V.E.L.A.

Versatile Emergency Landing Aircraft

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Dear Sir,
This letter is to certify that this essay was written by Edric San Miguel and Vito Morlino and is their original work. They completed the essay under my supervision.

(Joy W. Young, NORSTAR Instructor, Norfolk Technical Center)

I. Abstract and Plan of Investigation

How can NextGen aircraft contribute to the future rescue missions? The purpose of this paper is to present a design for a future amphibious tiltrotor rescue aircraft, named VELA, which stands for Versatile Emergency Landing Aircraft. It discusses, in detail, the different aspects of the design that will make this NextGen aircraft both feasible and beneficial for the year 2020. Design tradeoffs to allow for multi-capabilities are addressed and explained in this design paper as well.

In order to execute successful and informative research, both primary and secondary sources are used. From September 29 through October 1, 2009, we attended the NASA Fundamental Aeronautics Program Annual conference in order to familiarize ourselves with NASA‟s intended goals for futuristic aircraft. In summary, when dealing with future tiltrotor, NASA seeks to create a more versatile, efficient, and powerful aircraft that challenges state-of-the-art propulsion system technologies. These are the goals we had in designing the VELA. Other primary sources include casual interviews with local engineers regarding the feasibility of integrating the proposed technologies into the design. A myriad of online articles, patents, and magazines were used to gather ideas that will streamline the aircraft‟s operation in the future.

"Efficiency" is a universal term when it comes to aircraft performance. Whether it be fuel efficiency or mission efficiency, the VELA will utilize advanced technologies that will allow for maximum performance. Different parts of the design contribute to different types of efficiency. A mixture of present-day and future technologies will maximize the VELA‟s operational efficiency. Aerodynamics and lightweight structures ensure fuel efficiency for the aircraft. In addition, the key to keeping operational cost low is through high efficiency. In the future, the VELA will exhibit this virtue.

II. Introduction

Mobility, readiness, and efficiency are just some of the many key components in rescue missions. Past rescue operations, dealing with both man-made and natural disasters, relied heavily on rotorcraft to provide air support especially when roadways were congested. Rotorcraft play a crucial role whether it be fighting wildfires, providing relief, or rescuing people. So what role does NextGen aircraft play in future rescue missions? Current rotary wing research focuses heavily on "efficiency, including aerodynamic performance and structural weight; productivity, which includes high speed, large payloads, long range, and good maneuverability; and environmental acceptance, particularly regarding noise and handling qualities" (Springer). Through this kind of research, a better tiltrotor with amphibious capabilities will be made possible in the future and will address key rescue mission components in order to increase the rate of success in future rescue missions. These are the goals that our amphibious tiltrotor design, Versatile Emergency Landing Aircraft [VELA], will achieve.

VELA flying over a tsunami disaster site

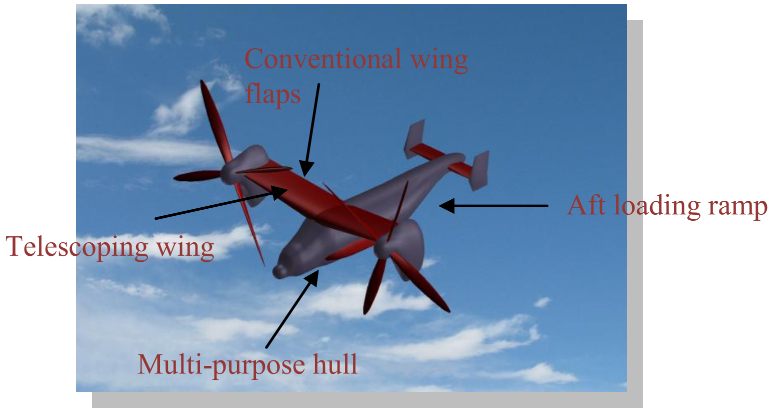
III. General Structure Design & Aircraft Capacity

The VELA design is based on the Boeing V-22 Osprey tiltrotor but it will also incorporate designs from other existing aircraft to make it useful in various rescue missions. The V-22 Osprey was chosen as a foundation of this design due to its unique characteristics such as "increased speed because [it is] twice as fast as a helicopter, much longer range resulting in greater mission versatility than a helicopter, and [has] multi-mission capability" ("Boeing: V-22 Osprey…"). Similar to the V-22, the VELA will have a rear loading ramp, which when closed, comprises the lower portion of the aft fuselage section (Pike "V-22 Osprey: Design…"). This will give easy access to all cargo and passengers. In addition to the V-22 Osprey design, the VELA will be lightweight, low drag, and aerodynamic through the use of advanced technologies and materials.

Payload is an essential factor to consider when designing a rescue aircraft, the higher the passenger capacity, the more efficient the rescue will be. The VELA will be able to accommodate 50 passengers with space for 25 stretchers, if needed, or 100 passengers without stretchers. With higher payload, the number of trips needed to go back and forth to the disaster area is lowered resulting in quicker, more successful rescue missions. The high cargo capacity will also make sending relief to devastated areas more cost efficient.

The VELA will also utilize parts of the Gevers Aircraft Inc.‟s Genesis design. One feature of which is the telescoping wing. The wings are composed of a fixed center section, connected to the fuselage, and two extendable outer sections spars on each side which increase and decrease wing span. These extendable section spars interlock and are guided on rollers to extend or retract the wing. The telescoping wings are used to give the pilot control over wing span according to the desired speed, range and trajectory of the aircraft. This system is simple, rugged, and fail-safe. ("Telescoping Wing…")

Beneath the fuselage, the VELA will have a hull similar to a ship‟s hull. This will not only be used for landing on water but as storage for siphon tanks, landing gear, retractable skis, and excess cargo as well. Though it is unusual for an aircraft to have a hull under the fuselage, it will not interfere with the aerodynamics of the aircraft due to the similar fluid properties between air and water. The additional weight that this hull would cause will be compensated through the use of advanced lightweight materials.



