A SYSTEMS ENGINEERING DEFINITION OF THE AIR CRUISE SHIP CONCEPT

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Abstract

This paper formulates the development of large airships capable of carrying groups of people on pleasure trips with the amenities of the modern ocean cruise ship. The argument is advanced that current market forces have elevated this subject from the realm of historians and dreamers to a matter for serious technical discussion. The historical record of airship development in the 1920s and 1930s is summarized to provide the background needed to understand the phases of airship development and the reasons for their disappearance. The application of systems engineering is discussed to give direction for the successful implementation of future air cruise ship development.

Distinctions Between Airplane and Airship Development

Despite the communality of both being aircraft, the development of airships is distinctly different from the development of airplanes. Whereas, the development of a new airplane might require 1000 production models to justify the development costs. A particular airship design needs to justify the development costs after only 2 or 3 production models. In this respect, the development of airships must be viewed in the context of the ship industry and not the airplane industry.

Another distinction between the development of an airplane and an airship is that airship system development must include greater attention to defining infrastructure requirements. The operational environment for airplanes continues to evolve as a system unto itself providing interface requirements designed to accommodate airplane development. But, the absence of airships of the scale needed to perform the air cruise ship mission has left a void in areas such as ground support & handling and air safety.

Phases of System Development

Systems engineering functions as an iterative process by which all aspects of a system are addressed in each phase of a system's development. The progression of phases represents a learning process whereby the mission requirements for a system are accomplished with the objective of minimizing risk and cost. The definition of phases may vary depending upon needs of the customer. For a customer interested in the acquisition and operation of an air cruise ship, system development may be seen in the following five phases.

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Concept Exploration Phase is an evaluation and planning exercise for the accomplishment of basic mission requirements. Activities should include definition of performance criteria; evaluation of existing technology and technology being developed for other systems; exploration of different design concepts; evaluation of production and operation feasibility; establishment of cost limitations based on anticipated return of investment; allocation of resources for the execution of subsequent phases of development; and life cycle analysis of the production air cruise ship system. This phase is primarily a paper exercise; however, some funding might be allocated for technology development and experimentation. Systems engineering organizes the information learned to establish a *structured understanding* to serve as a baseline for the execution of subsequent phases.

Demonstration/Validation Phase is the integration of technology and design concepts to produce one or more airships to evaluate requirements leading to an allocated baseline which defines system, segments, components, and configuration items. Research during this phase should lead to realistic models for life cycle cost and operational effectiveness (performance, reliability, and maintainability). Systems engineering analysis should include analysis of requirement verification methodology.

Prototype Phase is the construction of an airship for the purpose of identifying problems prior to the allocation of a greater amount of resources for the production model. Whereas airships constructed in the *Demonstration/Validation Phase* may have been certified as experimental, the prototype airship must qualify for a standard air worthiness certificate. The prototype airship should be based on the production model baseline with performance modified to minimize development costs.

It is possible that the *Prototype Phase* may be eliminated through careful risk analysis and implementation of systems engineering in the *Demonstration/Validation Phase.*

Production Phase is the construction of an air cruise ship system capable of performing to the established baseline within the defined operational environment. Systems engineering verifies the system requirements independently of design engineering. It is an important cost consideration that development of verification methodology be properly funded during the *Concept Exploration Phase* and the *Demonstration/Validation Phase.*

Operations Phase is the implementation of the air cruise ship system with considerations for the cost to support the necessary infrastructure and disposal at the end of the life cycle. Systems engineering continues to update the *structured understanding* of the system throughout the life cycle. The current production model may then serve as a prototype for future systems. A good example of this practice is the development of new generations of communication satellites.

Although past airships were not built using phases as defined above, the concept of progressive steps is apparent in historical airship development.

Rise & Fall of Golden Age of Airships

War was the cause of both the rise and the fall of the "Golden Age" of airships.

Prior to World War I, the airship and the airplane were in their infancy. The technological advances of each type of aircraft were steady but progressing slowly. The advent of World War I greatly accelerated the development of both types of aircraft.

The most significant achievement of the airship during World War I was the demonstration of the airship as a long range transport. Towards the end of the war, a naval blockade prevented supplies from reaching German forces in Africa. The German military responded with a program to develop a new class of airship designed to carry the needed supplies to Africa. The program was not able to respond in sufficient time to supply the German troops in Africa. However, the airship did arrive in Africa. In November 1917, this airship covered 4200 miles (approximately the distance from Friedrichshafen, Germany to Chicago, U.S.A.) in 95 hours with a fuel reserve for an additional 64 hours. This intercontinental airship carried 22 people and 15 tons of cargo.(1)

After World War I, the German economy was in a period of hyper inflation, an economy ruined by war and vindictive Allied Forces. In addition, stipulations in the Treaty of Versailles restricted the development of a commercial German airship industry.

