Airships to the Arctic
Fourth International Symposium

MAKING IT HAPPEN
HELD IN WINNIPEG, MANITOBA October 29th-31st, 2007

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AIRSHIPS TO THE ARCTIC IV

Making it Happen

PROCEEDINGS

Held in Winnipeg, MB

October 29th-31st, 2007

Edited By:

Dr. Barry E. Prentice

Gary Wylie
Dedicated in Honour of Hubert T. Kleysen, Entrepreneur

The theme of the fourth Airships to the Arctic is “Making it Happen”. Thus, it is appropriate that this conference is dedicated to the entrepreneur. History is made by those who have the courage of their convictions to try something new and different. When they are successful, entrepreneurs improve all of society because they grow the economy and the choices of consumers.

As the former Chairman and Owner of Kleysen Transport Ltd., Hubert T. Kleysen has been an outstanding entrepreneur and an innovator. During his long career he has been successful in trucking, railroad building, road building and operating an airline. He holds patents on the forklift of the 5th wheel, a tipping dumping system for unloading potash and sugar beets, and co-engineered an automated spiker for railroad track laying, inventions recognized and honoured by Transport Canada.

Hubert T. Kleysen assumed control of the company in 1960, on the untimely death of the company’s founder, Harry Kleysen. Hubert T. Kleysen expanded the company with innovative strategies for the carriage of bulk products. Kleysen Transport became a leader in the movement of sugar beets, cement, potash and nickel. He was also a pioneer with Canada Post in the shift of the national mail to truck movements. In the 1990s, Kleysen Transport built large distribution centers in Calgary and Edmonton to provide warehousing, overhead cranes, bulk hauling, oil field pipe and steel storage. Hubert Kleysaen also led a private sector attempt to establish WinnPort, an inland air-truck distribution centre. In 2006, Kleysen Transport was sold to Mullen Trust keeping all 1200 employees in their current positions.

Hubert Kleysen is recognized for his contribution to Manitoba as a preeminent entrepreneur in the transportation field. The work he has done in building a successful enterprise, his vision of an inland port for Winnipeg and his many selfless charitable endeavours have earned national respect.

The advance of modern airships has been held back by a lack of business confidence that the market is ready for the technology. Without entrepreneurs to “make it happen” a terrible thing occurs: nothing. This conference is dedicated to entrepreneurs like Hubert Kleysen that make a difference by their personal energy, enthusiasm and creativity.
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Welcome

Russ Wyatt
Councillor, City of Winnipeg

It is an honour to bring greetings on behalf of his Worship, Mayor Sam Katz and all members of Winnipeg City Council to welcome the delegates who are attending the 4th International Symposium “Airships to the Arctic.” I want to congratulate Dr. Barry Prentice. Dr. Prentice has been a leader in our community with regards to the study of transportation and new forms of transportation including airships. It was an honour to work with Dr. Prentice on the Task Force studying rapid transit in Winnipeg. Many of you are probably from cities that have rapid transit. Winnipeg does not at this point and we were studying forms of rapid transit that would be financially feasible for us. Dr Prentice’s work was crucial to delivering a successful report.

Winnipeg has a proud history of transportation that begins with the Assiniboine and the Red River. We were founded at the very heart of the continent because of these two rivers and the fur trade they supported. The cargo business of our City continues to grow and has a future. There is no doubt that you are breaking new ground, and the work that you are doing is not going unnoticed. We are facing some huge financial crunches with regards to infrastructure costs, and the price we are paying for having such a successful and growing economy.

The work you are doing with regards to the Arctic is extremely timely. The cost to build and maintain new roads into the North is astronomical. The greenhouse emissions that it would produce in the process are huge, and we are trying to lessen the footprint we are leaving on our environment.

So I congratulate you for that work. It sounds like there is going to be a lot of exciting news on airships in the future, and Winnipeg should be the center of it. We have developed new industries in the past and we have some very important industrial leaders with us this evening that have done a
lot to grow our City. Airships are going to be part of the future transportation economy and how we extract resources and develop the North.

If you go to the Manitoba Legislature you will see a statue on the top of the building that is called the Golden Boy. The Golden Boy holds sheaths of wheat and he stares out to the north. The reason he looks North is because he represents, youth and vitality and the future. For generations, Manitobans have dreamed of that the north would be a source of income, a source of wealth and a source for growth for the future of this Province. I hope this Conference may speed the development of an airship industry to help deliver the dream embodied in the Golden Boy. Welcome to Winnipeg, Welcome to Manitoba and I hope you enjoy your Conference.
Lighter-than-air (LTA) Technology: A View from Europe

Speaker
Charles Luffman
Aeronautical Engineer, Specialist in LTA Structures

Lighter than air balloons and airships are aircraft. Airships are the biggest aircraft, by size, but the airship industry is the smallest branch of aeronautics. Lighter-than-Air (LTA) aircraft is an emergent industry that is breaking new ground, but is not very well funded. LTA aircraft are environmentally friendly and they can be produced with ordinary skills. They are cost effective and they can fulfill rolls that heavier-than-air vehicles cannot do yet. Despite some nasty incidents in the past they have an excellent record in actually carrying passengers. Consequently, LTA vehicles deserve support.

Lighter-than-air is the first type of aircraft that came into the world. In the 1670s Francisco de Lana presented the theory for the first time about how it would work. It was not until 1783 that the Montgolfier Brothers actually did it. Then there were a series of people who produced other balloons. In 1783 Professors Charles and Roberts filled their balloon with gas instead of hot air. In 1784 Jean Baptiste Meusnier, produced a design that is, fundamentally, the basis of all airships now. He did not actually produce this aircraft, but this design has been around since then.

A series of other experimental airships were built prior to the First World War led by Santos Dumont and Count Zeppelin. A lot of people do not understand that dirigibility means the ability to steer the aircraft and follow a course - the one you determine, rather than the one the wind determines. Santos Dumont’s flight around the Eiffel Tower (1901) proved his powered balloon was dirigible.

The airship industry established a number of milestones in the 20th century. The British airship R34 crossed the Atlantic (both ways) in 1919. This was repeated in 1930 by the R100 airship, which flew from England to Canada. Some other major events that are very important include the Paris airlift (1870), the flight of the Norge over the North Pole (1926) and of course around the world flight of
the *Graf Zeppelin* in 1929. Dirigibles demonstrated that LTA technology has the endurance and capability to cross oceans and reach remote areas.

Dirigible airships are generally classified as rigid, non-rigid, and semi-rigid. New designs have been added to the classic cigar-shape, such as spherical airships and hybrid aircraft. Hybrids combine the aerodynamics of an airplane in a lifting body shape that is filled with helium to enable aerostatic lift.

Non-rigid airships do not have any internal structure to make their profile. The non-rigid has an envelope full of gas that is pressurized in order to stabilize the membrane that forms its shape. The tail surfaces, gondola and engine systems are supported from the membrane structure.

The rigid airship has an internal structure that is covered with fabric. The individual gas bags that contain the helium are held inside this structure. The gas can be put into the bags of a rigid airship in stages, whereas the non-rigid airship has no compartments, as it is just one big bag.
The semi-rigid dirigible is a halfway stage. It has a keel that runs the length of the airship and an envelope full of gas, but the envelope does not have any structure. The keel structure holds the tail surfaces, gondola, engine pods and the nose.

There is a vast range of different types of LTA aircraft that can be used and have been designed in the past. The Spacial MLA-32-B Tocula is a Mexican design with a lenticular form. The lenticular form in their arrangement is unstable and needs tail surfaces that make it fundamentally into a lifting body. The Megalifter was a Boeing design from the 1970s where they put some wings on an airship body. The Cyclo-Crane and the Aerocrane are twins where one rotates on a vertical axis and the other rotates on a horizontal axis. The Cyclo-Crane wings give lift and direction like cycloidal propellers. As the body rotates, the blades could be angled to different directions to cause thrust to move the vehicle along. The Aerocrane was used the other way, to give lift, with standard engines to propel it forward.
The Aereon 26 is a hybrid type of vehicle that was designed in the 1970s and did fly briefly\(^1\). The Dinosaure is another lifting body, developed in France, but only as a model that flew around inside the hangar. The PA-97 Heli-Stat (1986) was an airship envelope filled with gas that had a series of helicopters attached to a frame. There were 4 helicopters: two on each side. The helicopter rotors gave enough thrust to lift a heavy load. The theory was tested, but the Heli-Stat shook itself apart on its maiden flight and one crew member was killed.

The Magnus Aerolift LTA 20-1, which was a Canadian project, used a different type of lift, called the Magnus effect. The sphere, which is full of helium, rotated to pass the air flows over it creating a pressure differential and additional lift. The idea was tried out on a remotely controlled model that was flown in a hangar. The Tentai III is Japanese design that had a sort of donut shaped envelope full of gas and a rotor in the middle to draw the air down for additional lift.

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\(^1\) A book titled the "Deltoid Pumpkinseed" explains the development of the Aereon.
Lots of ideas for LTA vehicles have never been properly tested. Some of these machines, one might say are contraptions that do not have a chance. A failure mode effects analysis on some of these designs would find unacceptable risks. For example, on the Heli-Stat, if one of the arms broke, it could cause chaos (which, tragically, it did). So while there are many different ways to do something, not every way is a good way. They all have merits and they all have disadvantages. The compromises have to be studied very carefully through research and testing, before actually deciding on an airship design.

Hybrid Proposals for Transport

**Lockheed Martin (LM) – P-791**

**Claims:**
- Don’t need ballasting or a mast and mooring arrangements.
- Can hover & STOL.
- Don’t need much infrastructure (such as hangars) for support.

**Prospective Concepts – Stingray**

**Ohio Airships – Dynalifter**

**RosAeroSystems DC-N1**

**Worldwide Aeros Corp – Aeroscraft**

**Millennium Airship – SkyFreighter**

**Advanced Hybrid Aircraft – Hudson Aerial Freighter**

Hybrid Aircraft are in vogue at the moment because they are thought to be a good way for transporting freight. I say at the moment because several hybrid concepts have been explored already, but none of these designs have been properly tested. A number of models and test vehicles have been produced and, some are quite big, like the *Lockheed Martin P-791* and the *Dynalifter*. Hybrids need to move through the air to get lift when they are carrying a payload.
Design Considerations

Of all the different types of LTA vehicles, which is the best? Small airships are best made non-rigid. It is a fundamental aspect of size that a rigid structure is difficult to make light enough at a small size. It does not become efficient until it is quite a large airship. Airships, in general, do not become efficient until they are large. This is a problem because it is expensive to build a big airship and investors have to have confidence that it will have a market. People who are building small airships are having a problem to make them economic because of their size and design issues.

Would you make a very large airship a non-rigid? It is possible with modern, very high strength materials that are now available. You could make them as big as the Hindenburg, or bigger if you want to. But would you do it? These questions have to be asked.

When airships are large you have to give consideration to filling them with gas. Compartmentalization of the gas bags, as in the rigid airship design, allows the gas filling to be staged. The non-rigid design does not afford this luxury. The CargoLifter CL160 that was intended to be built in 2002 would have contained 550,000 cubic meters of gas. At the time, this was half of Europe's annual demand for helium. Where does all the helium come from and how is it accumulated? The logistics would mean building a gas storage system to fill the airship. These technical and economic issues are solvable, but they are aspects that need to be considered when designing a lighter-than-air ship.

There are some very basic principles involved in LTA aircraft: the gas laws, buoyancy, which was developed by Archimedes, Euler’s fluid flow dynamics and of course Newton’s equations of motion. These principles are used by the engineers in the design stage.

The buoyancy from the displacement of one cubic meter of water is one metric ton. The displacement of air by the same volume of helium will lift only one kilogram. So there is a thousand

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2 In stratospheric applications, developers have gone straight to designing an airship in the stratosphere with a classic form. The classic form is not necessarily the best type. It is a form that has been a preconception of heavy lift transport. Each type of airship needs special consideration to suit their roll.
times difference between what you can achieve with water. This is why submarines are very effective, compared to what we can achieve in the air with an aerostat or an airship.

Airships obtain buoyancy by displacing the air. Air can be displaced with a number of gases. Hydrogen is the best, but unfortunately it has a bad safety record. Helium is very good, almost as good as hydrogen with respect to lift, but its cost is very high because it is a rare gas. Steam can be used, which is not very well known, but carries the risk of scalding. Methane is very bad because it is flammable and the resulting lift is not so good. Ammonia stinks a bit, and the lift enabled by it is even worse. Finally, hot air can be used in balloons and hot air airships. Hot air facilitates very poor lift and energy is required to heat the air, whereas gases enable floatation without any input. Its advantage is that hot air can be vented or allowed to cool to control buoyancy.

These gases can be used in combinations. An airship might use helium as its main source to enable lift and use another gas for a different reason. For example, hydrogen could be used for fuel. Hot air could be used to change buoyancy as could steam. Heat would give the airship a way to vary the lift that could replace ballast.

Gas management must be considered in the design of these aircraft. The airship must be able to maintain or adjust pressure, temperature, volume, movement and perhaps central buoyancy. Liquid faction systems generally are not used due to system weights and complexity of helium compression. Large vent valves, about a meter diameter, are needed to control the pressure. Valves that work properly are tricky to design. They have to basically snap shut and snap open exactly, at the right moment – under very small changes.

The maximum volume of an envelope is fixed, but airships are not completely filled with gas. The gas must be able to expand or contract, so some air is contained in an inner compartment called a ballonet. The position of the central buoyancy can be adjusted by moving the gas around. Ballonet may help the airship adjust its trim and pitch into a level attitude – but only at low altitudes.