IV. Aircraft Technologies

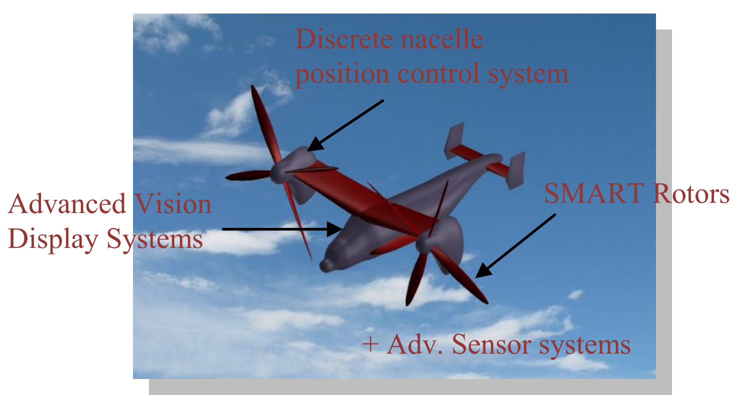
In the future, advanced technologies will be used to increase the usefulness and longetivity of an aircraft. These technologies are also necessary to compensate for changes in structural designs of the aircraft. The VELA will incorporate both present-day and future technologies to make it easy to use even in unusual conditions, especially in harsh weather conditions. The VELA will rely on these technologies to adapt to environmental uncertainties in the atmosphere. This is essential when flying during rescue missions.

The VELA will have a central nervous system composed of sensors, actuators, microprocessors and adaptive controls. With this system, the aircraft will be able to monitor its own performance and will assist the pilot in ensuring a safe and efficient flight (Schultz 171). A Damage and Tamper Detection Sensor System will be integrated into the VELA to detect damage. This wireless sensor system "can be placed on or embedded in materials and structures" that need to be monitored (NASA Langley "Damage and…"). Real-Time Interferometric Fiber Optic Bragg Grating Sensors will "enable real-time monitoring of structural and environmental conditions for vehicle health monitoring." It will allow the aircraft to sense strain, temperature, pressure, and chemical presence (NASA Langley "Real-Time…"). Finally, a Fluid Measurement Sensor will allow the VELA to measure "fluid level, pitch and roll angles, and volume" (NASA Langley "Fluid Measurement…"). All these sensors will be wireless and powered through the use of a magnetic field response measurement acquisition system. This will eliminate the need for heavy, long wires. In addition, all these sensors are crucial during rescue missions in case the VELA gets damaged due to rough conditions.

Regardless of weather conditions, vision and navigation are still one of the most important elements of a rescue mission. An advanced display device will be used by the pilot when flying the VELA. This head-worn display system will "improve safety and efficiency in aviation operations… by enabling pilots to taxi alertly without having to look down at a cockpit screen." It is a voice-controlled system which gives the pilot a real-time, virtual view of the aircraft"s surroundings (NASA Langley "Advanced

Display…"). The VELA"s display system will also allow for clear visibility regardless of weather conditions or heavy smoke from wildfires. Thermal vision will also be integrated to give the pilot an idea of where hot spots are located when firefighting. As a replacement for antiquated radars, the VELA will use the Automatic Dependent Surveillance Broadcast [ADS-B] which gives the pilot exceptional views of what is going on within a certain radius. Along with the Global Positioning Software [GPS] technology, the pilot will not only know their own location, but that of other aircraft in the area as well. Hence, the VELA will be able to change altitude, speed and trajectory when necessary. In aerial firefighting operations, pilots experience reduced visibility, turbulent wind conditions, steep terrain and congested working area (Eggleston). These technologies will not only increase rescue efficiency, but they will ensure the safety of the rescue crew as well.

The VELA will be a highly advanced tiltrotor aircraft. It will utilize rotor blades "made with piezoelectric materials that flex when subjected to electrical fields" known as "smart" rotors (Banke). This technology will significantly improve the performance of the rotors and allow the aircraft to fly with longer range. The rotors will use pneumatic artificial muscles in order to actuate a trailing edge flap device for management of rotorcraft vibration. This will allow for on-blade active control and individual blade control including control surface actuation, trailing edge flaps, and integrated blade manipulation (Kothera). Furthermore, there will be aeroelastic stability in the rotors to prevent the unstable flexing of the tilt rotor. This system of unique actuators will dampen the motion and lessen the instability of the proprotor. As a tiltrotor, the VELA will have a Discrete Nacelle Position Control System which will automatically adjust the nacelles to new positions at modest rates. It will allow the pilot to focus on primary flight control. In addition, there will be a flight control system that will control the aircraft"s pitch, roll, yaw and thrust in all modes of the aircraft [helicopter, tilt, airplane] (NASA Langley "NASA Aeronautics…"). All these technologies will allow the VELA to be easily maneuvered which is essential in rescue missions.



V. Rescue Equipment

Since the VELA will be an amphibious tiltrotor for rescue operations, it will be complete with first aid and essential hospital equipment such as stretchers, oxygen tanks, and defibrillators. This rescue equipment is crucial when rescuing survivors after devastating events and transporting them to the nearest hospital. The VELA will be capable of dealing with various types of rescue operations through integration of technologies that will be suitable for different disasters.