England was particularly interested in limiting a German commercial airship industry. Influential individuals in England were developing plans for a commercial airship route that would fly to Cairo, India, Singapore, Australia, and New Zealand. An additional route was being planned for flight to South Africa.

The English had been developing their own giant airships during the war. But, England was always far behind developments in Germany. With Germany unable to develop giant airships, England was in an excellent position to lead the world in the development of intercontinental airships. In 1919, The British demonstrated their prowess in airship development by flying the first airship, *R34*, across the Atlantic. Although *R34* had been based on a German design, the achievement of constructing the airship and flying across the Atlantic accomplished the *Demonstration/Validation Phase* of airship development.

At the end of World War I, the United States was still in the *Concept Exploration Phase* of development. The United States interest in airship development was as a long range reconnaissance aircraft for use in the Pacific. During the war, England and France had provided the United States with technical information from two German airships, captured in 1916 and 1917. By 1920, the United States was prepared to enter into a *Demonstration/Validation Phase* which would consist of a plan for four airships, two built in the United States and two built by the English. This program ended with only two airships built, the airships *R38* and *Shenandoah*. The British built airship, *R38*, crashed due to apparent structural problems during her fourth flight trial in August 1921.

The loss of *R38* caused a schism in American respect for British capability in airship design. With the ratification of a peace treaty with Germany in October 1921, the United States was now able to seek German airship expertise.

The loss of *R38* also dashed efforts for a commercial British airship industry. In May 1921, a post war depression forced the British government to close the airship service and dismantle all remaining airships. With the departure of American involvement in British airships, there was no financial support to continue.

The five best German airships that had survived the war were to be divided among the Allied Powers. A group of German airship men did not wish to allow their former enemies to benefit from these airships. In 1919, these German airship men destroyed the airships.

In June 1921, the Inter-Allied Aeronautical Commission of Control determined the punishment for the destruction of the German airships. There had been two airships whose construction was completed by Zeppelin after the war. These airships were in use within Germany providing a regular scheduled civilian passenger air service. As punishment, these airships were seized. One airship was given to France, the other to Italy. Germany was ordered to compensate the remaining Allied Powers for the loss of the airships.

After the destruction of *R38*, the United States wanted the Zeppelin Company to build a new airship. The Americans wanted an airship of 3.8 million cubic feet. But, the Treaty of Versailles prevented the

Germans from building an airship greater than 1 million cubic feet. England and France were initially against the United States going to the Germans for the construction of an airship. After much negotiation, approval was given with the limitation that the airship could not be greater than 2.5 million cubic feet (considered the minimum requirement to safely cross the Atlantic) and that the United States could only use the airship for civilian purposes.

The airship built by the Zeppelin Company for the United States would later be named, *Los Angeles*. The Zeppelin Company personnel believed that this would be the last airship that they would ever build due to hyper inflation and restrictions under the Treaty of Versailles. This contributed to the *Los Angeles* becoming the best airship built of its time. After completion of the *Los Angeles* in 1924, those Zeppelin engineers who desired to continue to work on airships immigrated to the United States to work with Goodyear.

As 1924 saw the apparent end of the airship era in Germany, a change in England gave rise to renew their airship prominence. The British Labour Party, now in control of the government, supported a program to develop two 5 million cubic foot air cruise ships. One ship, *R100*, would be built by a private company. The other ship, *R101*, would be built by a public company.

With the British air cruise ship program more than one year underway, the restrictions on a German commercial airship industry were removed by the signing of the Treaty of Locarno in October 1925. Now the Zeppelin Company only had to overcome the financial barriers.

Over the next 2.5 years, the Zeppelin Company managed to raise 2.5 million marks through private contributions and 1 million marks from the government. This was only enough money to build the airship, later named *Graf Zeppelin*. Because there was not enough money to build a new hangar, *Graf Zeppelin* was limited in size to being an extended version of the *Los Angeles*. *Graf Zeppelin* was designed to carry 20 passengers in great luxury with a 40 member crew.

In September 1928, *Graf Zeppelin* made her first flight. Later that year, *Graf Zeppelin* made her first flight to the United States.