An airship can also use aerodynamic means and vectored thrust to obtain lift. The airship can use mass change, in other words dump water ballast, or vent gas to change the lift. Buoyancy is a gift rather than an impediment, because it enables one to float without power, and without movement.
Water is generally available for ballast in an airship and it is easier to manage than putting fuel in an airplane. The fuel system is far more complicated because of its explosive medium.

Once an airship becomes buoyant and is flying through the air the pilot has to be able to control the aircraft. Fundamentally, dirigibles are not stable in the air. They tend to pitch or yaw and consequently they need tail surfaces to stabilize them. Designers do not make the tails as big as they need to be because they would be too heavy. So we have to do the analysis and calculate what would be acceptable. The instability is slow to develop, so the airship can be allowed to be a little bit unstable and let the pilot/avionics control the instability. When an airship is going through the sky, it may have a tendency to porpoise. If the pilot lets go of the controls it may start to go into a left or right turn. Once it goes into that turn it will continue in a circle in a stable situation. The airship would not come out of the turn until the pilot puts opposite force to control it again. The gas may also be moved around to adjust the center of buoyancy that will allow some control as well.

**Issues with LTA aircraft**

Airships are as light as air and because of it they are a bit fragile. They are also subject to the disturbances of the air, so one has to always pay attention to the weather. This is not unusual for aircraft, but it is a sensitivity of LTA aircraft that one must pay attention to.

The public’s perception of airships is poor. It would be nice if we could improve that perception and the level of development investment which is almost nothing.

The rules for certification are stringent and that is necessary because airships are aircraft and they must meet aircraft rules. The problem is that meeting the standards of aircraft rules when the industry is trying to develop makes it more difficult for the technology to emerge. When the heavier than air industry was developing they did not have such stringent rules.

Of course no one is left that worked on the giant airships of the 1930s. There are no engineers these days with the knowledge of the old airships, only historians. Practical engineers with airship experience are few in number. The infrastructure also does not exist very much and needs to be developed.
Those are some of the general problems; let’s look at a few more specific to Canada where there are cold conditions. Snow is a problem for airships, if it accumulates. As the weight of snow increases on the top surface, the center of gravity of the whole airship rises. When it gets to the center of buoyancy the whole aircraft turns over and rolls the opposite way up.

This actually happened in 1985 in Japan, where I went to repair the damage to the airship. As it overturned it hit the tail surfaces on the ground and turned right upside down. The snow came off and then because the snow was off, the airship then rolled the other way. Due to momentum the airship then carried on creating more damage. Airship operators must pay attention to the weather and get the snow off.

Handling and mooring is not a big deal, it has been worked out long ago. In the picture of the large Zeppelins nobody is rolling around or panicking. There are lots of people on the ground with the airship next to them and nobody is being hurt. Its under control, it is not on a mast. In the top right corner the Zeppelin is being drawn up to the mast and the nose probe is going into the cup on the top of the mast. Once it is on the mast the airship just swings like a weather cock: it just goes around or up and down if the wind causes it to. It freely moves and this is always the best situation for an
airship because it has a very large profile. An airship with wind on the side cannot be held because the forces are enormous. Using the least energy principles to hold it from the nose and let it do what it wants is the best way to handle it.

In the 1930’s, the big airships had large ground crews. A hundred or so people were needed to move the airship. These days we would use mechanical methods that were developed from the 1940’s to 1960’s, principally, by the U.S. Navy’s non-rigid fleet.

Certification is controlled by the National Airworthiness Authorities. In Europe it is controlled under EASA, which is the European Aviation Safety Agency. The EASA was only recently set up and has not developed their airship regulations yet. They do have some codes that are in preparation for small airships and balloons. Regulations need to be developed for large airships. Certification has an implication on cost. As a rough rule of thumb, it costs about 1000 euros per cubic meter of displacement. Some people who are developing airships might take issue with this number, but it is a rough guide of how much money is involved. Developing a very large airship involves many millions for certification.

In addition to certification costs, airship builders need to consider the cost of purchasing equipment, constructing hangars, and training operators. The heavier-than-air aircraft industry has airports so the aircraft manufacturers already have handling methods ready for them. The airship industry has to develop equivalent ground handling systems.

Airships have advantages that make their costs worthwhile. They have very long endurance because they float without power. I was involved on an airship design that would patrol the oceans for a month at a time without landing. These extended missions are only possible in an airship. They can hold a geo station position very easily. This is why people are looking at stratospheric applications.

Airships can hold a station at any altitude. So they might provide a platform at a lower altitude, over the city for example, for the police to use. They have low noise and emissions, low fuel consumption; they can remain afloat in the sky if there is a power failure. Airships make very good camera platforms because there is very little vibration. People are looking at geo physical examinations with sensitive instrumentation because of their low vibration and their large size,
where sensors can be put out on the extreme positions. They have a very gentle ride and very good visibility.

Question 1 – What is the highest payload airship?

Answer 1 - The *CL160* was being designed to carry 160 tons but of course this project was never completed. The Cargo Lifter is being revived and they may yet come out with a new design.

Question 2 – Why are airships unsuitable for fighting forest fires?

Answer 2 - Fundamentally, the lift comes from the air not from the helium. The airship gets lift because of the air it displaces is heavier. If the air is hot, it has less density and because it has less density it has less lift when you displace it. The amount of gas you have in the envelope is fixed; you cannot displace more air with it. In the hot air over a forest fire the lift would go down and the airship may fall out of the sky.

Question 3 – Why are airships so sensitive to weather conditions?

Answer 3 – It depends on the situation. If the airship is on the ground then it is in a vulnerable situation. If it is in the air, the airship has a better situation. The pilot does not have to force the airship through a thunderstorm. If he knows where it is, he can use the circulation effect to get to where he wants to go. The minimum solution is to drift with the wind; a balloon which is drifting with the wind feels no effect. When the airship is resisting the wind on the ground it is a different thing all together. Airships of the classical form must use a minimum energy solution to resist the wind which is to hold it on a mast by the nose.

Question 4 – What do you see for the future of large airships?

Answer 4 – It is possible to make airships as big as the old rigid airships, non-rigid these days. Materials like nylon and kevlar could be used, but they are subject to ultra violet light degradation. There are better envelope materials that do not degrade as quickly in sunlight and it is quite possible to design an airship to the capacity of 500,000 cubic meters, which would be two to three times the
size of the Hindenburg. The problem is putting the gas in and managing the manufacture of the airship. The airship has to be assembled. If all that gas is put in when it is just an envelope, the vehicle has lift already. The airship must be held down until the gondola, engines, and other parts are added that would normally counterbalance the buoyancy. Lift becomes an issue in manufacture that needs to be managed and clearly this is managed best in a suitable hangar where all other forces are neutralized.

Question 5 – What are the limitations on the size of non-rigid envelope?

Answer 5 – With modern materials, there is no known limit to how big an airship can be made. The more important limitation is the size of the hangar available for its construction.
A Bird’s Eye View of Riverbank Erosion

Speaker
Dr. James Blatz
Associate Professor, Civil Engineering, University of Manitoba

It is a pleasure to be here this evening. My background is Geotechnical Engineering that considers all aspects of soil behaviour. The specific talk I am giving tonight is on the application of the use of an aerostat to study riverbank erosion in the City of Winnipeg. The title of my presentation is “A bird’s eye view of Riverbank erosion.” This is a very valuable application, where the Aerostat has provided a solution that was not previously available. The City of Winnipeg is a leader when it comes to dealing with asset management of Riverbank property. The activities of the Riverbank Management Committee and the Waterways Engineer are being watched by other major centers that have riverbanks as well. The City of Winnipeg owns approximately 240 kilometres of waterfront property. The 49 city owned riverbanks that were identified in the riverbank asset management report are valued at $100,000,000 (year 2000 dollars).

St. Vital Park is a classic example where the City has lost a significant piece of property to riverbank erosion. There is also infrastructure at risk in the form of potable water and water mains in other areas. The bridge pictured in the photo had to be removed. More parkland area is being lost on a continuous basis.

\[3 \text{ I want to acknowledge Don Kingerski, the Waterways Engineer at the City of Winnipeg who has been instrumental in supporting this work. The Riverbank Management Committee of the City of Winnipeg is also to be commended for their support. The graduate student, who conducted a lot of the work, is Leanne Fernando. She is now a Dam Safety Engineer at Manitoba Hydro.} \]
An article in the Winnipeg Free Press in 2005 outlined the river’s toll on private homeowners as well as the City of Winnipeg, and it really demonstrated how incredible the impacts are right after a flood event. How do we stop these riverbank failures from being so aggressive? We often look at engineering studies to examine how to best remediate riverbanks. But those are one off solutions that really don’t give us a sense of perspective of the behaviour of the entire riverbank system, or how to solve these problems. We often look at how we can reinforce the riverbanks. An analysis is usually based on the existing geometry and ignores the longer term effects. Even though we might stabilize the riverbank, how are things going to change as erosion occurs up and down stream of the repairs? We often ignore erosion quantitatively, even though we know it will occur. This project is intended to examine that and the impact of flood events.

Numerical models depict in a theoretical sense what we understand about riverbanks. We can understand how they fail as a snapshot in time, but we do not see what is happening down below as time goes on.

Erosion is very difficult to quantify, theoretically or empirically for that matter. This study is directed at trying to do that. For the first time we are trying to develop some predictive tools, so we can quantify how flood events are going to change the riverbanks and lead to instability. If we can quantify erosion and its effect then we can understand how the river is going to move and change with time.

A key question is the annual reduction in the factor of safety for a typical riverbank. The factor of safety is a ratio that describes the resisting forces over the driving forces. If the resisting forces are equal to the driving forces the factor of safety ratio is unity and the riverbank fails. We use that as a gauge to assess what is going on with the riverbank and how close a riverbank is to failure.

We know floods impact erosion empirically but we do not have any definitive tool for predicting the magnitude. Is the size or the duration of the flood more important? How effective are remedial measures in comparison to natural conditions? What are we really getting when remedial measures are put in place?
The summer flood of 2005 were relatively long duration and with modest peaks. They had a traumatic impact on a number of properties and city owned riverbanks. This was in contrast to the typical short duration high intensity spring flood conditions. So the research plan was to establish a theoretical basis for erosion of cohesive soil, determine the necessary material properties to assess erosion, predict erosion and change in riverbank geometry and therefore stability, and of course verify predictions with field evidence.

Fluid shear stress at the river bed initiates particle movement and causes particles to be suspended in the water such that they are carried downstream. The critical shear stress is a material property. When flow over the riverbed reaches the critical shear stress and particles start to move, erosion occurs. How does that translate into an erosion rate we can use to look at the change of the banks? The velocity of the water at the interface with the channel bottom is what generates the erosion. In the cross section diagram, as the flood goes up so does the magnitude of the shear stress at the river bed and erosion takes place. The deeper the water, the higher the shear stress at the river bed surface.

So we know what generates erosion but how can we determine when the soil in a riverbed is going to start to move? An instrument called the Erosion Function Apparatus (EFA) can be used. A tube of soil is put into the EFA and water is run over it to determine when the soil starts to erode using a light probe. A number of tubes of material from the banks of the river were tested with the EFA to determine the rate of erosion change as the water was passing over it at different velocities to
calculate an erosion curve. The key velocity value is the critical threshold shear stress value where initiation of erosion occurs once exceeded. After that velocity is exceeded the rate of erosion increases notably. By multiplying the erosion rate by the time over which the erosion in occurring, you can assess the total erosion. Now predictions can be made regarding the impact of erosion on the riverbank.

What is the other piece of the puzzle? Measurements of river hydrographs, which provide the water surface level, can be used to determine the water surface level at any point in time. From a series of points along a slope, the river level can be determined on any given day. We can back calculate the velocity and knowing the critical shear stress, we can determine if this has been exceeded and estimate the magnitude of the erosion.

It is always wonderful to do things in a lab, but how do we verify that the proposed method is actually going to work? We obtained historical cross sections at a given location along the Red River. The distance between the toe for a given reference water surface elevation represents the erosion. Over a period of almost a hundred years only three different surveys and three sets of air photos could be used to determine whether or not what we predicted with our lab results was in fact meaningful from a physical standpoint.

We compared our predictions from the lab using our numerical methods with the surveys and aerial photography and of course these theoretical results match the practice perfectly. Do we now have a flawless method for assessing erosion rates? Of course this is not the case. Riverbanks do not erode
at the rate shown in the geometry, however we can calibrate the erosion curves to fit our field measurements. We need better information from the real world. We identified a number of problems with the way the tests were conducted. It is very difficult to replicate conditions from the Red River in the laboratory. We needed to move out of the lab and get into the field and start working at a scale where we are actually looking at these riverbanks as a system.

We can now link different flood events that were known to be major erosion events. This is the first time we have been able to do that with any sort of confidence. This is not perfect. We need to do a lot more to better define the erosion processes but we are at least now getting down to a first step. What this really did was to demonstrate that aerial photography is key. We need to get more photos, we need to get better photos and we need to get them at times right after the riverbanks fail.

We needed better data regarding the transient erosion from the field and this is where we introduced the geo aerostat. It was purchased from a company called the Blimp Guys in Ontario. The aerostat is 21 ft in length, 7 feet in diameter and holds 450 cubic feet of helium. The lift is 18 pounds and the payload is only 6 pounds according to the design specs. I can tell you, without question, the payload is much greater. Outdoors at 150 to 200 ft in the air and a relatively consistent wind the lift from the aerodynamics is quite remarkable.