In case of wildfire or any other events that involve uncontrollable spread of fire, the VELA will have the characteristics of a helitanker. This means that the VELA will be suited for direct bombing on hotspots or line-building ("Helitankers"). In the hull of the aircraft, there will be a fixed 2,000 gallon tank to hold the siphoned water. Tanks are one of the most popular water containment objects especially for precision of water release ("Becoming an Aerial…"). Attached to this tank will be a snorkel and a submersible hydraulic pump which can be lowered into a body of water for pumping water up the snorkel and into the tank. The centrifugal hydraulic pump is capable of filling the tank in less than one minute. This electric in-line snorkel pump system is "capable of delivering 1,000gpm through a 6 inch diameter snorkel at a head of about 12 feet and operates at about 7.5 horsepower off a 10kW or less on board generator" ("Electric In-line…"). When siphoning water, the VELA will hover over an open reservoir, including seas, lakes and oceans, and release the hydraulic pump from the hull into the water. After the VELA fills its tank, it will fly to the wildfire area and expel water. The pilot will have an option of how to release the water, either through water bombs, spray, or a wall of water, depending on the intensity of fire. The wall of water has been a very effective method of firefighting, as demonstrated by Air-Crane Helitankers ("BBC News…"). The VELA will also be equipped with modern fire retardants consisting of "ammonium polyphosphate with attapulgite clay thickener or diammonium phosphate with a guar gum derivative thickener" (Slaughter). In the past, borate salts were used as fire retardants. They were effective in fighting fires, but at the same time, they sterilized the soil and were toxic to animals. These modern retardants that we use today are not only harmless, but they serve as fertilizers to help plants grow again after the fire (Slaughter). Wildland fire foam will also be available which is effective for several hours and are used when supporting ground firefighters (Slaughter).

The main goal in most rescue missions is to find survivors. However, even for aircraft, this can be difficult depending on how severe the destruction is. For example, in a powerful earthquake, it is hard to find survivors especially those who are trapped under destroyed buildings. The VELA will have advanced night vision and thermal imaging equipment in addition to search lights. It will utilize a Forward-looking Infrared [FLIR] system which can detect a human in terrain through warm body detection technology (Day). This equipment will make it so much easier for rescue troops to detect survivors. There will be multiple mounts of hoists so the people being rescued can be easily lifted to safety. The winches will be connected to a 400 feet cable carrying a horse-collar rescue sling, a rescue basket, or a stretcher. Having multiple mounts will make rescue quicker especially if there is a group of people trapped around the same area. In addition, this mount system will also allow the VELA to lift heavy objects and transport them from one place to another.

VELA lifting a heavy object

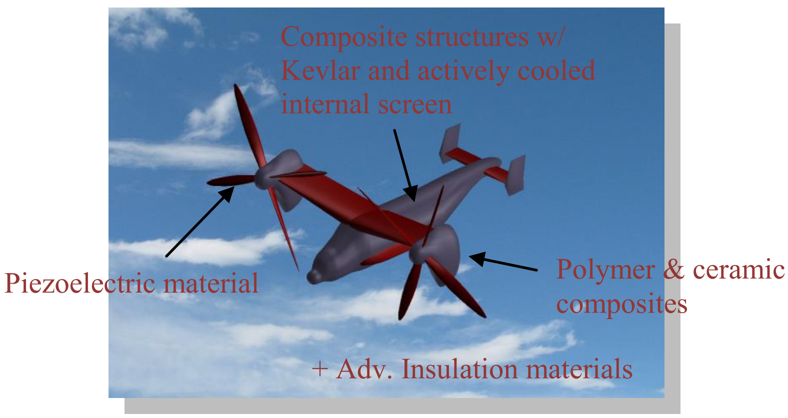
VI. Materials

When it comes to materials, NASA research puts heavy emphasis on advanced materials for airframes and engines, durability, and damage tolerance (Springer). Weight vs. performance is an essential factor to consider when designing an aircraft. Most aircraft today use aluminum for their external structures. Even though aluminum is easily replaceable, it is way too heavy for the VELA which requires less structural weight. The VELA must be as lightweight as possible in order to compensate for added benefits such as high payload, transportation of heavy equipment, and siphoning 2,000 gallons of water. All these design trade-offs translate into additional functionality. Therefore, every component of the VELA will be made out of advanced and promising materials to reduce empty weight. These include advanced structural materials, drive system materials, aircraft systems group materials, and rotor blades and hub materials. In addition, weight is "a primary design consideration because it affects the rotor‟s capacity for vertical lift, which, in turn, affects the aircraft‟s range and ability to fly at safe altitudes" (Iqbal). Every pound saved will allow for additional improvements in efficiency, performance, ballistic tolerance, maintenance and reparability.

The VELA‟s external structure will be made out of fail-safe high-temperature composite structures. This material is a combination of structural support and thermal protection system (NASA Langley "Fail-Safe…"). Carbon composite structures are critical in reducing aircraft weight because they are lightweight and stronger compared to aluminum. These structures are monocoque in design with multiple layers of one-dimensional woven fabric. Tests have proven that because of this, they are highly damage tolerant, and they are an effective barrier to fire and heat as well. The burn through time for composite structures is significantly longer than aluminum ("Firefighting Practices…"). This will provide great safety especially when firefighting. Kevlar polymer fiber will also be used to reinforce these carbon composites, which further strengthens the material ("Composite Materials"). Under the composite material, there will be a layer of actively cooled internal screen which will absorb the heat experienced by the outer shell of the aircraft ("LAPCAT") whether it be from friction during flight or heat from fires while firefighting. Fire-resistant, lightweight electrical insulation materials will be used in order to improve survivability and continuity of the electrical power supply (NASA

Langley "Fire-Resistant…"). This is essential to ensure that the wirings of aircraft devices are protected even at high temperatures. Finally, the use of high-performance polyimide insulation technologies will allow for effective thermal and acoustic insulation and high-performance structural support through the use of low-density foams (NASA Langley "High-Performance…").

Propulsion materials will be lighter and durable with improved acoustic performance. Engine performance is affected by the heat tolerance of their materials; therefore, the VELA will utilize engine materials with higher specific stiffness and damage tolerance at high operating temperatures. The engine will be made out of titanium aluminide, polymer and ceramic composites. Titanium aluminide is half as dense compared to today"s current engine materials. This allows the engine to perform at higher temperature without affecting its performance, resulting in a more efficient engine (Campbell). In addition, polymer and ceramic composites will make that aircraft lightweight while maintaining maximum engine performance ("Concorde"s Successor"). Stiffer and acoustic absorbing materials will be used for the nacelle, which houses the engines. These materials will reduce vibration noise and sounds emitted by the engine.



