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EFFECTIVE ALTERNATIVES FOR AIRCRAFT AND SATELLITE BASED CAPABILITIES

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Introduction

The first forays by man into the air involved use of large kites able to carry a man aloft and lighter than air gas filled balloons. Hot air as well as hydrogen gas were used to fill the balloons to make them buoyant. Dangers in handling the very inflammable hydrogen gas led to utilisation of inert Helium in later years. Hot air balloons continue in use even today for hobby purposes and for a few commercial applications such as advertising. By and large the invention of heavier than air aircraft appeared to consign balloons to the bin of obsolete and no longer used technologies. Innovative thinkers and engineers have come out with several new applications for old superseded technologies, such as lighter than air flying devices, to solve real world problems. Two such are, firstly the modern day use of tethered aerostats (or anchored lighter than air balloons to provide a longer line of sight and hence coverage for radio frequency emitters for commercial communication purposes, and secondly for military applications) by carrying a radio frequency antennae aloft. These new innovative applications have resulted in lighter than air flight technology in the form of balloons coming to occupy a respected place alongside heavier than air flight technologies.

Modern Applications of Lighter than Air Flight Technology

Hot air balloons have stayed in use especially by ballooning enthusiasts and for a few advertising ventures, hence their use is not too out of the ordinary. Modern hot air balloons gain from the results of modern technology in being made of more sophisticated materials and having more efficient inflation and other systems, including even hand held global positioning system (GPS) satellite navigation sets on board. However, essentially these comprise a hot air balloon with a basket suspended under it for accommodating passengers / operators. Hot air balloons depend upon prevailing winds for the path they fly on. Weather balloons in free

flight have continued in use by meteorology departments all over the world to determine wind velocity at high levels through tracking the movement of, earlier hydrogen, but increasingly helium filled, balloons. The dirigible, or airship, which was first developed in the later nineteenth and early twentieth century was a rigid cavernous structure given buoyancy through filling it with hydrogen. Later, after the passenger carrying airship Hindenburg's disaster on 06 May 1937 at New Jersey[1], the use of helium was introduced due to its inert nature in place of hydrogen. Dirigibles were adapted for military use in the early twentieth century. The main uses were reconnaissance while some experiments at weapon delivery were explored in Europe. For the most part dirigibles came to occupy a niche use for long distance passenger transportation in the early part of the twentieth century. Airships had a rigid metal frame structure to give them shape and incorporated several large bags to carry the lift providing gas. Forward motion was provided by engines mounted on the rigid structure. This innovation made dirigibles free of the dependence upon prevailing winds suffered by free flight balloons. Usually a cabin for crew and passengers was suspended below the large structure that housed the lifting gas. Stability and directional control was provided by fins at the rear that also incorporated simple control surfaces akin to rudders and flaps on modern aircraft. The largest airship ever built was the Graf Zeppelin of Germany. By 1940 heavier than air aircraft replaced airships in most applications. Interestingly the Graf Zeppelin Company is still building airships, though mostly for tourism and similar applications[2].

Many modern uses of lighter than air technology involve use of blimps, or non-rigid lighter than air vehicles. Unlike dirigibles, these blimps have no rigid structure to give them shape and rely upon inflation of the carefully contoured gas holding bag for their shape. There are also uses of semi-rigid balloons that have non-metallic shaping structures built into the gas bags. The use of tethered balloons has been there for many years. Aerostats or tethered lighter than air balloons have been used for myriad purposes. One such military purpose is to increase the radar horizon by lifting a radar antenna aboard a tethered balloon[3]. Through this means the radar horizon can be increased substantially with significant military gains. Use of aerostats can increase the radar horizon for low flying aircraft from a mere 20-25 kilo meters (km) typical for ground based radar to as much as 320-400 km[4].