This is what it looks like when we are getting it together. We have unravelled the main component of the aerostat. They have a very simple configuration to set up the fins.
We are just starting to fill it with helium and it is starting to take shape. This point was about 30 minutes in. This is the first time it ever came out of the shipping package. It is quite a simple procedure. The fins are all lined up but they do not actually go together until the aerostat is nearly blown up. It started to get up in the air after about one hour.

The camera assembly (circled) is the piece we attached down at the bottom.

The camera assembly has two servo control arms. It can turn in the horizontal plane as well as in the vertical plane. Vertical photos can be taken straight down which is traditional aerial photography. It can also turn to take perspective shots from different angles that are really quite useful.

The aerostat launching, in the atrium, was a huge success. It provided an opportunity to get used to the camera assembly and the equipment. The big test was to take it out to the riverbanks where it is meant to be deployed.

We have a heavily instrumented riverbank location. We can see what is going on with the water levels and the movements. We inflated the aerostat in the same manner (it only took 40 minutes the second time). A team of graduate students were on hand because we were not sure how it was going to handle in the wind. We had some pretty heavy weights as an anchor because we recognized early on that the payload is greater than the specifications. The camera technology allows storage cards up to 16 gigabytes. It takes about 30 seconds to get the aerostat up 200 feet and about the
same time to get it down. We can quickly reel the aerostat down, take the pictures off the card, erase the card, send it back up and start again. It also works with a digital DVD camera that provides full motion video.

This data are tremendously valuable. From the riverbank we can obtain high resolution digital photography. It is all geo referenced with a GPS receiver on the ground. We have set targets that we can geo reference and tie this into any GIS package.

Groups of pictures can be put together using a digital stitching package. We can very accurately map the top of the bank. This of course is the ultimate goal of why we purchased the aerostat. It is working incredibly well, even in areas that are heavily treed. We are going out in the next couple of weeks in areas where we can see through the trees.

It would take literally weeks, and I cannot imagine at what cost, to fly the riverbanks in an airplane and would be tremendously expensive. It takes a long time to get that organized and goodness knows what is going on with the river the day you want to go out. Literally within the hour you can drive out to the site and have the aerostat in the air. The helium is delivered right out to the site. They will also pick up the bottles when we finish.

We walked up and down a section of River Road Park and obtained a tremendous amount of photography. If a large riverbank failure occurs and the Waterways engineer calls us right away we can have the aerostat deployed in one hour and we can get high resolution photos back within two
hours. We can actually map out an obstruction into the main river flow well before it disappears with the water level. This is a tremendously valuable tool for looking at very recent failures.

The path forward is to develop a riverbank asset management study for the City of Winnipeg. It is going to aid in prioritization of remediation planning. This will be based on physical measurements and sound scientific principles and public policy decision making. The project is funded by the Riverbank Management Committee under the direction of the Waterways Engineer. Ultimately a decision-making tool based on these measurements from the aerostat is going to give them more optimal use of their budget that, of course, is limited. The Aerostat has been identified as an invaluable tool for monitoring riverbanks and measuring erosion features.

Question 1 – Would a remotely controlled airship do a better job than the aerostat?

Answer 1 - Having recognized some of the limitations of the tether, I wish I had bought the remotely controlled airship. It is quite a bit more expensive and that was perhaps the reluctance to put the capital outlay at the start. The grad students get a little nervous when they are standing on the edge of the river and the aerostat is bobbing up and down. Its pull is more than the manufacturer states.

I would love to have the remotely controlled airship but that does open up regulatory issues. When we take the aerostat out we have to report to Winnipeg Control Tower at the International Airport so they recognize where it is and what it is doing. It would be tremendously beneficial to move about and to be able to do more in terms of distance than from just one position. I am working with the University of Calgary, to put in a joint application to do some measurements on the Bow River. If we get a remotely controlled airship for that project there would be a $100,000 worth of equipment attached to study the impact on fish species habitats and so on.

Question 2 – Could you provide specifications on the economics and safety features of the aerostat?

Answer 2 - The Aerostat cost was $3,000. The camera assembly was $2,000 and the camera was $2,000. The helium is about $200 a shot. It is all expelled into the environment after the flight.
We have added a rip patch with a steel tether that is separate from the main tether of the aerostat. If the aerostat starts to take off, the steel tether pulls the rip patch creating a hole that brings the aerostat down on a slow descent.

Question 3 – Where else is photography used in geo engineering?

Answer 3 - We use aero photography for so many applications. It would be wonderful to use airships on projects like construction in the north with respect to highway routing, and so on. The expense would allow you to use the airship to get photographs right away and not have to wait. In Calgary they are using infra red as well. They are looking at differences in water moisture and plant strength as well. These are things that change from morning to evening, it changes depending on the season, and it changes depending on whether it rained last night. They want to get out as soon as these events happen. You cannot be taking photographs with an airplane all these times. An aerostat or remotely controlled airship is really valuable when you want to take photographs from the air of areas that change rapidly.

Question 4 – What are your views on UAV’s?

Answer 4 - When we started looking at the remotely controlled blimps for Calgary, we started looking at UAV as well. We did not get a lot of the costing because we got scared to death at having a $100,000 invested in a small airplane. When you handle the aerostat you feel very confident and comfortable with it. I am sure the remotely controlled one would be the same. If you are cruising along and something happens to the UAV, and a $100,000 worth of cameras and infra red detection equipment fall into the river, it would not be a happy sight. You do not really gain anything by using the UAV. The advantage of the aerostat is to get out in the field when you need to get the photos. With the UAV it would be exactly the same but the risk could be much greater if something goes wrong.

Question 5 – How have the people in Winnipeg responded to the aerostat?

Answer 5 - It created a tremendous amount of attention. They thought we were doing everything from filming a movie to photo radar from the air. People would walk by and ask questions. It was a
big attention grabber. There have been a few people approach me since the articles in the newspaper and asked if we are willing to look at commercial applications. I have a couple of people, a realtor, and someone who wants to take it to the stadium for some use.

Question 6 – Would the aerostat be cost effective for studying flood conditions?

Answer 6 - It would be great to get photos during a flood. The flood is actually the worst time to look at the River because you see so little of the bank. You see the most when the river is at its lowest level. But having said that the flood is also the time when you can see where the water is from a spatial standpoint and get a sense of how it is moving. It would be invaluable but I have not done any costing so I really could not respond to that question.

Question 7 – Could you comment on the impact of wind conditions?

Answer 7 - Wind is critical. You really cannot use this device when the winds are consistently above 30 or 40 kph. At high wind speeds it becomes unstable in terms of the photography. Below 30 it just weathervanes into the wind, especially when you get it above the area where you have gusts. It is incredible how stable it is.
Airships to the Arctic IV Day One:

Welcome

The Honourable Ron Lemieux,
Minister, Manitoba
Department of Infrastructure and Transportation

Good morning Ladies and Gentlemen it is a real pleasure for me to open the fourth Airships to the Arctic Symposium. Some of the people in my Department, the Assistant Deputy Minister, John Spacek, and other staff are here and wanting to hear your comments. I would like to extend a welcome to all of our guests from out of town. I understand the audience includes representatives from Australia to Japan to Germany to the United States, Mexico and the United Kingdom. We also have many people from Canada who are outside of this Province, so welcome each and every one of you. We do appreciate you taking time from your busy schedules to attend the Airships to the Arctic Symposium. This is the fourth conference in Manitoba where we have been discussing airships.

The Province of Manitoba has always felt that airships have a real role to play. Manitoba has many remote and isolated communities and we use winter roads a lot. Regrettably, you build winter roads for a short period of time, spend a lot of money doing it and then they melt. There are a lot of dangers with regard to winter roads. We have had fatalities. It takes a lot of hard work to make sure that winter roads are safe.

When you examine the expenditure on winter roads, you could make a case that it is not very well spent, but what if you do not have any alternatives other than an all weather road, which is very costly to build. The investment to build an all weather road on the east side of Lake Winnipeg, for example, would be in the neighbourhood of half a billion dollars. It takes a huge initiative and a huge commitment to be able to do that. We are certainly looking at whether or not that is the way to go.
We have had a lot of discussions with regard to airships over the years. The Zeppelin Company is going to be here. They toured Winnipeg about 2 years ago. They were impressed with, not only the people here who are very knowledgeable about airships, but that our aerospace industry puts Manitoba in a strategic advantage. We are centrally located in the country and have a trained aerospace workforce that is familiar with all aspects of this industry.

Airships have had quite a history. When the Hindenburg crashed in 1937, it essentially sent the industry up in flames. After the war we had huge surpluses of fixed winged aircraft and it seemed like airships lost their favour in the world. They are starting to make a comeback now for a number of different reasons. There is recognition of the negative aspect that aircraft have on the environment, and that airships would not produce as much greenhouse gas as other aircraft. The environmental benefit is a huge plus and Governments are certainly looking at such issues all the time.

I spoke earlier about Manitoba having a lot of remote and isolated communities. A lot of our First Nation’s people and the reserves are scattered throughout Northern Manitoba. Every year, we build winter roads trying to get into these remote communities within a window of one to two months. If we are lucky, we are able to bring in foodstuff and fuel to last them for the better part of the year. This has been getting more difficult over the last number of years because the seasonal use keeps getting shorter.

We have been working with the Russians and others on the Port of Churchill as an all weather port. This may be still a few years away, but global warming is having a huge impact on our winter road system. We have to look at other ways of getting goods and services into those communities. We are looking at many options. Once, any time you mentioned airships there was this huge, I call it the “giggle factor”, but I really feel we are all past that now. We are talking about airships being viable. When I mention it now I do not get the response that I used to, even 4 years ago. People thought it was a pipe dream and there was no way that airships would be viable. I believe with the technologies we have now, airships could play a huge role with regard to where we may go.

People are here to look at why they are going to be on the market. People knock on Government’s door for assistance, in the research and development or whether is it possible for Manitoba to be a
player in regards to constructing airships. As a Minister, I have to go to Treasury Board, or to my Cabinet to convince people that this is viable and that the money is going to be well spent in research and development, or putting the monies into a company to assist them to do the work. Governments move slow, and corporations that look at airships also move slow, so this is not something that anyone is expecting to happen overnight or even within a year. But a lot of movement has taken place with regards to airships.

I know Barry, you have been talking about airships for a number of years now. I would be remiss in not congratulating you and the organizers of this symposium, the fourth now to talk about this area. You have been really responsible for keeping it up front and in the public eye for a number of years now. One day we will look back on those days fondly because airships will be a reality. We certainly want to be part of that. We were just recently elected last spring as a Government and we have a mandate of four to five years. In those four to five years to come we are certainly looking forward to much more progress being made on this particular file.

The speech I had prepared for me talks about why Manitoba has been important with regard to Transportation. Manitoba has always been a transportation hub. We are served by three major railways, and a great airport that hauls a lot of cargo. We are also home to some of the largest trucking companies in Canada. Manitoba has been recognized as a transportation gateway for many decades. At one time, Manitoba was looked upon as the gateway for goods coming from Eastern Canada to the developing Western Canada. We have positioned ourselves over the last while as a gateway to North America for the World. People from India, Russia and China are looking at how to get goods into the heartland of the U. S. or into Ontario much quicker. There are backlogs in Vancouver; there are backlogs at Long Beach, all the ports on the west side are backlogged. This is why people are looking at Churchill as a viable port to come into Canada.

The reason I mentioned this is because Manitoba has people that have been involved with transportation and moving goods through Winnipeg for many decades. This is our history.

What is going to make airships viable is a vehicle that can carry 50 or 70 tons of goods, around our Province. I understand people will look at maybe, a twenty ton airship to start. I understand this varies from company to company and people who are promoting airships. We do have a trained
workforce, we have the aerospace industry, there are many reasons why this could be the center for airships. I would personally like to see that.

It is going to take a lot of work on behalf of companies to make sure that airships become viable. I believe this is the 3rd or 4th time that I have had the opportunity and pleasure to speak at the Airships to the Arctic conference. Every year we seem to move a little bit closer to the goal of viable airships. A lot of research is taking place and many different companies from around the world are looking at how to take advantage of airships. There has to be a market for them in Manitoba because we have a lot of remote and isolated communities. The fit for airships in those communities, is a good one.

Premier Gary Doer passes along his regrets that he is unable to make it this morning. As Minister of Infrastructure and Transportation representing our Government in this particular portfolio, I have to tell you how supportive I am personally and how supportive our Government is with regards to airships. We do not know where all of this is going and where this issue is going to land, quite frankly. In the years to come, we believe it is going to be positive and we look forward to working with the aerospace industry in Manitoba, and outside the Province. Also, with Barry, we have a great Transport Institute located in Manitoba that we work closely with and I know they are doing some research in this area as well as other transportation areas that we work with them closely on.

So having said that I just want to say enjoy yourselves in Winnipeg. It is great to be talking about airships, but this City has a lot to offer for visitors and guests coming to renew friendships, make new ones, make new contacts and share ideas. You all have one thing in common; a vision for the future of where this technology might go.

There have been many other examples of where people believed that, a new idea was just talk. No matter what the idea was. Airships are at the point where a lot of research is happening with regard to the viability of airships. We are on the cusp now of really doing something with regard to airships overall. I look forward to coming back again, Barry, I really enjoy this. It is a pleasure for me to have talked to a number of people in the room in regard to airships. You can see the passion people have for airships the moment you start talking with them. Welcome to this great Province and the City of Winnipeg. Keep up the great work. The progress we will make in the years to come will
really bear fruit. Thank you for inviting me, I thank you once again Barry and congratulations to all the organizers.
Session One:
Logistical Challenges in Resource Extraction

Forest Product Transport in Manitoba

Session Moderator
Eric Hinton
Golder Associates Ltd.