In March 1929, *Graf Zeppelin* flew to the Middle East with the exception of Egypt. The British denied *Graf Zeppelin* permission to fly over Egypt because they wanted either *R100* or *R101* to be the first airship to fly over Egypt.

In August 1929, *Graf Zeppelin* made her historic flight around the world, flying non-stop from Germany to Tokyo via the Soviet Union; and crossing the Pacific Ocean in approximately 79 hours. *Graf Zeppelin* spent the remainder of 1929 giving passenger flights in Germany and Switzerland.

By October 1929, the British finally made the first flight of *R101*. The airship *R100* made her first flight in December 1929. Both ships suffered from a series of accidents, and in the case of *R101*, design flaws that would delay the first of these airships from becoming fully operational until July 1930.

In May 1930, *Graf Zeppelin* made the first trip in what would later become a commercially successful route between Germany and Brazil. The flight carried 38 passengers and took approximately 62 hours. The return flight included a stop in the United States.

By July 1930, *R100* departed for a tour of Canada, her first flight outside of England. Also in July 1930, *Graf Zeppelin* was flying a scientific mission in the Arctic.

In October 1930, *R101* departed England for India after making only one trial flight following the completion of major rework that summer. The flight was being rushed in order to arrive in India before the Imperial Conference on October 16.

Political reasons were also the basis for the decision to select *R101* over *R100* for the trip to India. The two ships had been developed in competition in which the British Labour Party, again in power, hoped to show that the airship industry was best operated under public control. The politics of socialism aside, *R100* was clearly superior to *R101*.

R100 and *R101* were both *Production Phases* of airship development. One of the better airships ever built by England, the airship *R80*, represented the *Prototype Phase* for the people behind the development of *R100*. The ill-fated airship *R38* had represented the *Prototype Phase* for the builders of *R101*. Although failure need not necessitate stopping, or even delaying, the next phase in a system's development, building from success represents a sounder approach for risk management.

In the trip to India, *R101* became unstable while flying over France during a storm. The airship had been forced above her pressure height and lost a significant amount of hydrogen gas. The airship did not crash, but moved slowly across the countryside with very little ground clearance. Confronted by low hills, *R101* was unable to climb and touched down into a hill. The impact was not severe. However, the hydrogen gas was some how ignited. The result was a fire storm from which only 6 people survived.

That fact that *R101* was destroyed in bad weather does not lead to the conclusion that airships are limited to fair weather. *Graf Zeppelin*, *Hindenburg*, *Akron*, *Macon*, and *R100* had many successful encounters with severe storms. Airships have been proven to safely traverse thunderstorms, hail, and blizzards.

The ramifications of *R101's* destruction were profound. England was so aghast from the loss that all activities in airships were abandoned. *R100*, despite being an excellent airship, was dismantled. The funeral for those who died was attended by a delegation from the Zeppelin Company. In appreciation for their sincere condolence, England later gave permission for *Graf Zeppelin* to fly over Egypt. Also as a consequence of *R101*, the Zeppelin Company changed the direction of their *Production Phase* to design future ships that used non-flammable helium gas.

The Zeppelin Company hoped that the tragedy of *R101* would get the United States to rescind the Helium Control Act of 1927 on humanitarian grounds. The only known source of helium gas in the world at the time was in the United States. The value of helium gas for airship application was not realized until nearly the end of World War I. Helium production capability had grown during the 1920s, but helium remained a scarce and strategic resource. The United States continued to forbid the export of helium despite the holocaust of *R101*.

While England and Germany competed for the leadership of a commercial airship industry, the United States entered its own *Production Phase* with the submission of the proposal for flying aircraft carriers to the Secretary of the Navy in November 1925. The *Los Angeles*, which represented the United States *Prototype Phase*, was quickly tasked with a variety of operations designed to support flying aircraft carrier development.

After two design competitions and delays in getting Congress to provide funding, a contract to construct two flying aircraft carriers was awarded to the Goodyear-Zeppelin Corporation on October 6, 1928. On September 23, 1931, the first of these flying aircraft carriers, named *Akron*, made her first flight. According to airship historian Richard K. Smith, "Goodyear created an industrial plant of a magnitude which the airplane industry required almost a quarter of a century to develop." (2)

With respect to the technology of the period, the achievement of the flying aircraft carrier of the early 1930s is on par with the achievement of placing a man on the Moon in the late 1960s. The flying aircraft carrier operated with and contained maintenance facilities for 5 airplanes. The crew consisted of approximately 83 men. During an exercise in 1931, *Akron* performed a mission carrying 207 people, a world record at that time, to demonstrate her capability as an emergency troop transport.