The US was the initial pioneer in developing aerostat radars. However, today these are available from myriad sources. The US, seized with the requirement for adequate early warning and tracking of incoming cruise missile threats found ground based radars unsuitable and the deployment of Airborne Warning and Control Systems (AWACS) also apparently not feasible for this task. Hence the US has developed the Joint Land Attack Cruise Missile Defence

Elevated Netted Sensor System (JLENS)[5]. This system comprises a pair of aerostats that operate at 10,000 feet altitude and house powerful radars that provide 360 degree coverage and can detect and track aircraft, both manned and unmanned, as well as missiles, at ranges as far as 340 miles, 540 km, away. Such detection and tracking provides the warning and precision needed to effectively counter such threats. JLENS uses considerably less manpower as compared to AWACS for the same ask. Moreover, AWACS is touted to cost 500-700% more than JLENS to operate[6]. The JLENS blimps use helium gas and are designed for 24 hour operation while maintaining their station aloft for up to 30 days at a time. Data from JLENS can be forwarded to a variety of missile systems to shoot down detected threats[7]. The JLENS system can be said to be a specially tailored aerostat system. In fact the JLENS has been developed from the early aerostat radar concept.

Non –military uses of current day lighter than air technology also abound. In fact lighter than air technology is again entering the public consciousness based upon proposed civil utilisation concepts of these lighter than air flying machines. Google has proposed the utilisation of free flight balloons for providing internet access to remote rural areas. Google's Project Loon envisages a number of balloons that fly at altitudes as high as 20km above mean sea level (AMSL) and carry hardware to transfer data from balloon to balloon and to and from ground stations as well[8]. The incorporation of solar panels for power serves to ensure that the balloons can operate for large time durations without need for refuelling etc. Each balloon can provide internet access in a diameter of 40 km on the ground[9]. The relatively predictable steady winds of about 20 knots (nautical miles per hour) at 20 km AMSL give predictability about the movement of balloons[10]. Thus a series of relatively low cost balloons established along a particular latitude can provide high speed internet access at a fraction of the cost of the utilisation of space satellites or ground based infrastructure such as fibre optic cables and static wireless transmitters[11]. The relative ease of launching balloons also gives this system relative speed in establishing and maintaining a reliable network at short notice. Project Loon is aimed at providing 4G connectivity, which is the current cutting edge in India in terms of wireless internet access. The first trial of this technology was conducted in New Zealand, followed by Brazil. India is the fifth country to give approval for testing and initiation of Project Loon[12].

The implementation of Project Loon in India has the potential to provide affordable high speed internet access to the remote parts of the country. This could be very beneficial foe economic progress and development. The beauty of Project Loon lies in the fact that all the building blocks required for its implementation have been available commercially for quite some time. All that was required was application of

innovative thought to putting these together in order to find a cost effective solution for real world problems.

Project Loon brings out the modern day utility and effectiveness of lighter than air flight technology. Modern economies and military forces the world over rely upon satellite based communication and surveillance in addition to the same facilities provide by manned and unmanned fixed wing heavier than air aircraft. Heavier than air aircraft all suffer from the limitation of limited endurance. Satellites have the disadvantage of long time gaps between revisits to the same geographical locations due to orbital dynamics. Moreover, due to the extreme heights of even low earth orbit (LEO) satellites, the sensors on board for say, surveillance require very high technology in order for them to provide required high resolution. Of course, satellites, at least till date, have the advantage of operating above what is understood to be sovereign airspace of nation states and so can fly over other countries' physical territories unhindered while going about their designed tasks. A disadvantage of satellites is the long lead time involved in their manufacture ad launch quite apart from the high cost. Fixed wing, heavier than air, aircraft are constrained to operate for limited time periods due to endurance issues and usually fly within friendly airspace unless especially tasked to overfly hostile airspace with all the attendant risks.

Suitably designed lighter than air craft could have the ability to carry heavier payloads than fixed wing aircraft are capable of. These could also deliver greater endurance by orders of magnitude as compared to fixed wing aircraft. Through innovative design of payloads aboard lighter than air craft many essential services so far provided by satellites and high flying fixed wing aircraft could be made available at lower cost and with more flexibility. These is scope for use of tethered blimps as is done with JLENS as well as for powered dirigibles. While the former would cover fixed geographical areas, the latter could be moved around to cope with dynamic situations. China is experimenting with its helium lifted high altitude airship (HAA), the Yuanmeng[13]. The Yuanmeng HAA was tested till an altitude of 20 km AMSL in October 2015[14]. This is a simple military application of an old technology to deliver cutting edge capabilities for a modern nation state. The Yuanmeng can carry a wide range of sensors for myriad specialised tasks. While it can be argued that such a craft could be vulnerable to enemy action and hence would be constrained to operate within friendly airspace or in international airspace, the fact that it can operate at extreme altitudes, well above all but a handful of very specialised and expensive anti-air weapon systems could give such dirigibles a level of operational safety to allow their use in several situations. Sensors developed for use aboard satellites, if placed on board such dirigibles, could provide much higher resolution and better information as they would be much