Speaker
Richard G. Gibbons
Forester, Tolko Woodlands Forestry Department
Tolko Industries Ltd. - Manitoba

I would like to thank Dr. Prentice and the Committee for inviting me to this conference. I am one of the people that were referred to yesterday in the opening remarks on lighter-than-air technology. Until now I had dismissed airship technology as having little practical application for Tolko and its forestry activities. Perhaps this conference will revise that opinion.

I am a professional Forester. My activities, center around the development of best management plans for Tolko industries for use in our harvest management activities. I spoke to Barry before the Airships to the Arctic Conference about our transport issues. Not being all that cognizant of the airship business, I did not see a lot of relative applications. When I was talking to Barry, he suggested there would be a lot of people in this room that may not know about forestry and how transportation applies to forestry. So my remarks will start with the big picture of forestry in Canada and slowly drill down until we get to Tolko activities in the province of Manitoba. At that time, I will elaborate some of our concerns, and issues that we have transporting raw product from the resource base to the mill site.
Starting with the big picture, virtually 100 percent of the area where Tolko operates is within the Boreal shield area. The Boreal forest is a circumpolar band of primarily coniferous trees that extends across the sub-arctic latitudes of North America, Russia and the Scandinavian countries. It accounts for 25 percent of the world’s closed canopy contiguous forest.

It plays a significant role in earth’s environmental balance as a great producer of oxygen. The Boreal Forest is also playing an increasingly important critical role in reducing global warming. Canada’s Boreal forest area represents one third of the forests and occupies 35 percent of our land mass. It lays between the grasslands/mixed hardwoods and the tundra.

The Boreal forest has been adapting to natural disturbances including the impacts of the ice, wildfire, insects and disease for the last 3 million years. The forests took on their present character approximately 5000 years ago, and have been evolving ever since. It is extremely well adapted to the natural agents of change, like fire and insects, and lately the forest has had to handle the influence of man.

For those who like statistics, a few facts about forestry in Canada. Annually less than 1 percent of all forests are harvested in Canada. The export value in Canada of wood products was $41.9 billion. Overall forestry contributes to roughly 3 percent of Canada’s gross domestic product. Canada is the world’s largest forest products exporter and represents 15 percent of the world trade. Export markets account for 54 percent of production in Canada of which, 80 percent goes to the United States. The domestic market, (45 percent) generates revenue of 78.3 billion dollars. In 2005 the forest industry generated 12.5 billion in salaries. The forestry industry accounts for over 860,000 direct jobs which is 5 percent of all the jobs in Canada.

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4 These are sourced from Statistics Canada and are current to 2005-6, which is the last year they have compiled and released records.
Evolution of forest harvest methodologies

Early logging was a physically demanding job. It was very labour intensive, based on hand tools, livestock and small equipment. As technology and experience evolved, larger diesel powered electro-hydraulic mechanical equipment were developed. Mechanical harvesting increased productivity through the efficiencies of scale and the reduction of effort.

Effective planning, responsible management and improved operating techniques are reducing our ecological footprint in the forests today. Gone are the times when the forest industry would stake a section of forest and harvest what or how they felt best. As a forest manager today, I am required and committed to managing the forest to supply my needs, which are fiber, concurrently with the needs of other forest users.

These pictures come from the National Archives of Canada. The upper left hand corner is a team sleigh hauling on an iced winter road. To the right is similar type of transportation, but with wagons in the summertime. The logs lying on the road are called corduroying. It is an attempt to strengthen the soil for the repeated passing of heavy wagons. The self-gripping tongs on the lower left are an example of the equipment used to move logs around. On the right hand side is one of the first mechanical power sources, called a donkey engine. They were wood fired, steam powered boilers that were used to run mechanical winches.
A certain amount of rafting was also done in this province. The next pictures were taken in the early 1900s of The Pas Lumber Company. In the top picture is a train used to haul logs to the side of the river. In the spring huge stockpile areas would be released into the water and rafted up and boomed down to The Pas. The picture in the lower right hand corner is a boom.

Minister Lemieux said that the winter road network is still important for connecting remote communities. It is equally important to us now as it is depicted in pictures of the past. The log train represents about a million cubic feet in volume. It is being transported along the muskeg systems of northern Manitoba.

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5 Roads frozen and iced along muskeg draws were put into service as virtual railways to move logs using tractors and bob-sleighs. Pulls were to small mills, roads or riverside stockpiles for storage until release and formation of floating “booms” in spring driven to downstream mills.
Tolko corporately operates in British Columbia, Alberta, Saskatchewan, and Manitoba. We are an environmentally responsible and innovative company that serves the needs of many diverse customers. We produce random length lumber, pulp and paper, paneling, plywood, oriented strand board and other kraft paper products.

Our forest management license area in Manitoba is on open crown land. It encompasses a total area of 8.7 million hectares of which 3.5 million hectares is non-forested or non-productive. This leaves a net productive area of 3.7 million hectares (the balance is covered in water). My wood basket is these 3.7 million hectares.

At The Pas, we have the sawmilling complex and the kraft mill. The finished product is shipped by truck transport and train to international markets. The complex is self-sufficient for power that is generated from burning bio-mass waste product from the milling process combined with bunker C oil. Steam that is generated to dry the lumber in the kilns also produces electricity to supply power for the saws, debarkers, planers, and the paper machines. We have a co-management agreement with Manitoba Hydro. Electricity that we do not require for our needs is put into the power grid and distributed by Hydro.

Tolko Manitoba has two divisions: kraft papers and solid wood. Unbleached kraft paper serves the multi wall shipping sack market. Solid wood consists of kiln dried spruce, pine, and fir studs and random length lumber. Projected saw mill production for 2007 is 140 million FBM from a projected harvest of 1.1 million cubic meters. Acceptable softwood species are black and white spruce, jack pine and to a limited extent, balsam fir. No hardwood species are used in Tolko Manitoba operations.

Sustainable Forest Management

The forest management system requires a complex balancing act to provide the timber supply and address the concerns of the various stakeholders. More people are claiming their place in the forest and demanding that their activity not be negatively impacted by the activities of others. The road to sustainable management is continually changing with the shifting values, demands and multiple environmental influences on the forest landscape.
The reality of climate change definitely presents a challenge for a forest planner. Forests are considered to be a carbon sink. They absorb carbon dioxide from the air and convert it into fiber, leaves, and roots that store the carbon\(^6\). The carbon remains stored until such time as the tree decomposes or burns, then the carbon is released back into the atmosphere. When trees are manufactured into lumber and paper the carbon material is locked within these products until they decompose.

The Catch 22 is that global warming accelerates tree growth, which absorbs more carbon, but warmth also accelerates decomposition and releases more carbon dioxide. More gas emissions into the atmosphere increases global warming, global warming increases drought, drought increases the risk of fire, and increased fire reduces the number and the livelihood of trees which releases more carbon dioxide. Talk about a vicious cycle.

We do growth and yield research studies in the forest to forecast timber production. With the impact of global warming, these growth and yield forecasts may need to be revised due to the altered productivity of various types of species. The potential for the forest to sequester carbon introduces yet another demand on the balance that I use for planning.

\(^6\) Carbon dioxide is a major greenhouse gas that contributes to global warming.
The Operations section transfers the annual operating plan conditions and processes, to the ground. They monitor the progress of the various activities such as access development, harvesting, loading and hauling. Virtually all activity is conducted by contractors or specialized consultants.

Our planning process starts with an examination of the mapping data of forest inventory to design potential operation boundaries. Aerial photographs are pulled for the area in question. A stereomated pair of photographs is examined under a stereoscope so that the features are presented in three dimensional. It allows us to plan the best routing and to outline the specific harvest areas.

We need to consider and protect wildlife during planning. Both our environmental license and environment management systems have specific language developed for raptors. Nests must be identified and protected. Heron colonies are another protected area. Caribou management involves radio collars with satellite uploads to track the animal’s movement, and the collection of fecal matter for DNA sampling. The protection of wildlife trees is important. We try not to cut down or disturb trees that we do not harvest for our purposes. Trees are left standing in the cutovers behind our operations.

We are required to do an archaeological investigation on our activities. We contact and work with the Heritage Resources and Archaeological Department of the Provincial and Federal Government, if necessary, to design and document appropriate measures.

Protection of wetlands is another important consideration. Wetlands play a very important role in forest areas and we do our best to make sure that we do not negatively impact them. We undertake stream assessments and measure information on individual tree species.

In remote conditions, there are not many hotels, so while conducting forest investigation we do some camping in the wilderness country. Several weeks are spent in the bush investigating potential harvest areas, conducting post harvest coarse woody debris surveys and ongoing projects like the permanent sampling plot program. It takes about a week to set up just one of these sample plots. There are several plots established for each forest section and each forest type. We mark out a specified area on the ground and each plant and shrub is identified and catalogued and every tree is given a tag with a unique number that is recorded. Every five years we return to re-measure and to
note any changes. Specific information is tallied for each tree and bush to measure how much it has
grown, or if it died, or if it is still there and it has reproduced and so on.

**Silviculture**

Silviculture is the management of the regenerating forest, and indeed, replacing the forest. One
cultivation practice is scarification with anchor chaining. This is used primarily in a high pine sites.
Essentially, ship’s anchors are dragged across the landscape to break up the slash, expose the mineral
soil and distribute the seed source so that they can start renewing. A power disk trencher does
similar actions but it creates individual micro sites.

In a winter application we need much heavier and more robust equipment such as ripper tooth
plows to get through the frost. This is usually done in areas where there will be no road in the
summertime. It can also be an island out in the middle of a muskeg area served by a winter road.
Later in the spring/summer people would go (often by helicopter) and plant trees in these furrows
and trenches.

Helicopters are used to spray herbicides that help control vegetation in planted areas. Trees do not
grow in nice straight rows and patterns. They tend to grow in clumps, and indeed trees can grow so
thick that they stagnate each other. We have a program called release thinning where we pick the
best looking tree and cut down the other deformed and smaller ones around it. This gives the better
looking tree a chance to grow. We co-operate with Forestry Canada’s program for genetic
improvement of trees. Trees are grown in family plots and grafted in hopes that one day we will
come up with a super seed. Finally, we do sanitation cuts in an effort to eradicate disease, e.g.
mistletoe infestation, from spreading into the surrounding forest.

Tolko is responsible to plant 100 percent of the area that it harvests. We collect seed in the three
natural seed zones of the Province. The seed is sent to a nursery in the southern part of the
Province where it is stored and grown annually as required in greenhouses. The seedlings are
frozen, packaged in boxes, and shipped to us for planting. The seedlings are planted back in the
areas where seeds were collected and the trees were originally harvested.
We cannot always get into some area when it is time to plant trees in the summertime. We use snow caching to store our seedlings over winter into the spring. They are delivered in a semi truck when access is available in the wintertime. The seedlings are buried under a pile of sawdust and snow, where they remain dormant, until spring. In the springtime, planting crews are flown in by helicopter and the caches are opened. The trees are thawed out and planted by men and women.

**Infrastructure and Operations:**

All of our activities are conducted under the authority of work permits. Some of these activities are road location, layout and the delivery. We build all season and winter roads. The all season road is very similar to highway construction except it is not paved. The running surface is gravel but we use the same type of bridging material as the highway.

We use portable coffer dam systems to minimize environmental disturbance. Huge bags are laid across the surface of a stream and water is pumped into them. As they fill, they settle to the bottom
and become a dam. Once the coffer dam is full, water is pumped out from behind the dam. Then we can construct the road across the creek, or install a culvert or a bridge in the dry, without having to worry about impacting the purity of the water through sediment or erosion. Any little fish that are found behind those dams are carefully picked up and put back into the stream so they can continue their life cycle.

Building winter roads, as Minister Lemieux alluded to earlier, is not simply a matter of scraping away snow, smashing down trees or pumping a quantity of water to freeze on the surface. Winter roads are as complex to build as regular construction projects. Although minimum ice thickness is important, the serviceability of an ice road is a factor of its buoyancy and it is monitored that way. The utility of an ice road is a function of its weight bearing capacity. The better ice for winter roads is natural or blue lake ice. Natural ice is not always available to the extent needed, so we have to augment that with flood, or white ice.

Ice roads are affected by factors such as depth, currents, and the fluctuation of water levels. In Manitoba, several water systems have fluctuating water levels because of raising or lowering by
Manitoba Hydro to meet electricity demand. We have run into situations where a winter road was built one day and the next day it was a suspended road because the water is gone from underneath the ice. It is not simply the strength or thickness of ice but also the buoyancy of the ice but that is important. If the ice is no longer floating on the water it is no longer buoyant and may be unable to support the required load.

These pictures show what happens when things go badly on winter roads.

The way to build a winter road is to locate the routing and start tramping. Tramping is an endeavour to reduce the snow pack or take off the brush cover. Usually a winter road is made within a muskeg area where there are no forestry applicable trees growing; only small scrub or willows. It can be really difficult to build a winter road on muskeg. The weight bearing and stability can vary drastically within an extremely short distance. The muskeg gives absolutely no outward signs of its capacity. The packing serves to compact the upper organic layer so that frost can penetrate. It is the frost when the muskeg is frozen, that gives a winter road its stability; it essentially turns into rock.
I will just briefly touch on some of the harvesting equipment to give you an idea of the size and the scale. Bunchers and processors are used to cut down the trees. This equipment weighs in excess of 70,000 kgs., some of the de-limiters are in that same category. De-limiters take the limbs and tops off the tree for further processing. Skidding or forwarding equipment moves the tree to the roadside.