Akron was lost in the Atlantic Ocean on April 4, 1933 with only 3 survivors. *Akron* had been caught in a massive storm front. Following a routine procedure for storm circumvention, *Akron* flew East over the Atlantic Ocean. Unfortunately, a lack of barometric information resulted in inaccurate altimeter readings. Flying in zero visibility, *Akron* met her demise by flying into the ocean.

Three weeks after the loss of *Akron*, the flying aircraft carrier *Macon* made her first flight. *Macon* carried the burden to prove the value of the flying aircraft carrier. The upper echelon of the Navy did not want flying aircraft carriers. Ocean surface aircraft carriers were given only tacit support. These admirals believed that money was better spent on more battleships.

In April 1934, *Macon* suffered structural damage during a flight over west Texas in what may have been the most turbulent wind condition ever encountered by an airship. Under pressure to perform missions to prove the value of the flying aircraft carrier, *Macon* continued to fly without completing repairs.

Procrastination lead to *Macon's* downfall in February 1935. A gust of wind caused the destruction of *Macon's* upper vertical fin. The damage was not sufficient to down the airship. However, a series of actions would follow that left no choice but a forced landing into the ocean off the coast of California. 81 of the 83 member crew survived.

Support for the construction of another flying aircraft carrier was not to be found in the mid-1930s. *Akron* and *Macon* had been hounded by scandals and often unfairly treated by the news media. Without the support of the Navy, Congress would not act to appropriate funding to support airship construction.

By the start of World War II, there was a change in Navy leadership which now supported an airship program. However, a scarcity of resources to fight the war prevented the construction of airships on the scale of the *Akron* and *Macon*.

In addition to military reasons, the supporters of the flying aircraft carriers in the late 1920s hoped that a civilian airship industry would emerge as a result. However, the Great Depression of the early 1930s, coupled with questions concerning airship safety, failed to bring forth sufficient funding for a civilian airship.

A poor economy also prevented the Zeppelin Company from additional airship construction despite *Graf Zeppelin's* commercial success. In 1931, *Graf Zeppelin* made three profitable trips to Brazil. Nine trips were made in 1932 and again in 1933. Twelve trips were made in 1934. Sixteen trips were made in 1935.

In 1935, the Zeppelin Company formed a partnership with the German Nazi Government in order to obtain funding for the airship that would later be named *Hindenburg*. On March 4, 1936, *Hindenburg* made her first flight. Shortly thereafter, *Hindenburg* and *Graf Zeppelin* were used in a Nazi propaganda flight which gave the Zeppelin Company management regret for forming a partnership with the Nazis.

A couple of days after the propaganda flight, *Hindenburg* made her first flight to Brazil. In May 1936, *Hindenburg* made her first flight to the United States. *Hindenburg's* arrival was greatly heralded by the Americans who had not seen *Graf Zeppelin* since 1930. In October 1936, *Hindenburg* took up 101 passengers for a tour of New England organized by the Zeppelin Company. The flight, dubbed the *millionaires flight*, resulted in the formation of a consortium to build four airships similar to the *Hindenburg* for operation between Europe and the United States. One of the major reasons for travel by airship was that passengers did not suffer from motion sickness.

In May 1937, *Hindenburg* exploded just prior to landing in the United States on what was to have been the first of 18 trips for that year. The cause of the explosion will forever remain controversial as being either an act of God or an act of sabotage.

As a result of *Hindenburg's* demise, President Roosevelt pledged in June 1937 to allow the export of helium gas to Germany; *Graf Zeppelin* was grounded; and the consortium order for four airships was placed on indefinite hold. During the next year, Germany changed its entire airship infrastructure to accommodate helium gas and built another airship, later named *Graf Zeppelin II*, to replace *Hindenburg*. However, by May 1938, the political climate of the United States had changed. Fearing Nazi Germany would use the helium for military purposes, the United States continued the ban on helium export.

Graf Zeppelin II flew from September 1938 to August 1939 using hydrogen gas. Although *Graf Zeppelin II* was used in pre-war spy missions, the German military had no interest in airships as a weapon of war. World War II failed to advance the development of airships. The airplane, on the other hand, made tremendous strides.

By the end of World War II, the airplane had become an efficient means of intercontinental travel. The introduction of jet airplane transportation in the 1950s dissuaded investors from funding airship development. The air cruise ship had become a relic of the past.

