system would get even more automated, with the 'powers to decide' transferring to the machine – this would lead to further saving in manpower and reduction in objectivity in decision-making. Logistic provisioning in an area would become more automated, as a larger number of principles of logistics (enumerated earlier) would be brought under the ambit of decision-making by the UAS. Threat level and weather assessment in an area, heights and speeds to fly at, descent pattern to match the threat at the landing base, etc would be factors that would be determined by the UAS and modified by it, as the logistics campaign progresses in sync with the commander's plan. Consequently, day/night, and weather, to a certain extent, would not

28. *United States Air Force Unmanned Aircraft Systems Flight Plan 2009-2047,* HQ USAF, Washington DC, May 18, 2009, available at http://www.govexec.com/pdfs/072309kp1.pdf, p.14.
29. Ibid., p. 41. flt plan UAS.

be hindrances to continuous logistic stocking of remote bases and outposts whose approaches by road are not secure due to hostile activity.

A caveat needs to be added here, lest an impression of total invincibility is painted for the BURRO or any other such robotic supply mission tools. The air space environment in Afghanistan is totally benign. The International Security Assistance Force (ISAF) and the North Atlantic Treaty Organisation (NATO) complement have total air dominance in the area of conflict; thus, the BURRO has no threat of an aerial engagement. With underslung load, any aerial interception would be fatal for the robot, unless escorts are made available to it. Should there be manned escorts to an unmanned machine like the BURRO K-MAX? It would defeat the very purpose of utilising unmanned aerial machines in a particular sector. What if the unmanned BURRO was escorted by unmanned combat aerial vehicles with the power to take decisions? The answer to this is covered later in this paper; suffice to say that air dominance and aerial assymetry, such as that prevalent in Afghanistan, would be a rarity (if not an impossibility) for the next few decades in most of the areas of conflict in the world.

Operations in certain parts of the northern areas could benefit with automated air maintenance being done by night when the temperatures are lower, which results in greater load carrying capability of a helicopter.

IMPORTANCE FOR INDIA

The implications for India are many, if we were to acquire this technology. At present, other than some areas affected by left wing extremism, there are not many regions that have unsafe approach roads. But availability of this capability would ensure that there would be a competency on hand, in case such a requirement arose. However, operations in certain parts of the northern areas could benefit with automated air maintenance being done by night when the temperatures are lower, which results in greater load carrying capability of a helicopter – this is a theoretical statement, as the performance graphs of the helicopter being used would be the defining document, especially with underslung load which requires Out of Ground

Effect (OGE) hover load carrying capability. Another factor that would be of vital importance would be the narrow valleys, where launching such automated missions could be suspect. But, stretching the time horizon a little more, suppose the robot helicopter had Electro Optical (EO)/Infra-Red (IR) pods that beamed back in real-time the visuals around the helicopter? Well, a human could be put in the loop to monitor the flight path of the helicopter and flown safely from a base station in a virtual world, if required! Is this a far-fetched idea? Certainly not, if one considers that the Americans are already planning this as per their UAS Flight Plan 2009-2047:

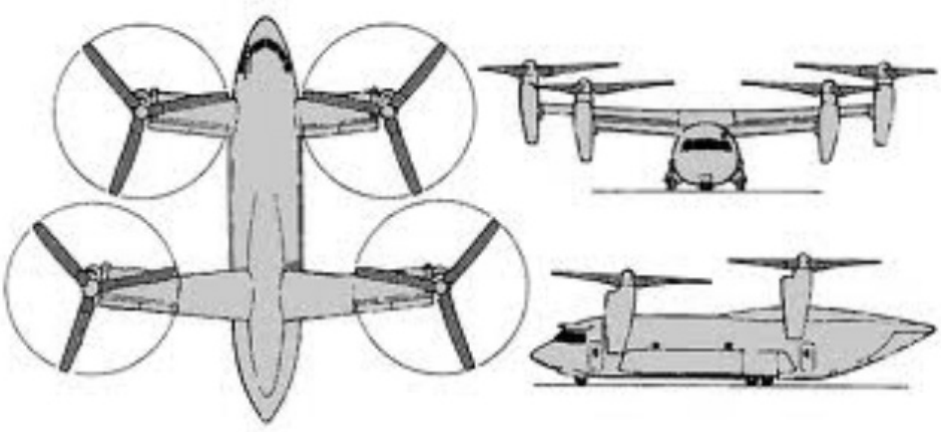
> The near-term concept of swarming consists of a group of partially autonomous UAS operating in support of both manned and unmanned units in a battlefield while being monitored by a single operator. Swarm technology will allow the commander to use a virtual world to monitor the UAS both individually and as a group. A wireless ad-hoc network will connect the UAS to each other and the swarm commander. The UAS within the swarm will fly autonomously to an area of interest (e.g. coordinates, targets, etc.) while also avoiding collisions with other UAS in the swarm. These UAS will automatically process imagery requests from low level users and will "detect" threats and targets through the use of artificial intelligence (AI), sensory information and image processing. Swarming will enable the UAS network to deconflict and assign the best UAS to each request.[30]