Skidders pick up and drag tree lengths to a location for further processing. The forwarders pick up short wood product that is cut into logs in the forest and deliver it to the road. Tree length at roadside is converted to short wood by slashing. Trees are converted into saw able or pulp logs roadside. Some operations harvesting pulpwood, feed entire small diameter trees directly into a mobile chipper. The chipped product is blown into a van and taken to the mill. At a chip dump station the whole truck is lifted vertically into the air and the chips slide out into the inventory pile. Some operations do not have roads, that connect to provincial road networks but they are beside the railroad spurs. We haul to the rail spurs and the wood is stockpiled on a landing for reloading and transport by train later.
Transportation Costs

Some of the following factors contribute to the high transport costs. Manitoba is one of the smaller have-not Provinces of Canada and most of the population lives in the southern third. The north area does not have many adequate roads. The Provincial infrastructure is outdated and carries excessively restrictive weight and axel configuration requirements; bridges on major road arteries have weight restrictions that impact our ability to haul economically. Average haul distances are between 200 and 600 km round trip and will increase as harvesting operations expand. With little opportunity for loaded back-hauls (trucks travel empty 50% of the trip), low volume stands separated by distance depletion charges and per unit costing is high. Boreal shield topography (bedrock) and lack of natural gravel sources increase road building efforts and costs. Unstable soil
conditions can require the extensive use of either repeated annual installations, or single use ice roads. We all know how expensive it is to build all season roads in the north.

Here are some of the transport issues for the forest industry that perhaps this conference can help with. Road building is relatively costly: the country is rough, rocky, and swampy. The swamps can be deep, difficult, expensive and time-consuming to cross and re-cross. Construction and availability of winter road networks is weather dependent and the recent past has produced conditions of no freeze-up to poor freeze-up. Roads must be built to a minimum standard for safety irrespective of the volume available so economy of scale advantage can be non-existent. Suitable material for all weather road building is in short supply blasting and quarrying rock then crushing to gravel is difficult and expensive.

Due to terrain, truck and trailers need to be more robust than typical highway equipment. This involves higher capital costs and maintenance requirements. The world shortage of rubber has reduced the availability of large tires necessary for the forestry equipment. Mud, gravel, pushing and pulling across rough terrain all impact on maintenance costs and operating costs. Fuel used in resource extraction adds to costs as oil prices rise. Finally, distances between our fiber sources and the mills are large and continue to expand.

Access management can be an issue. The roads do not belong to us. They are built under permit on crown land. As such we are normally obliged to allow other people use our roads as well. If they can use them without damaging them there is no issue. But some people use our roads at no cost to them but at a repair cost to us. Finally, as part of Environmental Management, we must decommission and reduce our footprint on the land when we are finished with the road. Sometimes, decommissioning a road can be just as costly as building it. Roads no longer required by Tolko increase our liability because the public still has the ability to use them. Therefore if the road is no longer needed for our purposes, we try and divest ourselves of it.

The road network is built to accommodate trucks. Only a few weeks of rain and bad weather can make it unsuitable. The picture explains what happens when things goes badly on the all season roads in the summer.
We had to make all sorts of arrangements to get a different type of equipment in. Tracked equipment with large trailers and flotation tires was used to haul this load out to a location where the trucks could reach it. This was not budgeted for and would obviously add extra costs plus the additional costs involved in remediation of these areas.

Airships could have some potential silvicultural applications in crew transport and perhaps equipment transport for replanting. It costs us roughly 4 to 8 thousand dollars per block to cache seedlings.

There is potential revenue available in the forest industry for people that build airships. Airships could reduce the requirement for temporary roads across extraordinarily rough ground. Airships may possibly provide access to land-locked inventory that is inaccessible by ground transportation. In the Province of Manitoba there are a great number of parks and protected areas and areas of special interest that corral the open areas of timber harvest availability. The timber is within our permitted area but there is no way to take it out because we are not allowed to build roads through parks or these areas of special interest. Perhaps a balloon system could levitate equipment over top of these restricted areas and allow us to work in the open zones.
Working across navigable waters and larger waterways is becoming increasingly a challenge. Sometimes the process to put a bridge or crossing in place takes as long as a year and a half, because of all the permitting to cross fish inhabited waterways and navigable waterways. Maybe a cabled balloon system could get us there a little quicker.
Session One:
Logistical Challenges in Resource Extraction

Mining Beyond the Roads

Speaker
Ron Malashewski
President, Cliff Lake Capital Limited

I am going to provide a general view of some of the challenges and considerations that exploration companies may face in remote areas. We are going to look at two cases: Great Western Minerals Group and Starfield Resources.

Many mining and exploration operations are in the middle of nowhere with no utility service, roads, or other infrastructure nearby. The traditional source of power in those areas is diesel-fired generators. There are transportation issues with bringing in diesel fuel over potentially sensitive areas. While the arctic sea freight season is increasing, the winter road season is decreasing. This can have an impact on operations in remote areas.

Exploration is a long-term, expensive proposition. The minute an exploration company is listed as a publicly-traded company, the shareholders will remind you that you are behind schedule. You may not even have the property yet, but they remind you of that often. The process from exploration, discovery, and mining could take 10 to 15 years. Prior to the production stage there may have been two or three exploration companies that have taken a run at the property, but ran out of money. The need for investment capital is often inversely proportional to its availability. In other words when capital is needed most, it is not there.

Let’s look at a couple of the transportation challenges that exploration companies face as they head toward production. Starfield Resources and Great Western Minerals are both exploration companies. They are not mining companies yet; they are still at the pre-feasibility study stage.
Great Western is operating primarily in Northern Saskatchewan and Starfield is in Nunavut. Great Western’s Hoidas Lake Deposit is pretty much in the northern tip of Saskatchewan. There is infrastructure nearby, but not close enough. Starfield’s Ferguson Lake project is a further north in Nunavut. The Hoidas Deposit is 860 kilometres north of Saskatoon. Ferguson Lake is 240 kms from Rankin Inlet, 460 kms from Churchill and 760 kms from Thompson. Baker Lake is north about 160 kms. Those are challenging distances.

Now before we get into too much detail on Great Western or Starfield there is a cautionary note regarding forward-looking statements. Starfield and Great Western are both publicly traded companies. Whenever we are doing a public presentation, we always bring it up. We do not want to create the wrong impression with some of the words that we are using. We are discussing possibilities, and not probabilities based on the information that is currently available (for the presenter it is just a reminder that “when you are right, no one remembers; when you are wrong, no one forgets”). As the project moves from exploration to pre-feasibility and
maybe into feasibility, the probability may change, but that does not mean it is going to get better; it may actually get worse. The project may become uneconomic for a variety of reasons.

**Starfield Resources**

Starfield is a TSX listed company, a junior exploration company based in Toronto. The opportunity that Starfield has at Ferguson Lake is a significant rare discovery of a large nickel-copper-cobalt-platinum group metal bearing sulfide deposit. What is significant is the size of the deposit. The structure is about 18 kms long, but the story that we tell is when the drillers were not paying attention they went down another 15 meters below the main structure and came across what looks like a river of platinum and palladium. There is no other deposit in the world like that. So here is an opportunity for two mining operations. One is base metals and the other is platinum and palladium.

This is another qualifying statement that we have to make. At the time of this presentation (Oct 2007) Ferguson Lake project does not yet have a positive economic evaluation. You will see that statement in many of the resource companies’ news releases. The flip side is that it has not had a negative one either. The evaluation is under way right now.

In 1949 to 1957 Ferguson Lake was explored by Inco, which is now CVRD. It was acquired by Starfield in 1999. The property is about 1.3 million acres. Inco gave up that project in 1957 and opened up Thompson, which is a fairly significant nickel producer. The landscape at Ferguson Lake is pretty flat and barren. There is about 1.8 kms of outcrop that can be mined right off the surface.

There is a new all season permanent 50 plus staff camp on the property. There are daily commercial flights to Rankin Inlet from other major centers. When you are in Northern Manitoba, Nunavut, and the Northwest Territories the major centers are Rankin Inlet, Thompson, Arviat and

7 That “50 plus” refers to the number of employees and not age. This is not a senior’s wilderness camp.
Yellowknife. Some of these communities have only a thousand or fifteen hundred people, but they are important service centers.

An airstrip is on site and a longer airstrip will be built at the new camp. The marine shipping routes to Arviat, Rankin Inlet and Churchill are changing. They are starting to open earlier and remain open longer. There are also overland transportation routes which are pretty much winter roads. The rail head at Churchill could be a significant player in northern development.

These are some methods used to bring in cargo. The back hoe at the bottom left is taking equipment off a plane. If the operator hits the wrong lever he will increase the size of the cargo door on the aircraft. Such risks can only be mitigated by getting more suitable equipment for unloading planes, changing the way that they are unloaded, or looking at a different type of transportation.

Ferguson Lake will be looking at larger aircraft and more frequent cargo flights. If a hybrid airship is developed there may be opportunities to use it here. Generally the flight from Winnipeg via Churchill and Arviat to Rankin Inlet is about 5.5 hours. Then it is usually a helicopter ride to Ferguson Lake. Baker Lake is the nearest community on water. There may be an opportunity to get
goods and services or primarily ore from Ferguson Lake up to Baker Lake and then out through Rankin Inlet.

Winter ground transportation depends on cat trains. Maybe up to three deliveries take place over a winter. These pictures were taken two years ago. Most of the cargo is fuel and materials for the new camp.

With regard to outbound freight, a possibility is a deposit that would be mining about one and a half million tons a year. When you break down based on the grades, the bottom line is about 35,000 tons of metal concentrate per year plus the platinum group elements. At 35,000 tons of concentrate per year, about 3,000 tons per month would have to move from Ferguson Lake to the nearest port. The challenge is how to do that.

An all season road study underway by the Manitoba Government is looking at three different routes. This is a fairly major and expensive undertaking, in the neighbourhood of $1.2 billion to serve about 30,000 people. It is unreasonable to expect that the Federal or Manitoba Governments are going to

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8 Platinum and palladium would be flown out.
do it alone. Industry is certainly not going to do it alone either, but it depends on what the road is going to accomplish. Much of the exploration activity is on a line running north/south from Ferguson Lake. There are 15 to 18 exploration projects going on at different stages.

Mining companies have to look at access to the coast from 200 km to 250 kms inland. Transportation on winter roads is possible on a route from Ferguson Lake to Baker Lake. The ore could go out from Baker Lake to Rankin Inlet. If we can get the ore to Rankin, maybe it can get to Churchill on a ship or barge. Once the ore reaches Churchill, there is a deep water port as well as a railway to reach world markets.

The status right now is that drilling continues. Only a fraction of the property has been examined and there is a pre-feasibility study underway. In the meantime, the cat train method of ground transportation over a winter road is still going to be used.

Great Western Minerals Group

Great Western Minerals Group (GWMG) is an exploration company involved primarily in the rare earth elements (REE). Very few people are familiar with REE unless they are specialists in that area. In terms of exploration companies, there is literally only a handful in the world. REE are not glamorous like gold, silver or base metals.

Again, the disclaimer on forward looking statements applies. This presentation is about possibilities with Great Western rather than probabilities.

GWMG owns 10 percent of Great Western Diamonds and 100 percent of Great Western Technologies (GWTI), which is a fabricator of designer alloys. GWTI fabricate alloys based on formulas provided by many sectors, but primarily the automotive and aerospace sectors. GWMG also owns 100 percent of Great Western USA covering the US properties. The GWMG project at Hoidas Lake is located near the Northwest Territories border in Saskatchewan.9

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9 Saskatchewan is going through a boom - people are moving back from Alberta and land is cheap. The world's largest uranium producer is located in Northern Saskatchewan. The tar sands do not stop at the
REE are considered to be critical metals for many applications. What defines a critical metal is that, if you do not have it, production stops. The prices of critical metals may limit commercial applications and delay the introduction of new technologies. REE are in the lanthanide series on the Periodic Table plus scandium and yttrium. They are used in a lot of modern day technologies: disc drives, hybrid vehicles, communications and aerospace. The manufacture of one Toyota Prius, for example, requires 22 kilograms of rare earth elements. A tremendous drive is on to increase the use of rare earth, particularly, neodymium that is used in manufacturing extremely powerful magnets that are used in motors and braking systems. Many REEs are also used in the nickel metal hydride batteries.

A supply shortage of rare earth minerals is looming. China is really the only global source of rare earth elements, with 97 percent, coming from one mining area, and most from one mine. Late last year, China cut back exports by 30 percent and increased tariffs. The Chinese are challenged because they need the rare earths for their own internal use. We are bordering on demand exceeding supply. We are not talking about hundreds of millions of tons of these elements; it is more like 105,000 tons. So, GWMG is one of the few companies that are exploring rare earth deposits.

At Hoidas Lake, the measured, indicated and inferred resource totals about 1.5 MM tonnes at 2.77% total rare earth oxides. What that means is if you add up all the percentages of the elements in the sample you will get 2.77 percent. The total deposit of 1.5 MM tonnes, does not sound like much compared with Starfield, who will do that amount in nickel each year. The target of 1 to 1.5 MM Tonnes would provide an estimated mine life of 15 to 20 years. With a mine life of 20 years and production at 500 tons per day, output will be 180,000 tons per year. This would yield about 5,000 tons per year of the rare earth oxides.

Alberta border. Saskatchewan seemed to be too shy to talk about the tar sands but now they are starting to tout them. There is gold and diamonds in the Province. The Candle Lake Kimberlite Pipe may be world’s largest kimberlite pipe. As you move further south, Saskatchewan has rich reserves of potash, oil and gas.