A New Market for Air Cruise Ships

Airships, as a means of transporting people or cargo, do not exist today because they can not compete economically with airplanes. However, if the objective is not to get from point A to point B, but to experience the pleasure of the journey, then perhaps there is a justification for air cruise ship development.

When turbojet airplanes buried the resurgence of airships in the 1950s, another casualty was the ocean liner. By 1960, the cruise ship, which had been providing intercontinental transportation throughout the world, had all but completely sunk.

It wasn't until the 1970s that a miracle occurred which saved the cruise ship industry. This miracle was the television show, "The Love Boat." Dubbed in many foreign languages, this television show helped the world re-discover the pleasures of cruising the oceans.

From a few hundred thousand passengers in the 1970s, the cruise business grew to attract 4.5 million passengers in 1992.(3) The cruise business is expected to attract 10 million passengers per year by the year 2000. To accommodate this market growth, there are more than 80 new cruise ships on order.(4) In June 1990, one new cruise ship was completed at a cost of $200 million.(5) A 354 passenger ship, *SSC Radisson Diamond*, was built at a cost of $125 million.(6)

It should be noted that none of these ships are being constructed within the United States due to government policy. It has been estimated that this policy has cost the United States more than 500,000 new jobs.(3)

If ocean cruise ships can succeed, then why not air cruise ships?

There has been much romantic appeal by the public for space travel. Yet, the reality is that the astronaut corps will continue to grow but remain an elite group of individuals. The average person will not experience space travel for many decades. However, by combining historical experience with modern capability, the average person could soon experience life among the clouds.

Tailoring the Systems Engineering Approach

Systems engineering is the utilization of tools to develop a *structured understanding* of an unbounded system without constraints on time or cost. Once a system is defined, such as an air cruise ship, the system becomes bounded and the necessary tools may be selected and prescribed to implement a *structured understanding*. A Statement of Work will provide the directives as to what needs to be accomplished. However, the plan to implement the use of systems engineering tools is placed in the Systems Engineering Management Plan (SEMP).

A SEMP should be prepared for implementation of each phase of a system's development. The knowledge and experience of each phase is incorporated into the SEMP for the next phase. Aspects of systems engineering may vary in emphasis depending upon that state of system development.

Modern airships have been under development for more than a decade. Much of the work already performed may be applicable to the development of a *structured understanding* even if the individuals performing the work have had no formal training in systems engineering. This is because systems engineering consists of a large part of common good engineering sense. To get a *structured understanding*, one must identify the deficiencies in the work that has already been accomplished and elaborate upon other areas. In airship development, one area that needs greater emphasis is Life Cycle Cost Analysis.

The majority of airships currently operating were developed with little or no government financial assistance. Commercial considerations require that the airship be placed on the market in the shortest time possible in order provide investors with a return on their investment. The systems engineering effort needs to adapt itself accordingly. Unfortunately, areas such as Life Cycle Cost Analysis and other areas are typically not given adequate resources relative to the size of the system being developed.

Air cruise ships have historically never been successfully developed without government funding. Government has the advantage over commercial development in that the return on investment can be over a greater period of time. By working together, government and private industry might tailor a systems engineering effort better able to provide a long term cost saving for the system being developed.

Sizing the Systems Engineering Approach

How much money should be spent on systems engineering and when should this money be spent can play a critical role in creating an economically successful system.

Figure 1 shows a typical distribution for the expenditure of money over the life of an aerospace system. Of importance to note, the majority of costs occur during the *Operations Phase* of the systems life cycle. Yet, experience on various aerospace systems has shown that almost 70% of the total life cycle cost will be determined from decisions made in the *Concept Exploration Phase*. About 90% of the total life cycle cost will be determined by decisions made prior to the conclusion of the *Prototype Phase*. If short-cuts are performed in the early stages of system development (e.g., neglecting proper concept studies, development of alternatives, trade studies, functional analysis, etc.), the consequence could be orders-of-magnitude increases in production and operation costs that could jeopardize the economic success of the system.