VII. VTOL, STOL and Multi-Surface Landing

One of the most outstanding qualities of the VELA is its ability to take off from and land on multiple surfaces, such as hard, snow, water, and high grass areas. There are different potential problems associated with landing in different surface. For example, when landing on water, the aircraft must be stable. Strong waves and water currents are capable of tipping over an aircraft if it is unstable on water. Other problems include strong shocks on landing experienced by some aircraft. As an amphibious tiltrotor, the VELA will address these problems and allow for successful multi-surface landings.

Vertical take-off and landing [VTOL] and short take-off and landing [STOL] will make multi-surface landing easy for the pilot. A slow vertical descent will allow the VELA to land on any surface as long as it has the proper landing gear for that surface.

VELA vertical take-off

The VELA will utilize both the triphibious design of the Genesis by Gevers Aircraft Inc. and the characteristics of seaplanes. There will be different repositionable and retractable landing gears from which the pilot can choose in order to suit the type of landing surface. All landing configurations can be selected during flight, eliminating the need to change gear components on ground ("Multi-configuration Landing…"). An indicator will notify the pilot of the gear mode and its current status. The advantage of repositionable landing gears is that they "can be repositioned in flight without the aid of electrical or engine power to allow a normal landing on either a hard surface or water" ("Sport Pilot…"). Just like seaplanes, when landing on water or land, the VELA will use repositionable landing gears. These gears "must be repositioned in flight to execute a normal amphibious flight operation, but need not be repositioned more than once" ("Sport Pilot…") The hull of the VELA is meant for landing on water but there will also be retractable skis from the both sides of the hull that will help stabilize the aircraft on water. Again, the pilot will be able to control how far the skis are extended. Both the amphibious hull and the skis are shock mounted which will absorb water-landing impact ("Multi-configuration Landing…"). They will also allow the VELA to not only land on water, but cruise through it as well. When it comes to snow, the retractable skis used to stabilize the rotorcraft on water will act as helicopter landing skids. Depending on the depth of the snow, the skids can be extended and retracted at different lengths. The skis are "fully raised for dry surfaces, partially lowered for intermittent snow patches on hard surfaces, and fully lowered for deep snow conditions" ("Multi-configuration Landing…"). The extendable skis are also useful for landing on high grassland areas, desert, and shallow swamps. The ruggedness of the design makes the VELA very tolerant of "rough handling in adverse conditions and harsh terrains" ("Multi-configuration Landing…"). This system is extremely beneficial in rescue missions because disaster can happen anywhere and the VELA must be able to adapt to the environment. For pilots who operate strictly from developed and paved landing areas, there will be no disadvantages for having multi-surface landing capabilities since the entire gear assembly is a simple rugged design which retracts into the aerodynamic hull ("Multi-configuration Landing…").

As a tiltrotor, the conversion will be controllable by the pilot. The minimum time it takes to convert from hover to airplane mode is 12 seconds (Pike). During VTOL, the rotors will be tilted up 90 degrees. Also, the telescoping wing will be fully retracted to reduce the drag in VTOL. As the tiltrotor tilts forward to zero degrees and gains forward speed between 40 and 80 knots, the wings begin to produce lift and the ailerons, elevators, and rudders become effective (Pike). For STOL, the tilting of the rotor will be at 45 degrees for takeoff. By using a tiltrotor aircraft, the VELA will be able to take off and land quickly and easily on disaster areas.

VELA's process of conversion

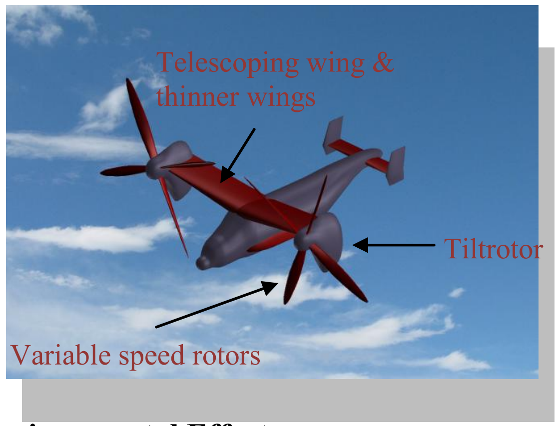
VIII. Speed of Travel

Speed is an essential contributor to the success of rescue missions. Rescue aircraft must be punctual when arriving at devastated areas to rescue as many survivors as possible. Another major capability of the VELA is its ability to fly faster speeds without sacrificing power and efficiency. As a dual-piloted, twin engine, tiltrotor aircraft similar to the V-22 Osprey, the VELA combines the "speed, range, and fuel efficiency of a turboprop aircraft with the slow flight and hover capabilities of a helicopter (Pike). The tiltrotor will make the aircraft easier to maneuver and control the trajectory. Its maximum cruise speed will reach up to 400 knots. This will be made possible by aerodynamics and high lift over drag ratio.


VELA with fully extended wings

The VELA"s thinner wings will reduce profile and compressible drag (Wilkerson). The telescoping wings play a major role in eliminating drag as well. There are two components in wing drag: induced and parasite drag. Induced drag comes from lift while parasite drag is due to surface friction, which means that the greater the wing area or span, the more drag there is. For low speeds, the majority of the drag comes from induced drag, while at high speeds; it comes from parasite drag. So while longer wingspans are favorable to low stall speed, they are detrimental at high cruise speed ("Telescoping Wing…"). Even though the VELA will fly at both low and high speeds, both drags will be minimized because the telescoping wing will allow the pilot to adjust the wing span according to the rotorcraft"s speed. At low speeds, the telescoping wings can be fully extended and at high speeds, it can be fully retracted to withstand high „g" loads ("Telescoping Wing…").