The lanthanides are La (lanthanum), Ce (cerium), Pr (praseodymium), Nd (neodymium), Pm (promethium), Sm (samarium), Eu (europium), Gd (gadolinium), Tb (terbium), Dy (dysprosium), Ho (holmium), Er (erbium), Tm (thulium), Yb (ytterbium) and Lu (lutetium).
Where it is and how do we get it out? There is an all weather-road up to Points North. Beyond that there is a discussion about constructing a winter road between Stony Rapids and the south shore just below Fond du Lac. Fond du Lac is on the north side of the lake and a potential site for a processing facility. The Fond du Lac First Nations have expressed interest in doing some of the processing.\textsuperscript{11}

From Fond du Lac to Hoidas Lake is about 50 kms. Do we need to build a winter road, an all season road, or use some alternative transportation? The time frame for this preliminary economic study could be the end of 2007. Beyond that there is the feasibility study which is intended to be completed, depending on the preliminary economic report, towards the end of 2008. A lot of the base line work is already done for the environmental assessment which should be completed towards the end of 2008. The production decision will not be made until 2009 or 2010 based on the information that comes out of the studies. Production could commence, possibly, in 2011.

Summary and Conclusions

\textsuperscript{11} One of the by products of the rare earth extraction is phosphate. Phosphate can be used as a fire retardant. Up North it is tough to get resources quickly to deal with some of the fires so that can be turned into good business.
The mining industry faces many transportation and logistics challenges in remote areas. More cost effective, environmentally-friendly transportation solutions are needed. If there is a way to improve transportation then let’s do it. A new generation of cargo airships is a technology that could be a great asset for the Canadian mining industry.

The theme of this conference is “Making it Happen”. For the most part, the exploration mining sector relies on the logistics service providers to develop transportation solutions. Mining Companies are not necessarily in the transportation business. They need to look at getting goods and services from this point to that point, but they sub-contract or contract that out to other companies. In terms of the alternative solutions, some of the mining people I have talked to say we are relying on the tried and true: show me first before I change. In the mining industry, like other industries, no one wants to be first and no one wants to be alone. It is overcoming that hurdle that we discussed yesterday in the pre-conference session. It is tough to get someone moving. Collaboration between industry, manufacturers and government is required to develop an airship solution.
Session Two:
Logistical Challenges in Resource Exploration

Arctic Gas Exploration

Session Moderator
Al Phillips
A.J. Phillips & Associates

Speaker
Stuart Russell
Vice President, Business Development, Braden Burry Expediting

Good morning everyone. Public speaking is not really my forte. I am really happier running around the Arctic with coveralls and work boots but sometimes you just have to grow into the new era and here we are today. Barry Prentice has an interesting position in his life and our logistics world by being the lightning rod for airship development in Canada. All of the people who support airships say Barry is the guy to keep everyone on track and they look up to him for his direction. Those people who are a slightly skeptical of the airships concept always say “there is that guy over there promoting airships again“. The bottom line for me as a Canadian is that I look to see what Barry is doing to enhance airships in the Arctic; and think it is great. I met Barry in Hay River last September at a transportation conference where I spoke about BBE and what we do and where we do it. Barry says “Come on down to Winnipeg next fall. I have some guys who would love to hear what you have to say about logistics in the Arctic.” I thought Barry was joking, but a little while later I get a note: when are you coming down to see us?

Needless to say that conversation led to where we are today. I hope to outline the services BBE provides and hopefully it will have some relevance to the airships and why we are interested. The Canadian North is a very large area, it is very remote, the distances are great, there is only seasonal
access to most locations and it has a very harsh climate. It is also very expensive to develop large projects in the cold.

Our world is focused on “resource frontier supply chains in remote locations”. We supply dedicated expediters at both ends of the supply chain coordinating and resolving issues with the flow of goods. To operate in the North we have to utilize every transportation system that is available: airplanes, helicopters, trucks, rail, ships, barges, and ice roads, and hopefully, with Barry pushing everyone on their merry way, we will eventually get to use airships within the next few years.

Braden-Burry Expediting (BBE) is a Yellowknife based company that has been in business for 30 years. The key to our success is a proactive approach our clients needs. The culture of our company is to learn and understand the required results our client is expecting and to provide the link to those results quickly and efficiently. We strive to be the first guy on the block to say our system can provide savings, cost efficiencies and better control and is simple to set up. We have been very fortunate to have worked with customers that have stood behind us as we have developed the systems and tools to match their growth. It has worked out very well for all parties.

I have had a lifelong interest in Northern Canada. I grew up in southwestern Ontario on the shores of Lake Huron and was the kid who was always outside with the shovel in his hand in the middle of a snowstorm digging a snow fort. Might have thought I was John Franklin when I was about 3 feet tall, but needless to say I have had a keen interest in the North for many years. I moved up to Yellowknife in 1971 and basically spent the next 10 years loading and flying on the Lockheed Hercules L100 as a Loadmaster for Pacific Western Airlines (PWA). We flew almost every type of
equipment that could fit into that amazing airplane and some that were not supposed to fly in the first place. Since then I have been involved in aviation, mining and oil and gas projects covering many areas of the globe. When PWA evolved into Canadian Airlines International in 1987, I worked with the project team that helped with the merger process. During the last 10 years of my airline career, my group at CDN was responsible for implementing and managing all changes to the airline flight schedule with the operations teams for our fleet of 80 jet aircraft operating on 5 continents. Logistics and planning on a global scale.

Every day resource projects are evolving to meet new realities coming to the North. In Canada we have 35 million people living within 3.5 million square miles of real estate, with much of it being very cold for a large part of the year. We believe new resource projects will continue to be developed up North because consumers need access to the resources we can offer.

There can be no doubt that logistics is a major component of every project that has ever taken place in the North. I would like to share with you some of the lessons we have learned. It is critical for the northern experts to share their knowledge with the next generations. In case you have not noticed the baby boomers are getting ready to go golfing or gardening or whatever they do when they retire. We need to share our knowledge with the younger generations so they can continue improving the logistic systems and the efficiency with which they operate. The North of the future needs young adventurers.

For remote projects, there is a critical need to plan the supply chain down to the most micro level of detail, otherwise cost control goes right out the window. BBE has consistently expanded our capacity and growth to match each new project. Large infrastructure cannot be built if there is no project to pay for it. Gordon Stewart, who purchased and expanded BBE 1988 /2007, was adamant about doing everything better than the guy beside you. He promoted the need to work a little harder, work a little longer, do not be afraid to get cold and dirty, and at the end of the day the customer will keep calling you back. This strategy has proved to be successful as we continue to grow across the North.

You may wonder how Barry talked me into coming to Winnipeg. Well, I am personally a strong supporter of airships, as is BBE. We have had the HAV group come to Edmonton, Calgary and
Yellowknife to meet some of the mineral and petroleum explorers to see the challenges that they have been experiencing as they build and refine business plans for the development of their projects. We believe in expanding the tools available for logistics support - our clients tell us they need them. They say, “What is the best way to do that?” If we come along with a business case that says you should use this unit because it does this, that and whatever, and they agree with us, we keep working with the project and someone gets a job for their flying machine. Our intent is to share our experience regarding Arctic heavy lift needs over 35 years.

Gordon Taylor, (HAV), showed us some of his hybrid airship designs. We looked at them and nodded and smiled and said that is pretty nice, but the cargo floor might need reinforcing. The specifications were initially perceived to require the standard aircraft floor loading capacity of 100 pounds per square foot for the cargo compartment, whereas the Lockheed Hercules is designed for 100 pounds per square inch to handle heavy dense machinery. We explained to Gordon it was our belief that the first D7 Caterpillar that was loaded into the back end of the SkyCat would go straight through the floor, as the 45,000 pounds is a very dense load. Back to the design board, and now it is 100 lbs per square inch. Extra strength is necessary especially at minus 50 when steel and other materials get very fragile. A tribute to the designers at HAV who recognized the enhancement.

We would like to see airships operationalized and the new prototypes used in Northern Canada to improve the capabilities for our clients. Many potential manufacturers have advised us they are going to put their aircraft in other countries. We have tried to explain all the reasons why we did not think they would work. Selfishly, I would like to see them deployed in Canada because we have huge expanses of undeveloped land mass and very little infrastructure. An airship that does not impact the ground environment to any great degree avoids disturbance of the land and land owners. Selfishly, again, BBE will gain knowledge by learning more about the airships. By coming to the Airships to the Arctic Conference, I have met numerous keen and excited experts with great knowledge to share. So far, everyone has an interesting story to tell, and with it, many aspects of the capabilities and timelines for airships. Sooner would be better!

Our role is to provide efficiency recommendations to our clients; that’s our job. We want to see supply chains adapted to match the 21st century technology and capabilities. As you have heard already, many believe industry has been doing the same things, the same way, for a long time and
technology needs to take a leap forward. Once, when I was in the airline scheduling department, surrounded by white boards with aircraft flow charts, computers with airplane schedules, crews, gates and runway slots and all that stuff, our Vice President, Don Casey who was an expert mathematician, jumped up and said “how can we expect to get different results if we don’t try something different, let’s change the plan”. The truth is that we are all creatures of habit and regular change is a healthy enhancement to our lives.

The key points for the discussion:

We build our logistics systems to meet the needs of our clients so they can manage their growth and maintain control over their projects and associated costs. In northern Alberta, for example, where they are mining and extracting oil from the tar sands we hear about $4 billion projects with huge cost overruns and wonder that happened? We believe it is basically all about control of the assets. In those huge projects with the extremely limited access to available staff, and the resources to get the job done, they do not have control over all their assets, for many, many logical reasons in today’s Alberta marketplace. Projects are unable to get personnel and their tools working together as efficiently as they require to get the projects built on time. Although BBE is not an expert in Northern Alberta heavy oil projects we believe if effective controls are developed into the process there is a far better possibility it can be managed effectively, even when constraints are many and costs are going up.

In Northern Canada we also believe it is essential to integrate the transportation modes. Where there is such limited infrastructure to use we have to maximize all the capacity. Whether there are 100 barges or 1,000 barges, you may have to use them all to get the job done for every client.

As a wholly owned division of the Norterra group, we promote investing in local hiring and training of young northern employees. We have hired many aboriginals who live in the Northwest Territories and Nunavut to work for us and our partner companies.
If you can imagine growing up in an isolated community of 800 people and moving to Yellowknife with 20,000 residents, it is like going to New York for us, and a huge, huge cultural contrast. When we exposed those young people to our computer system and educated them on the proper procedures for handling of the airplanes we found within 90 days they are just as good as anyone else that has come up through our system. We have been pleased that many of them have gone on to improve their lives and careers within our company and with other organizations as well. The experience they have gained has been very beneficial to the North.

BBE is big on managing data and integrating communication systems. Our impression is if you do not know where your materials or your people are, you cannot plan to get the results you want. Operational control, in our opinion, produces huge commercial benefits. Cost and efficiency always appear to come out of those two components. We believe it is critical to learn from experience and improve the processes going forward. At BBE we strive to be process focused.

In previous process related discussions the question of flying aircraft has come up and many wonder “How do you get pilots to do the same pre-flight checks every time when it is not the same pilot?” Common industry practice is to make a check list with 25 or 100 process steps and then whichever pilot is flying the aircraft follows the same process steps every time. It happens today either by an electronic checklist on the dashboard of a modern 747-8 or a more manually oriented Beaver on floats. The pilots know the checklist like the back of their hand, and by doing the same thing, the same way, every time, it produces consistent safe operating results.
“You know, it ain’t bragging once you have done it.”

Years ago I heard a motivational speaker make the comment at a training session where he said “it ain’t bragging once you have done it” referring to how some people can talk about climbing Mount Everest, but they do not have the same affect on you as speaking with someone who has already been there. BBE has seen it and done it across the North many times. I do not say that to brag but it is true. We are northern transportation experts in all modes of transportation because we have used them all. We believe in being safe, efficient and cost effective. We do not want to work on projects if we cannot add our values to the process. Some would consider BBE to be an expensive service provider in some cases, but we have immense northern experience and are very good at what we do. In certain applications smaller exploration companies may not require our level of expertise, and in other cases clients want the processes we provide to add that value to theirs, so we try to be as good as we can. Team work is important.

Our core competencies include air cargo handling, freight forwarding, logistics planning, onsite expediting, payload maximization and specialized cargo shipments. We work with all the freight forwarders that move products in and out of Alberta and handle cargo for 14 different airlines. We have developed our systems around the Edmonton gateway and the consolidation of freight through that hub. Everything that we gather from around the world that goes into the “funnel” is validated and comes out the other side of the process as containerized freight, either in trucks, igloos (aircraft containers) or 20/40 foot containers going some place in the North. If something is needed from Korea or Johannesburg for example, our international freight forwarding partner Kuehne and Nagel delivers it to BBE to take North. We hand it off either to our partner in the North, who takes it the last mile, or to the customer depending on the situation.

Logistics Management

If a client is planning a project, we are most effective when we are engaged right from the start. We like to participate with the planning phase because we can use our experience to assist others who may not have it. Our role is to maximize the payload on aircraft, trucks and barges. When we started consolidating trucks out of Edmonton seven years ago we averaged 32000 lbs per truck load in a 53 foot van. We now average 53000 lbs per truck load and that is the blended rate from
structural steel to cement to bacon and eggs. We have a private passenger terminal in Yellowknife for all the people going back and forth to the mines.