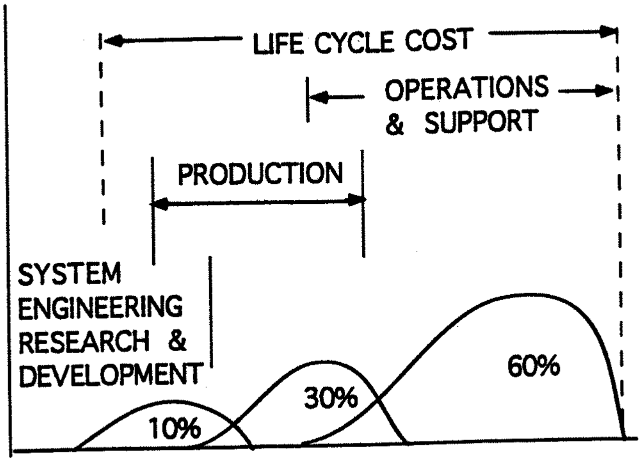

Figure 1 NOMINAL PROGRAM COST DISTRIBUTION

As discussed earlier, systems engineering plays a role throughout all phases of a systems life. But, to be cost effective, systems engineering must play a prominent role in the *Concept Exploration Phase* and *Demonstration/Validation Phase*. The resources that should be allocated to systems engineering during these phases should be at least 10% of the estimated overall cost of the system.

Estimates of the overall cost of the system should be derived from careful market analysis. Earlier, it was mentioned that a single ocean cruise ship can cost between $125 million to $200 million and approximately 80 cruise ships are under development. If market analysis were to conclude that the estimated overall cost of an air cruise ship system would be $10 billion, at least $1 billion should be allocated to systems engineering.

Square One: Defining the Problem

Designing beautiful airships with award winning layouts of accommodations and facilities is a good way to sell airships, but not to develop airships. Systems engineering develops a system by defining, rather than designing, requirements.(7) One way of defining requirements for a system is to a) establish measurables; b) identify interrelationships; and c) perform trade studies to identify sensitivities and key drivers.

When one describes the need for a given system, the description invariably contains statements that are both qualitative and quantitative. Qualitative statements do not provide limitations on design, nor standards by which a design may be verified. To define the problem, the system must be described in quantitative statements only. Measurables are quantitative descriptions of the system being developed.

When getting started, one should not be concerned with obtaining parameters for measurables as much as identifying the types of parameters needed. Measurables should be categorized by attributes such as *quantity*, *quality*, *coverage*, *timeliness*, and *availability*. As an example for an air cruise ship, *quantity* might include the number of passengers; *quality* might include the number of square feet of movement allowed per passenger; *coverage* might include the maximum operating altitude; *timeliness* might include time that the air cruise ship may remain aloft; and *availability* might include the number of days per year the air cruise ship must operate.

Once measurables have been established, the next step is to identify interrelationships with other measurables, external constraints on the system, and derived measurables. An example of an external constraint would be compliance of a government regulation. Derived measurables are measurables that are subordinate to other measurables. Examples of derived measurables would be under attributes such as, power availability or communications capability. A common way of identifying interrelationships is by creating block diagrams with interconnecting arrows.

With the structured understanding taking shape, the next step is to perform trade studies to identify sensitivities and key drivers. Performance and cost are the obvious criteria for decision making. Less apparent is the role of risk analysis.*

One possible trade study for the development of an air cruise ship would be to examine the use of space per passenger on board an ocean cruise ship. This measurable could be related to the cost of ocean cruise ship development in order to obtain parametric analysis that may be applied to determining the size and cost constraint of an air cruise ship.

Although the process of defining the system has been described in a linear fashion, the process is in reality an iterative process. Measurables, interrelationships, and parametrics must be continually reexamined as: new information is identified; and different operational scenarios are explored. At the

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* See Reference No. 7

conclusion, the effort neither provides an optimum, nor a complete solution for the problem. The result can best be described as the *preferred solution*, consisting of system requirements, as opposed to design requirements.[**]

The *preferred solution* is used to establish a baseline for the next phase of development. The associated documentation provides a *structured understanding* to evaluate baseline changes and guide design activities in a cost effective manner.

Conclusions

After decades of absence from aviation, market forces exist that could justify the cost of developing an air cruise ship system. This justification exists provided that the given system can deliver the expectations of people who vacation on ocean cruise ships. Under such circumstances, comparison between airplanes and airships becomes moot as getting from point A to point B is irrelevant.

An air cruise ship system has a better chance of becoming an economic success if at least 10% of the estimated life cycle cost is invested in the application of systems engineering prior to entering a *Prototype Phase* of development. More market research is required to establish the total life cycle cost. However, an investment of $1 billion is a reasonable estimate to complete the *Conceptual Exploration Phase* and *Demonstration/Validation Phase*. As this amount of initial investment is cost prohibitive for the private sector, government investment in air cruise ship development is needed.

The return on investment for government would be the creation of perhaps 500,000 new jobs directly related to an economically stable new aspect of the aviation industry.

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