Going a step further, the Bell company in the USA is developing a C-130 class quadrilateral tilt rotor aircraft called 'Quad Tilt Rotor' (QTR) that would take off like a helicopter, translate to fixed-wing flight by tilting its four rotors forward, like the V-22 Osprey, and land at the destination as a helicopter once again. It would, thus, have the advantages of Vertical Take-Off and Landing (VTOL) and high forward speed like a fixed-wing aircraft. Large volumes could then be transported to much greater distances at high

30. *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, HQ USAF, Washington DC, May 18 2009, available at http://www.govexec.com/pdfs/072309kp1.pdf, p 34.

speeds – typically, fly at 300+ miles per hour and be able to vertically deliver a 20-ton payload 500-1,000 miles.[31] Adaptation of unmanned autonomous capability would be easily achieved from the BURRO K-MAX trials and field usage. This, however, would be a call that would require deep evaluation, as transporting such a large amount of cargo or a large number of humans, without a man in the loop (pilot on board) would be a risky proposition. Whether this could this form part of the swarm philosophy of the Americans is difficult to say at this stage but a mix of manned quad tilt rotors and some unmanned quads, with the former controlling the latter in a formation, is not something that can be discounted. Thus, insertion of a fighting group from a continental base direct to a scene of conflict at a future point in time, with all complete support, is not in the realm of fantasy. Imagine if Patton had this capability in his drive through France in World War II! His thrust would not have lost the momentum, as K-MAXs with underslung fuel bladders would have supplied his troops to his rear areas**;** or, quad tilt rotors with 20-ton payloads of fuel (in each quad) could have flown directly from Britain without them being brought first by ship to French ports and then tranported by trucks to his field army.

Fig 2



31. See http://www.globalsecurity.org/military/systems/aircraft/qtr.htm, accessed on January 23, 2012.

The quad tilt rotor would be for a different role altogether, ie, to induct large cargo and fighting groups directly to the zone of engagement.

ECONOMICS OF THE PROJECT

Cost is one of the principles of logistics. In terms of capital, the Chief Executive Officer (CEO) of Kaman Aerospace claimed that the K-MAX uses less than half the fuel of manned assets with similar payloads, with fuel cost savings of more than $85 million in one year alone.[32] Add the pure logistic support sorties flown in Afghanistan and Iraq, and one would get an idea of the colossal savings that would accrue. The savings in cost with automated quad tilt rotors (if the principle is accepted) would be even larger, as intermediate transit points (initial positioning at a base by fixed-wing aircraft and/or ships and then load transfer to helicopters) would be avoided. The saving of lives that would result from automated aerial delivery cannot but be underscored – it would be an intangible that cannot be priced and would be welcomed by the military heirarchy as well as by the political leadership (in more ways than one).

CONCLUSION

So, where does technology take us from the K-MAX operation? An army can, in future, plan to deploy and keep supplied its armed posts in areas whose access is difficult due to road-bound threats. The human toll in road convoys due to IEDs, roadside bombs and ambushes would be greatly reduced and aircrew losses due to missile and small arms hits from ground forces on aircraft and helicopters on supply missions, eliminated. If the K-MAX experiment succeeds (and there are no indications that it would not), then the next step could be the adaptation of the tilt rotor V-22 for such supply missions as the loads carried would increase substantially. The quad tilt rotor would be for a different role altogether, ie, to induct large cargo and fighting groups directly to the zone of engagement, and as brought out earlier, its automated flight would call for a deep introspection and debate.

32. Full transcript of interview with Mark Tattershall, Director, Marketing and Business Development, Kaman Helicopters, with *Rotor & Wing* magazine, available at http://www.aviationtoday.com/rw/military/utility/71406.htmm, accessed on January 22, 2012.

The availability of air dominance in the sector would be a requirement in case of a hot war, and would be an important planning and decision-making criterion.

Would the BURRO K-MAX herald a revolution in the conduct of military operations? Only time would answer that, but one needs to remember that the inventions of the wheel, gun powder, telegraph and railroad were also viewed as innocuous events but transformed the battlefield in more ways than one. The country that did not or was slow to adopt the technology did so at its own peril. As they say, war is all about logistics. The operationalisation of the unmanned K-MAX may be the harbinger of such a coming – for sure, it cannot replace logistics by road, but automated replenishment by air, come day or night, would serve as a game changer in certain key and pivotal operations. The Dien Bien Phus, Stalingrads and Afghanistans (the British in the earlier part of 20th century and the Soviets in the later period), where the long lines of communications could not be protected,[33] may become a thing of the past with the robotic delivery of logistics by air power. May be it's time to add another 'T' in a famous adage and say, "Time, tide and technology wait for no man."

33. Sarah E. Kreps, "Air Power's Role in Asymmetric Operations: The Case of the Second Lebanon War" in Joel Hayward ed., *Air Power, Insurgency and War on Terror* (Cranwell, UK: RAF Centre for Air Power Studies), available at http://www.airpowerstudies.co.uk/Hayward%20Insurgency%20Book%20%20A5%20Web.pdf , p. 155.