BBE’s statistics speak for themselves: 17,000 tons of road cargo. We tracked 126,000 items last year, almost 50,000 items in SAP or GSAP. Our largest mining client, BHP Billiton, uses accounting capabilities of SAP so all of our receiving staff are trained on SAP. Our staff updates the information in SAP to match the purchase order and validate when correct material comes into BBE possession. Then the software updates our own internal freight tracking system LMS. To give you an example of the volumes; we handle in excess of 4,500 tons of air cargo, 18,000 tons of road cargo and 60,000 passenger through our terminal in Yellowknife. In Yellowknife we also handle 3,000 flight departures annually off our private ramp in with most of the aircraft being Hercules, Boeing 737 combis and even some DC4’s and DC6’s.

The gold rush in the 1930s showed that airplanes could be used to do all sorts of things that could not be done on the ground in such remote locations. They revolutionized the mining world, and airships could have a similar leading effect in the future. The big uranium rush that occurred in the 1940’s stimulated new supply chains. Lead/zinc mines in the 1970’s with Nanisivik and Little Cornwallis Island led marine resupply. Diamonds in the 1990’s and now uranium again in the 21st century are demanding more logistics services. The scale and construction and resupply of these projects is huge. A billion and a half dollar mine spends a large percentage on transportation logistics to bring in their supplies.

Oil and gas activity now represents a larger part of BBE’s revenue and in turn a heightened interest in the supply chains needed to support it. In the 1920s when oil was found in Norman Wells it was not imagined how important that field could be until the Second World War when Americans were concerned about the supply chain needed to support their troops fighting in the Aleutian Islands. The urgency of the war efforts created the requirement to build the Alaska Highway and the CANOL Pipeline from Norman Wells straight west to Whitehorse. Needless to say, the CANOL pipeline was never used but today the highway stands as a tribute to their efforts to expand the supply chain.
In the 1970’s, the race to develop the Mackenzie Delta and Canadian high Arctic resources was in full swing. In 1974 Resolute Bay was the busiest airport for aircraft movements in a 24 hr period in Canada and just a reflection of activity level spurned on by the first oil crunch. Pacific Western Airlines alone had 4 Hercules, 3 Electras and many Boeing 737 / 727 combi aircraft flying around the clock to support the explorers. Every aircraft you could imagine was flying out of there during that period. The recommendations of the “The Berger Report” in 1977 proposed a 10 year moratorium until resolution of the aboriginal land claims before proceeding with the Mackenzie Valley Pipeline. It is now thirty years later and we are still working on bringing that project to fruition. The largest potential logistics challenge in Canada.

As you may well know the Beaufort Sea exploration projects were booming in the 1980’s after the explorers found oil and gas off shore. The Petroleum Incentive Grants developed by the Canadian government funded a huge percentage of exploration costs of Dome Petroleum, Gulf Canada Resources, Pan Arctic Oils and their partners in the expensive search for resources in the Arctic. When the program was dismantled and the funding ended the explorers went home. A company could drill a land well in Alberta for about three million dollars because it is close to the supply chain. It is not surprising to visualize how a well offshore in the middle of the ice infested waters of the Beaufort Sea could cost 60 million dollars. The same reality is there today; so the need to find the most efficient supply chain to the North is critical for company shareholders so they will continue to explore.

It has been our operating practice to utilize a small team of experts and give them the authority to make decisions. We let them know what we want to get done and when we want it finished then leave them alone to get the results. The larger the team, the more the discussion and less chance of getting good timely results. We advise our clients that they need to be clear and concise about what they want us to deliver. Priorities for us are safety, efficiency and cost effectiveness. We want to make sure nothing we do impacts the land or the people. It is essential to care.

Remote projects require intense pre-planning. We believe that having the logistics team involved early in the process has many advantages to getting the best results. All modes of transport have to be evaluated, as each of the transportation components available in the North are usually part of that overall solution.
“The faster something moves the more money it costs”. The least expensive transport is the water mode and the most expensive is air. One of the business issues for airship developers is to convince those big clients that air is not necessarily more expensive. Contingencies at the time of the event can cost a phenomenal amount of money to recover from. The barge does not get in, the winter road goes out, 3,000 loads are left behind and the cost just went through the roof. If you have to fly them in, the cost goes up immensely. In seasonal shipping scenarios if we do not get the barges in this year the opportunity may be lost. You may not be able to put outsized pieces into an airplane, the mine gets delayed and away go the costs

The Devon Paktoa project 2005/2006 was the first off shore drilling project in the Beaufort in 15 years, so all the infrastructure was gone. Original explorers probably had in excess of 5 billion dollars worth of drilling and marine equipment operating in the Beaufort 25 years ago. They had floating dry docks and support bases and millions of litres of fuel in their tank farms, but when Devon wanted to go drill, it was all gone. It had all been sold for a dollar or given away when the money stopped coming from the government. Devon found a drilling location and operating crews that could run the unique SDC drilling rig needed to drill their offshore well and had BBE build a customized data management system to manage their expenditures.

**Devon Paktoa logistics challenge**

The supply chain for the Paktoa offshore well in the Beaufort ended 175 kms north of Inuvik by aircraft and started with many of their suppliers in Edmonton 3,000 miles away or beyond. The SDC was floated to its location and set down on the bottom in 60 feet of water so it could drill all winter. It was designed with a checkerboard like pattern of plates that sinks into the mud so the ice cannot move it when drilling.

BBE developed their supply chain to include truck or rail from Edmonton to the terminal in Hay River where the freight was loaded onto the barges and then shipped down the river. Hay River to Inuvik on the barge is approximately 10 days and from Inuvik to the SDC another 3 days. The barging season is usually from mid June to October. After the barge tow had sailed, we would then have to truck 3200 kms to Inuvik to catch up with the barge for the last leg or we would have to fly it 4 hours.
The highway to Inuvik has the last 750 kms covered with loose gravel and crosses ferries at the Peel and Mackenzie Rivers. The ferries are not very large and cannot take big modules like the road to Fort McMurray can. Some years we have to wait for the river to freeze solid for outsized cargo that does not fit on the ferries. The Devon drilling site was an hour north of Inuvik so we deployed most modes of transport: helicopters were flown until we had a runway built on the ice for the Twin Otters that were then used for crew change and resupply flights. As the ice thickened ice roads were built out from the land to provide access for the trucking of an emergency drilling rig to the location and timely return of their rental drilling tools.

The processes and systems developed for use with clients like Devon have been utilized on other large remote projects and statistical data regarding the shipments, their weights, dimensions and travel patterns are all known for the future.

Whether it is the renewed interest in offshore oil and gas exploration or developing the large mineral deposits scattered across the North it is our belief that airships, whether they are 50, 100 or 200 ton lift are eventually going to be built and used in Canada. We expect things will change for the better when that happens.

Question 1 - Do you see a use for Airships moving bulky low density freight or high density freight?

Answer 1 - We would put anything into an Airship that would fit. When Pacific Western bought their Hercules in the sixties they learned a lot about building machinery to carry very long pieces of heavy drill pipe on the airplane and engineered / built a 6000 gallon aluminum fuel tank to go into
the back of the aircraft and hauled millions of gallons of fuel. I believe an airship would also have to be set up to carry fuel because fuel is a component of life in the North.
We have to look at airships from two perspectives: technical and financial. I would like to suggest a business concept that could get an airship created and have it fly to a remote destination with supplies in its belly. The delivery of products into a Northern community would be the test to ensure that the technology works. If the new aircraft can also work from the financial side to deliver cargo at a competitive price, then a long-term contract can be structured.

We need to be innovative in the design of procurement tools and contract award strategies. I am a procurement expert; I work with the Government of Ontario on the hospitals that are being renovated and rebuilt. Our Company provides fairness monitoring services for those contracted procurements. We follow the procurement from start to finish. We certify whether it was done in an open, fair and transparent way. Consequently, we get a birds-eye view of cutting edge procurement strategies.

There is an obvious problem with the winter roads in Canada. In the last 20 years, they have lost more than half the time they can be used. The large scale movement of material for infrastructure can no longer use the winter roads. We know the demand for cargo airships is real. The need is expressed by the theme of the conference “Making it Happen”.

Who are the parties that would be involved if we were too “Make It Happen?” The airship industry and the First Nations in northern communities are significant stake holders. The current air and overland service industries that are currently serving these communities need to be involved too, as

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well as the Federal and Provincial Governments. If we can get individuals within these groups together we can make something very interesting happen.

The Concept

To make it happen, we could create a competition with a long-term contract as a prize for the winning aerospace company. The winning airship would have to transport specific amounts of material over a specific distance and deliver them safely within a fixed time frame. This demonstration would be evaluated from a technical standpoint. The second part and more important part to anyone involved in supporting this project is the airship operation’s financial model that demonstrates they offer more value for money than current options. The reward, if the technical and financial requirements are met, is a contract for the winning company to provide freight operations for a specified period of time, such as 10 years.

Any major procurement has an ownership side. For example the ownership side of a new hospital in Ontario includes an architect, the Ministry of Health and Infrastructure Ontario. The people on the market side, in this northern transport case, are the aerospace companies and input suppliers that are creating these craft. They will probably want the opportunity to form a consortium with other companies like an air cargo carrier that provides operational services.

The future procurement process is the “carrot” that would drive this development. It needs to be an open, fair, transparent procurement process that leads to a contract award that moves from concept to reality. Essentially, it is an output specification award. The procurement specifications could read “able to carry 50 tons from Thunder Bay to Big Trout Lake and back within a certain time frame”. The operators have to be able to do this at a price competitive with winter roads and airplanes.

I am suggesting a process that is similar to military procurement. The U. S. Air Force calls for proposals, the aerospace companies compete, and the best one wins the contract to build the planes. This is the same thing, but in a civilian contest of an open, fair and transparent procurement process. This is important. If we’re going to get the Government onside, and they are going to stick
their neck out, as we are sticking our necks out in the development of airship technology, the procurement has to be open, fair and transparent.

**Procurement Process**

Stakeholders need to be apprised every step of the way. Communications are important to keep people up to date in any new type of procurement. When public private partnerships (P3s) are done badly, they cost everyone a lot of money. Some people will say they are good, some will say they are bad, but when they are done right everyone is on the same page, nothing falls through the cracks or costs extra money.

**Project Preparation**

Project leadership and champions are needed. These are the people that are going to drive these ideas or take the political risk to get this moving. These leaders could come from the northern communities that are going to be served. Procurement expertise is needed to lead this project right from the needs analysis stage through to the contract award. Technical expertise is needed to evaluate the airships. Experts in air transport finance are needed to assess the business model. Legal review is required once the contract is being developed. Someone working with the main project team has to pull the project agreements together.

We are fairness monitored when we do P3s in Ontario. Open, fair and transparent means that everybody has the same information; it is a level playing field. By creating a level playing field for everybody, the consumer and the owner get a better product.

**Project Phases: Needs Analysis:**

Step 1 – Invite the current companies that are working this market to participate. You want to get a really good idea of the market in the area to be served with the results of this procurement. This could be a review of information available on the market capability, your capability and the project objectives. This work could be done by a small group of people including ISOPolar and government agencies who are interested in northern transport.
The needs analysis is required to show the business case for this procurement. We need to pull together a group to define the project and write a proposal that can be presented to potential government funders or some major private companies that are looking at northern transportation services. Let’s consult with the stakeholders, let’s look at the market, let’s identify some key success factors, and then let’s identify the funding agencies and/or private sector companies that want to get involved in solving the northern transportation problem.

Step 2 - Project Definitions: Once the needs are defined a project team can be formed. The team needs a project champion that is going to sell this politically. Obviously some people are going to question it. You are going to need political project champions and you are also going to need significant project leadership. A government or a large private company needs to say yes, if you can find a company that is going to be able to provide these services, we will guarantee a contract for X years. They are going to be the owners of the procurement. At this stage, the team is formed that leads the procurement right to the end.

Whenever you are doing procurements, you can either be on the owner’s side or on the bidding side. You cannot be on both sides, because a fairness monitor would stop the procurement. You must pick your side, if it goes forward.

A governance framework is needed to guide the project, develop the options, and determine what is in/what is out. Meaning what is required within the procurement. What are the expectations of the company? What kind of risks are they going to bear? What risks are going to be borne by the local communities and/or government? A bunch of different things have to be discussed at this point, because this really defines the project scope. At that point, you have to be sure that the revenue and funding people are committed. If it is the government, are they going to support this procurement all the way through?

Just because you get to step 2 does not mean the process cannot be halted. There are procurement tools that can indicate whether the market is ready. The procurement can be stopped at any time if the market is not going to be able to deliver.
The end of Step 2 is finalizing the business case options and recommendations. Usually what happens is that the bureaucrats involved have to go to their senior management to get approvals that, yes, we see the business case, and we are buying into this.

Concept validation

Concept validation takes what was done in steps 1 and 2 of the business case and seeks opinions from the market. This is where the word gets out to the market informally. Letting them know hey, this is actually coming, you may want to start building some partnerships. Subsequently the business case is finalized with result based outcomes. At this point the other members of the project team and bureaucrats would have to get final approvals for the procurement strategy to move forward.

Step 3 - Request for Proposals: At this point, all government approvals are done, the funding approvals are set, and documents are ready for the market. The project might begin with a request for qualifications. The qualification would ask the companies for computer generated models and/or proof that they can build an airship. A request for qualification stage shortens the list of bidders to those who can develop a credible consortium.

Based on the request for qualifications, a request for proposals is issued. An evaluation of the request for proposals has two parts - Can the airship carry the load required over that distance time frame? Can the airship meet the competitiveness requirement?

Contracting with the winning company is where the fun part comes in. If there are further things that can make this a better project, you may want to look at a second negotiation stage after the preferred proponent is selected. Finalize your contract management, sign the agreement with the winning company and make the big announcement.