Advanced rotor concepts will reduce main rotor "drag" (Wilkerson). In order to maximize performance efficiency, the VELA will use the optimum-speed system founded by Abe Karem. This system will "allow the helicopter rotor to be operated at an optimal rpm, minimizing the power required to turn it" as well as reducing noise and extending rotor, transmission and engine life ("Look Ahead…"). The system has been tested on the A-160 which demonstrated significant increase in endurance and high drag over lift ratio ("Look Ahead…").



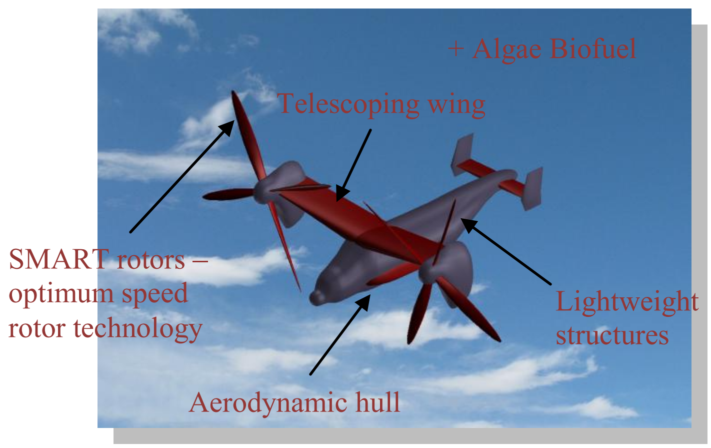
IX. Fuel Efficiency and Environmental Effects

In order to make rescue missions efficient, a rescue craft must have high range. During a mission, an empty gas tank should be the least of the pilot‟s worries. Today‟s aircraft can be even more aerodynamic to eliminate drag, which negatively impacts both speed and fuel efficiency. Modern aircraft are 70% more fuel efficient than 40 years ago, and 20% more efficient than 10 years ago. The goal of any airliners is to achieve an additional 25% fuel efficiency by 2020 ("Fuel Efficiency"). Some may think that being "green" is not an important factor to consider when designing a rescue aircraft. However, trends in new vehicle making lean towards being environmentally friendly. In the future, it is expected that all methods of conveyances are green for the environment, whether it be through eliminating the use of fossil fuel or reducing noise.

The VELA will have a range of 900 nautical miles. This will be made possible through aerodynamics, lightweightness, and greater lift over drag ratio. The greater the ratio, the less the power required to cruise in the air. Even though it is unusual for aircraft to have amphibious hulls at the bottom of their fuselage, it will not cause severe drag. Thus is because the VELA‟s hull is similar to that of a ship‟s hull and both water and air share similar fluid properties. As mentioned before, the telescoping wings will significantly reduce both induced and parasite drag while the VELA is in operation. Furthermore, the pilot will have control over the rotations per minute [RPMs] of the rotor blades at different altitudes and cruise speeds. This capability "not only saves fuel, but also improves the overall efficiency of the rotorcraft" (Iqbal)

Noise levels from rotorcraft can be drastically lowered with the aid of advanced rotor designs. Most helicopters today produce loud beating noises due to air vortices generated at the blade tips of each rotor. When the rotors are spinning, each rotor blade passes through the wake vortex created by the blade in front of it. This cycle translates into a beating noise ("Making Helicopters…"). To eliminate this noise, the VELA will use "smart" rotors similar to Eurocopter‟s Blue Edge rotor blade. This system uses flap modules in the trailing edge of each rotor blade. Piezoelectric motors actuate the flaps 15 to 40 times per second which reduces the beating noise (Paur).

The VELA will be powered by Algae biofuel. Many alternative fuels have been tested on various vehicles. However, the most anticipated alternative that will be available to replace fossil fuel is Algae biofuel. Test results so far have been promising. In fact, scientists predict that algae biofuel will be available for commercial use in the next 10 years (Lane). There are many reasons as to why Algae biofuel is a good candidate for the future. Algae can produce 100 times more fuel than soybeans in the same acreage and does not compete for arable land (Phenix). They emit lower carbon compared to fossil fuels with 25% less particulate emissions ("Biodiesel"). Growing algae needs a steady feed of warmth, light and CO2 (Henley). Therefore as aircraft and other algae fueled vehicles emit carbon, it will be taken in and used by the growing algae, resulting in carbon neutral outcome (Watts).



X. Operation Cost

Operation cost plays a major role in the development and marketability of the VELA. Though it is promising and will be wanted by many countries, it is still necessary to find ways to minimize the overall cost for minor countries. One of the best ways to do this is to balance luxury with necessity. Although the technologies that will be utilized for this aircraft sound extravagant and high-tech, they are necessary to ensure maximum rescue efficiency. Technology grows so fast that prices go down on certain devices. For example, today some may say that the price of a computer is very expensive. However, by the next year the same computer will be sold for a cheaper price because new computers with more advanced features would have been introduced by then. The same concept applies for the future and the technologies integrated into the VELA. What we consider "Hi-Tech" today will be a basic necessity in the future. Currently, basic GPS systems are available to be used in automobiles for a low price, so the cost of GPS systems for aircraft in the future is negligible.

Fuel efficiency combined with cheap fuel production is definitely a key to lowering operation cost. The bigger the range, the more profitable the VELA will be.

Long life materials and advanced technologies will also ensure that the rotorcraft is low maintenance and high damage tolerant.