closer to the areas they require viewing. The loss of such a fixed or mobile ;lighter than air craft could be replaced through launch of a standby on the ground much faster that is possible with satellites. The potential utilisation of such technology for both military as well as civil purposes is limited just by the imagination as Project Loon and the Yuanmeng demonstrate.

India's DRDO, through its ADRDE (Aerial Delivery Research and Development Establishment) located at Agra Cantonment has been involved in development of aerostat technology in India[15]. The Airwat aerostat was tested successfully up to altitudes of 1 km, reportedly in year 2010[16]. At the initial stages the payload carriage and altitude achieved are yet to match those available from similar systems available from established aerostat manufacturers in the world. It is hoped that over time the DRDO will be able to develop critical technologies such as light weight low leakage materials for the gas capsules, lighter structural frames, solar panels for on board renewable power supply, etc. to enable higher altitudes, larger payloads and higher endurance to be achieved. Such technology could have immense application for the military forces as well as for the country in general, especially in times of disaster relief operations. Damaged ground infrastructure could be replaced rapidly through lighter than air technology, facilitating easier relief operations.

Conclusion

Lighter than air flight technology was one of the first means used for man to go aloft. Invention of heavier than air technology due to its benefits of speed etc., soon relegated lighter than air technology to hobbyists and limited commercial use. Application of modern technologies and innovative system and structural concepts have made lighter than air technology relevant even in today's high technology aerospace environment. Innovative utilisation of lighter than air dirigibles as well as tethered blimps has potential to solve several seemingly unsurmountable problems in the civil as well as military domains of operation. Examples such as the US JLENS and China's Yuanmeng exist. India's indigenous efforts in this direction are being led by DRDO's Agra based ADRDE. Lighter than air technology appears to have entered a new phase of its resurgence and acceptance as cutting edge technology after almost a century of playing second fiddle to heavier than air flight technologies.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies [CAPS])

Notes

[1] Dean Nickolas, "The Hindenburg Disaster and the End of the Airship Era", http://www.historytoday.com/dean-nicholas/hindenburg-disaster-and-end-airship-era#sthash.xDTwuG8w.dpuf, accessed on November 04, 2015.

[2] Ibid.

[3] Fas.org, "Tethered Aerostat Radar System", http://fas.org/nuke/guide/usa/airdef/tars.htm, accessed on November 04, 2015.

[4] Ibid.

[5] Raytheon.com, "JLENS", http://www.raytheon.com/capabilities/products/jlens/, accessed on November 04, 2015.

[6] Ibid.

[7] Ibid.

[8] Google.com, "Balloon-powered Internet for everyone", http://www.google.com/loon/, accessed on November 05, 2015.

[9] Ibid.

[10] Ibid.

[11] Ibid.

[12] Timesofindia.com, "Rural internet from balloons in the sky: 6 facts", http://timesofindia.indiatimes.com/tech/tech-news/Google-to-beam-internet-from-sky-6-keyfacts/listshow/49640182.cms, accessed on November 05, 2015.

[13] Kyle Mizokami, "China's New Spy Airship Hunts Aircraft Carriers From the Edge of Space", http://www.popularmechanics.com/military/weapons/a17858/chinas-new-spy-airship-cruises-near-space/, accessed on November 05, 2015.

[14] Ibid.

[15] The hindu.com, " DRDO successfully completes trials of big aerostat system", http://www.thehindu.com/news/national/drdo-successfully-completes-trials-of-big-aerostat-system/article1018741.ece, accessed on November 05, 2015.

[16] Ibid.