XI. Possible Impact on Previous Disasters

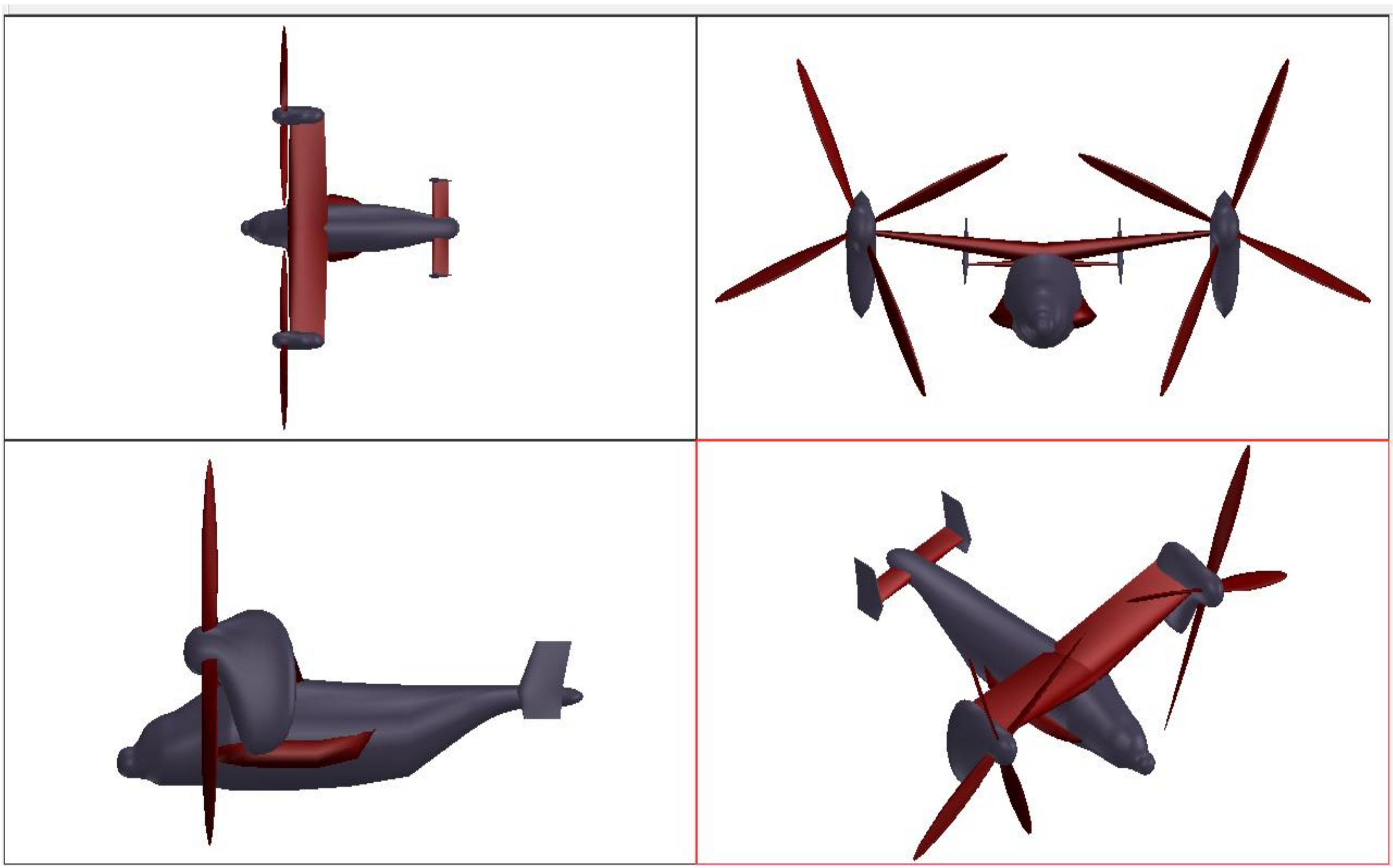
In recent disasters, both natural and man-made, the VELA could have been an extremely beneficial rescue aircraft. With multiple capabilities, this one aircraft can be used in all types of disasters and still be efficient in rescue missions due to its advanced technologies. Finding and rescuing survivors will be quicker by hovering through the disaster area and using the FLIR technology to detect human presence. The high payload will be beneficial as well. For example, if the VELA was used in the 2004 Tsunami or the 2009 Typhoon in the Philippines, then more survivors would have been saved by using the multiple winches to pick up struggling survivors. The VELA could have even landed on water and rescue drowning victims. In previous California wildfires, the VELA could have easily siphoned water from the nearest water reservoir and expel it onto the fire. The advanced, high temperature materials would have allowed the rescue troops to hover closer to the fire and search for possible survivors without experiencing damage. This would have also been useful in saving stranded victims on top of the building during 9/11. In the recent Haiti and Chile earthquakes, the mount system could have easily lifted the debris of fallen buildings in order to save trapped survivors. In addition, sending out relief and support would have been more efficient due to high cargo and passenger capacity of the VELA. Regardless of the disaster type, the VELA will be ready to provide rescue and support.

XII. Conclusion and Recommendations

The VELA‟s design is promising for future rescue missions. It will demonstrate excellent aircraft virtues such as durability, longevity, and profitability. Due to its multiple capabilities, this aircraft will increase the success rate in rescue missions and provide maximum support in disaster areas. The VELA will even be able to adapt to the environment in order to allow rescue in various disasters.

All the ideas proposed have the potential to be integrated into NextGen aircraft. Nevertheless, more in depth research must be done to examine the feasibility of these ideas in futuristic aircraft. For example, researchers must look more into the multiple landing gear idea because this concept seems complex; yet it will be necessary when landing on different surfaces. Environmental effects must also be looked into, to ensure the marketability of the VELA. If the aircraft is not green, then it will not sell in the market. The VELA requires highly advanced technology; therefore, it is necessary to keep up with the trend of increasing technology in order to develop the necessary equipment for the future.

VELA flying over an earthquake disaster site



VELA multi-view

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Works Cited

Banke, Jim. "Future Helicopters Get SMART." *NASA - Home*. Web. Nov. & Dec. 2009. <http://www.nasa.gov/topics/aeronautics/features/smart_rotor_prt.htm>.

"BBC News | ASIA-PACIFIC | Elvis - King of the Firefighters." *BBC NEWS | News Front Page*. Web. Nov. & Dec. 2009. <http://news.bbc.co.uk/2/hi/asia-pacific/1740039.stm>.

"Becoming an Aerial Firefighting Craft." *Firefighting Helicopter*. Web. Jan. 2010. <http://www.firefightinghelicopter.com/FirefighterHelicopterMaintenance/FirefightingHelicopterParts.html>.

""Biodiesel" Fuel Could Reduce Truck Pollution." Science Daily. 16 Mar. 2000. 5 Mar. 2008 <http://www.sciencedaily.com/releases/2000/03/000316070132.htm>.

"Boeing: V-22 Osprey -- V-22 Osprey Home." *The Boeing Company*. Web. Nov. & Dec. 2009. <http://www.boeing.com/rotorcraft/military/v22/index.htm>.

Campbell, Josh, Jay Kruzic, Aindrea McKelvey, K. T. Rao, and Robert Ritchie. "Titanium Aluminides Program." Lawrence Berkeley National Laboratory. 2008 <http://www.lbl.gov/ritchie/Programs/TIAL/description.html>.

"Composite materials." Australian Academy of Science. Nov. 2000. 2008 <http://www.science.org.au/nova/059/059key.htm>.

"Concorde‟s successor." Professional Engineering Magazine : Home. 10 Dec. 2008 <http://www.profeng.com/archive/2008/2119/21190053.htm>.

Day, Dwayne A. "Search and Rescue Helicopters." *US Centennial of Flight Commission*. Web. 05 Jan. 2010. <http://www.centennialofflight.gov/essay/Rotary/SAR/HE9.htm>.

Demerjian, Dave. "GPS Navigation Could Boost Fuel Efficiency on Oceanic Flights | Autopia from Wired.com." Blogs Home - Wired Blogs. 21 Apr. 2008. 7 Nov. 2008 <http://blog.wired.com/cars/2008/04/gps-navigation.html>.

Eggleston, Thomas. *Helicopter Firefighting*. Tech. Print.

"Electric In-line Snorkel Pump for Helicopter Tanker and Method of Operation - US Patent 6209593 Description." *PatentStorm: U.S. Patents*. Web. Jan. & Feb. 2010. <http://www.patentstorm.us/patents/6209593/description.html>.

Firefighting Practices for New Generation Commercial Composite Structures. Tech. Washington: Boeing Commercial Airplanes, 2009. Print.

"Fuel efficiency." International Air Transport Association. 10 Feb. 2009 <http://www.iata.org/whatwedo/environment/fuel_efficiency.htm>.

"Helitankers -." *Wildfire Management Branch - Ministry of Forests and Range - Province of British Columbia*. Web. Nov. & Dec. 2009. <http://bcwildfire.ca/fightingwildfire/aviation/helitankers.htm>.

Henley, Paul. "BBC NEWS | Science & Environment | In bloom: growing algae for biofuel." BBC NEWS | News Front Page. 25 Jan. 2009 <http://news.bbc.co.uk/2/hi/science/nature/7661975.stm>.

Iqbal, Ahsan. "Article: Rotorcraft Design Takes Flight." *Next Generation Manufacturing*. Web. 26 Nov. 2009. <http://www.ngmanufacturing.com/currentissue/article.asp?art=271228&issue=218>.

Kothera, Curt. "Vibration Reduction Methods and Techniques for Rotorcraft Utilizing On-blade Active Control." *NASA SBIR/STTR*. Web. Nov. & Dec. 2009.

<http://sbir.gsfc.nasa.gov/SBIR/abstracts/06/sbir/phase1/SBIR-06-1-A2.10-9284.html>.

Lane, Jim. "Boeing sees biofuels certified for flight by 2013, algae to dominate by 2023; Airbus more conservative :." Biofuels Digest. 15 Dec. 2008 <http://www.biofuelsdigest.com/blog2/2008/07/01/boeing-sees-biofuels-certified-for-flight-by-2013-algae-to-dominate-by-2023-airbus-more-conservative/>.

“LAPCAT-Configuration A2 Vehicle.” Reaction Engines Limited. 6 Feb. 2008 <http://www.reactionengines.co.uk/lapcat_veh.html>.

"Look Ahead Airframes: Sleeker, Safer, Friendlier." *Breaking News and Analysis on Aviation Today*. Web. Jan. & Feb. 2010. <http://www.aviationtoday.com/rw/products/airframes/10931.html>.

"Making Helicopters Quieter: Losing the Beat." *EADS N.V.* Web. 13 Jan. 2010. <http://www.eads.net/800/en/eads_innovation/Innovation_Articles/aviation/heli_noise.html>.

"Multi-Configuration Landing Gear." *Gevers Aircraft - Genesis Triphibian*. Web. Nov. & Dec. 2009. <http://www.geversaircraft.com/ac/landinggear.htm>.

NASA Langley. *Advanced Display Device for Aviation Safety and Operational Efficiency*. Hampton: NASA Langley. Print.

NASA Langley. *Damage and Tamper Detection Sensor System*. Hampton: NASA Langley. Print.

NASA Langley. *Fail-Safe High-Temperature Composite Structure*. Hampton: NASA Langley. Print.

NASA Langley. *Fire-Resistant, Lightweight Electrical Insulation Material*. Hampton: NASA Langley. Print.

NASA Langley. *Fluid Measurement Sensor*. Hampton: NASA Langley. Print.

NASA Langley. *High-Performance Polyimide Insulation Technologies*. Hampton: NASA Langley. Print.

NASA Langley. *NASA Aeronautics Research Onboard Decades of Contributions to Tilt Rotor Aviation*. Hampton: NASA Langley. Print.

NASA Langley. *Real-Time Interferometric Fiber Optic Bragg Grating Sensors*. Hampton: NASA Langley. Print.

Paur, Jason. "Eurocopter Moves One Step Closer to Whisper Mode | Autopia | Wired.com." *Wired News*. Web. Jan. & Feb. 2010. <http://www.wired.com/autopia/2010/02/eurocopter-moves-one-step-closer-to-whisper-mode/>. .

Phenix, Matthew. "Pond Scum Makes Good: Algae as Jet Fuel | Autopia from Wired.com." Blogs Home - Wired Blogs. 12 Oct. 2008 <http://blog.wired.com/cars/2007/08/pond-scum-makes.html>.

Pike, John. "V-22 Osprey: Conversion." *GlobalSecurity.org - Reliable Security Information*. Web. Dec. & Jan. 2010. <http://www.globalsecurity.org/military/systems/aircraft/v-22-conversion.htm>.

Pike, John. "V-22 Osprey: Design." *GlobalSecurity.org - Reliable Security Information*. Web. 2009. <http://www.globalsecurity.org/military/systems/aircraft/v-22-design.htm>.

Schultz, James. Crafting Flight. Washington, DC: National Aeronautics and Space Administration, 2003. 171-173

Slaughter, Scott. *Firestorm: Fighting Wildfires From the Air*. Rep. Web. Dec. 2009. <http://www.abacuspub.com/freepress/Firestorm%20Fighting%20Fires%20From%20The%20Air.pdf>.

Sport Pilot/Light Sport Aircraft "Repositionalbe Landing Gear" Tech. Seaplane Pilots Association. Web. Nov. & Dec. 2009. <http://www.seaplanes.org/UserFiles/File/reposition.pdf>.

Springer, Tony. "NASA - Fundamental Aeronautics Program - Subsonic Rotary Wing - Aeromechanics." *NASA - Aeronautics Research Mission Directorate*. Web. Dec. & Jan. 2010. <http://www.aeronautics.nasa.gov/fap/srw_aeromechanics.html>.

Springer, Tony. "NASA - Fundamental Aeronautics Program - Subsonic Rotary Wing - Materials and Structures." *NASA - Aeronautics Research Mission Directorate*. Web. Nov. & Dec. 2009. <http://www.aeronautics.nasa.gov/fap/srw_materials_structures.html>.

Springer, Tony. "NASA - Fundamental Aeronautics Program - Subsonic Rotary Wing - Research Overview." *NASA - Aeronautics Research Mission Directorate*. Web. 02 Feb. 2010. <http://www.aeronautics.nasa.gov/fap/srw_research_overview.html>.

"Telescopic Wing - Gevers Genesis." *Gevers Aircraft - Genesis Triphibian*. Web. Nov. & Dec. 2009. <http://www.geversaircraft.com/ac/telescopicwing.htm>.

Watts, Susan. "BBC NEWS | NEWSNIGHT | Susan Watts's blog." BBC - Homepage. 11 Feb. 2009

<http://www.bbc.co.uk/blogs/newsnight/susanwatts/2008/10/all_of_a_sudden_algae_is_every.html>.

Wilkerson, Joe. "System Analysis of Technology Benefits to Civil Transport Rotorcraft." NASA Fundamental Aeronautics Program Annual Conference. Atlanta. Lecture.

Other Sources

"Boeing: V-22 Osprey -- V-22 Osprey Home." *The Boeing Company*. Web. Nov. & Dec. 2010. <http://www.boeing.com/rotorcraft/military/v22/index.htm>.

"Engineers Set out to Green Air Travel." *Kerala Website, Kerala News, National News, Astrology, Ayurveda, Malayalam Calendar, Malayalam Greetings*. Web. Nov. & Dec. 2009. <http://www.prokerala.com/news/articles/a112783.html>.

"Erickson Air-Crane Helitankers Dampen Wildfires from Southern California and Canada, to Europe and Down Under |." *Shephard Group*. Web. Dec. & Jan. 2010. <http://www.shephard.co.uk/news/3776/erickson-air-crane-helitankers-dampen-wildfires-from-southern-california-and-canada-to-europe-and-down-under/>.

"ISPUB - Mission Of Rescue Helicopters In Disaster Medicine." *ISPUB - Internet Scientific Publications*. Web. Dec. & Jan. 2010. <http://www.ispub.com/journal/the_internet_journal_of_disaster_medicine/volume_1_number_2_68/article/mission_of_rescue_helicopters_in_disaster_medicine.html>.

"Rostvertol Int'l - MI-26T Firefighter Helicopter." *Rostvertol Int'l - Transport Helicopters - Ambulance Refueler Firefighter*. Web. Nov. & Dec. 2010. <http://www.rostvertol.be/helicopters/firefighter.html>.

Scott, Richard. "BBC News - BA Agrees Deal for UK Jet Biofuel Plant." *BBC NEWS | News Front Page*. Web. Nov. & Dec. 2009. <http://news.bbc.co.uk/2/hi/8515620.stm>.

Springer, Tony. "NASA - Fundamental Aeronautics Program - Subsonic Rotary Wing - Acoustics." *NASA - Aeronautics Research Mission Directorate*. Web. Dec. & Jan. 2009. <http://www.aeronautics.nasa.gov/fap/srw_acoustics.html>.

Springer, Tony. "NASA - Fundamental Aeronautics Program - Subsonic Rotary Wing - Propulsion." *NASA - Aeronautics Research Mission Directorate*. Web. Dec. & Jan. 2010. <http://www.aeronautics.nasa.gov/fap/srw_propulsion.html>.

"V-22 Osprey." *GlobalSecurity.org - Reliable Security Information*. Web. Oct. & Nov. 2009. <http://www.globalsecurity.org/military/systems/aircraft/v-22.htm>.

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