Contract management is equally important in this type of procurement that is a 10 or 15 year carrot in the form of long-term haulage contract. Contract management ensures, in a public way, that you can demonstrate the contract is meeting its value for money proposed.

The airship developers are going to be the bidders to the contract. Where you see yourself in that industry is going to be very important. Depending on how big the procurement is, there may be
needs to assemble the airships, airship hangars and the maintenance of the airships. Also the landing and refuelling are needed.

I would not see myself involved in the bidding side of the procurement. I have no economic interest in airship development. My interest is in creating an environment where the airships can be put to work delivering 50 tons of equipment and material every day. I would see myself on the owners’ side because this is my interest.

So what are our next steps? We need to show governments that through this cost effective competitive method we can assist in solving this northern transportation challenge. We must have the business case to back it up. The next steps are the needs analysis and the business case to show the actual opportunity. Once we have done that, hopefully we will be able to convince governments and larger private sector companies to invest in that long-term contract carrot.

The airship market needs some procurement expertise to capture the energy that is here and guide it in a systematic way to a new airship for northern Canada. The remote communities need a vehicle that can move housing infrastructure material to them.

I am the Project Director for an Organization that is called First Nations National Housing Managers Assoc. (FNNHMA). The FNNHMA hears about all the housing problems every single day. If we can create a vehicle that answers these problems we are going to be doing a lot for all the people in northern Ontario and Manitoba. I really hope that the airship industry can see where I would like to take this. I hope that those who are with government can see how we would create a new transportation paradigm, while protecting the interests of the companies and the public purse.

Question 1 – How big is the market and the required size of the airship, in your opinion?

Answer 1 - Most communities have a 40 or 50 home housing backlog, no hockey arena or other economic infrastructure. I am sure the remote communities could keep airships filled for the next 10 years by just moving construction materials. Once you start moving that type of material the mining companies and forestry companies will see opportunities, too. There is all this spin off activity that can happen. It could have the same impact as a railroad except it goes through the air. But it will be
up to the strength of the financial model. The value for money concept will dictate how big or small the airship will be.

Question 2 – How much are the airships going to cost?

Answer 2 – We need to do the needs analysis and the business case to get an idea of what the costs will be. We will have to wait and see what the private companies put on the table from a financial standpoint. This is the public private partnership model. It is based on government funding, but with the private sector taking the development risk and doing the flying. We would know the price once the bids come in. It is an output specification.

Question 3 – How long would it take to prepare the RFP and complete the contracting?

Answer 3 – If we were to start tomorrow with the needs analysis and all of the upfront work, I say eighteen months to be safe, but between one year and eighteen months. Once you get the funders to say yes, here is the authority for the contract, then you move back from that point and you set the date when the RFQ’s going out. You have to allow time for the companies to develop consortia. There is a time lag. Companies are not going to be able to say okay, tomorrow we can bid on this with all of the aspects. A new procurement like this is going to generate a lot of public opinion, both negative and positive. Leave yourself a good year to eighteen months to do it right and you should not have any problems. If you rush something like this, when you come out the other end, it is going to be one of those P3s that everyone hates and I do not want to be involved in that.

Question 4 – Are you concerned about weather conditions?

Answer 4 – I am not here to talk about what the airship does, or what the logistics do. I am here to talk about is how it can be done. I am just looking at the need of the communities that I know about. We need that amount of haulage and whether it is three times a day or once a day or week, I do not really know. You would want to find out and it would be indicated from the value for money test that it is going to be viable. As long as it comes back to the viability test, and we always bring it back there, it makes it very difficult for the naysayers to poke holes in it. If it makes
common sense and it is hauling much more than the current solutions it deflates their arguments against it.

Question 5 – How do you buy something that does not exist?

Answer 5 - You are having it proven to you that it does exist. Once it is flying and you have the financial model and it makes sense, then you are making your purchase from the time you start the award of the contract. No, you do not purchase a vehicle that cannot fly.

Question 6 – Are there funds to support this activity?

Answer 6 – Yes, collectively there is a lot of money to support the needs analysis and business case standpoint which is not going to take that much. It is not going to take that much to move this through the procurement process either. Where the money comes in is the 10 or 15 year haulage contract for all of northern Ontario. The challenge is to get the Government to see the business case behind creating this carrot. If you have that carrot, it is going to get the industry motivated to come forward with solutions.

Question 7 – You spoke about this as a prize. Could you elaborate?

Answer 7 – The prize would be the long-term contract. This has to be determined. I do not know how much the contract needs to be worth but, you are the guys in the airship industry. How much is the food mail program? - $42 million a year. How much haulage are they doing all over northern Ontario? You are looking at a significant amount. Clearly the contract has to be concentrated into a long-term revenue stream so the aerospace companies can invest knowing that there is a market at the end of the day.
Session Three:
Logistical Challenges in Serving Remote Communities

Air-Lift to Remote Communities

Session Moderator
Al Phillips
A.J. Phillips & Associates

Speaker
Fred Petrie
Accountable Executive,
First Nations Transport, Inc

The air vehicle that our company currently uses to meet the challenges of air transport to remote communities is the Curtis Wright C46 Commando. It hauls 15000 lbs, 250 miles, with return fuel, while landing on a 3500 ft gravel runway, all at a typical freight rate of 60 cents a pound or about 3 dollars per ton kilometre. This is 6 times the cost of trucking, but where there is no all-weather road it is very competitive with current alternative air vehicles. However, this plane is 63 years old as of August 14, 2007. I need to find a suitable replacement and, as I have been saying to Barry since the first Airships Conference, why not replace 60 year old technology with 80 year old technology.
Barry has always titled these conferences “Airships to the Arctic” and the Arctic does have a certain romance, but I would contend that the logistical challenges of serving remote communities by air are very much the same whether it is Rankin Inlet, 1500 kilometres (kms) north of Winnipeg, or communities within 500 kms. I have grouped the challenges into four categories: 1) The market 2) Infrastructure 3) Regulatory, and 4) Economic issues.

The Market

Remote community markets are small with populations from a few hundred to a couple of thousand people. Along with very limited economic development, small markets have a limited volume and inconsistent demand. Surges occur on welfare days while eight to twelve week shutdowns are experienced when and if the winter roads are passable.

Product shipments have a wide variety of characteristics. Perishables require temperature controlled handling. Many goods have high bulk which can require density surcharges. People in remote communities eat an awful lot of potato chips that do not weigh very much for the volume shipped.
This is somewhat compensated by canned soft drinks. Much as we would prefer to ship more milk and flour, these social issues are beyond the market challenges of this talk.

**Infrastructure**

The challenge caused by the lack of infrastructure is that all freight must be transhipped. A surface mode is used as far as possible to minimize costs. Cargo only transfers to the more costly air mode where there is no longer any surface mode infrastructure. To the Arctic this can mean a 1000 km surface trip by truck to Thompson then rail to Churchill before a flight to Rankin Inlet. In our operation we only have a 100 km truck haul to Gimli which is located on Lake Winnipeg. While the roads do go somewhat further north of Gimli there is no airport with the 5000 ft runway that the C46 needs to get airborne with a full load.

Extra handling and transhipment adds to cost. We try to minimize the handling costs by using unit load devices, a fancy word for pallets. Even when freight is palletized, it must often be resorted and re-palletized before it goes in the airplane. At the destination airport there are further challenges due to the limited facilities. The two busiest airports we serve in the region are at St. Theresa Point and Island Lake. Both airports are located on islands that require a marine portion of the journey to get the goods to the store shelves in the communities. Ground handling services are poor with limited equipment and unreliable staff. The lack of northern infrastructure limits the service to daylight hours on weekdays, which in turn limits transportation equipment utilization.

**Regulatory**

Regulatory challenges refer to the technical regulations for aviation safety, as transportation services have been de-regulated economically for twenty years. Our craft size places our company in the
airline category which has a higher regulatory burden than the commuter or air taxi categories. Our regulatory requirements are the same as Air Canada even though we operate non-pressurized, piston powered aircraft mostly under visual flight rules at low altitudes. As a cargo carrier, we do avoid the regulatory burden associated with carrying passengers.

Safety is the primary objective of quality assurance in transportation. There is a new regulatory approach called safety management systems (SMS). The idea behind SMS and performance based measurement is that the air industry is increasingly responsible for its own quality assurance. This has the promise of reducing the regulatory burden but so far it seems to be applied in addition to the old regulatory environment.

The larger regulatory challenge is the de facto limitations on introducing new aircraft. The best aircraft for our mission that can be acquired at a reasonable cost is the Antonov 26, which is a two engine, turbo prop, Dash 8-sized airplane. The Antonov 26 has a square fuselage and a rear loading door like a small Hercules. There are thousands of Antonov 26s in use throughout the world. However, the cost is prohibitive in terms of time, money and uncertainty to ever get the Antonov 26 approved for use in North America. It is ironic that a foreign carrier can operate the Antonov 26 to and from North America, relatively easily. In the Caribbean, an Uzbekistan company brought in a couple of Antonov 26s to serve these countries from Miami’s Opa-Locka Airport.

In terms of economics, if it costs $100 million to certify a new airship that can be built for $5 million, you will need to sell twenty to breakeven at a $10 million price, just to recover the regulatory cost of aircraft certification. With this capital cost barrier how do you ever get the first two into service to prove their efficiency? Perhaps Transport Canada’s new performance based risk management approach could see a flight authority being issued to permit a developmental service. An SMS approach to certification is well worth pursuing.

**Economics**

The primary economic challenges are the limited market size, variations in demand levels and the associated infrastructure limitations that compromise utilization. I hear the comment that only very large airships can be efficient and cost effective. We could have a long discussion about whether
bigger is better. We cannot keep a modern, efficient airplane in the air 16 to 20 hours a day because our market only requires utilization of 3 to 4 hours. The high capital cost of new equipment, including perhaps a new generation of airships, makes them uneconomic for our market. Now in theory, a modern airplane with high fixed costs and low variable cost is profitable once it passes the breakeven point. The problem is if the market is only big enough for a much lower breakeven point, the operation can lose a lot of money. This is why the northern aviation industry is forced into using old equipment that has low fixed costs.

The economics of serving remote communities require at least as much if not more public sector policy intervention then we had forty years ago. A reference was made earlier to the food mail program which is an example of how programs existing under the control of different stakeholders can distort the economics of a whole industry. The food mail subsidy program is funded by Indian and Northern Affairs Canada (INAC) and administered by Canada Post. Canada Post’s practice has long been to award a contract for mail carriage to one carrier in a region. The two major carriers in the Arctic are Canadian North and First Air. Canadian North has fought this Canada Post contracting process all the way to the Supreme Court, unfortunately it was thrown out. The issue is the gross unfairness of one carrier being given such a large chunk of the market; the result is a de facto return to economic regulation as practiced by the Transport Commission of the 1960s. If the transport of wholesome perishables is to be subsidized then that subsidy should be available to any carrier, with its market share determined by the customer, not by bureaucrats.

Making It Happen

These are the challenges I face as an operator, but changing hats for a moment to speak as a transportation economist I have regrouped the challenges into the economic realities of the market. They can only be overcome by a pro-active public sector with a clear policy framework and effective coordination of all stakeholders in the transportation system. Airships have been proffered as a more economic transportation solution. The problem is in the traditional separation of transportation infrastructure, which is largely provided by the public sector, from transportation services which are provided by the private sector. When each sector has a myopic view, the airship’s transportation advantage, which is the lack of infrastructure requirement, is overlooked. I am not

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advocating that governments take the lead in airship development, but they can facilitate overcoming the barriers in order for the private sector to develop new transportation solutions.

Let me return to my operator’ perspective and make some suggestions in what I would like to see in an airship to meet my challenges in serving the remote communities of Northeast Manitoba and Northwest Ontario. First, from what I have seen so far I would favour the hybrid airship approach simply because there is such a wide variation in the buoyancy required. To do it strictly with lifting gas is going to be more difficult. There has been a lot of talk about 50 ton airships being a minimum lift requirement. All I need is a ten ton payload which would be an improvement over the 15,000 lbs our C46 carries now. A 20 ton payload would be nice because that is roughly the capacity of a highway tractor trailer.

We do not need the aircraft speed for hauling freight, that we would if we were carrying passengers. A one hundred kilometre per hour cruise speed would be just fine. It would get me from Gimli to Island Lake in a 4 hour flight and allow more than adequate time to do a round trip or possibly two round trips a day. I would try to keep the overall size small so it could fit in a larger conventional style aircraft hangar.

Economically we must keep operating costs down to a dollar per ton-kilometre. The most important criteria, though, for a modern airship is that is has to be all-weather, and able to deal with fairly strong winds. I am not saying all winds, we do not fly our C46s above a 15 knot cross wind because it is susceptible. But as long as the wind is down the runway we can operate in 30 knots or better. We would want the same out of the airship.
The biggest operational constraint is icing and snow loading. We need a solution to those problems. I am really interested in learning more about hydrogen because I do not believe all the naysayers. It may be more risky than helium but under the SMS risk management approach it is a risk that might be manageable. The economic advantages in terms of greater lift and lower cost, could in fact, be sufficient to make those risks worth taking. Finally, the airship to serve our remote communities needs to take full advantage of modern automation.

I want to share some thoughts on how a demonstration service might be organized and financed. First, we should have a time definite trial. The precedent, I would suggest, is the Montreal – Ottawa STOL service operated in the 1970’s. Rather than pre-satisfying all the regulator’s requirements, the demonstration would be monitored by the regulator to develop the data that would be used in future regulation of airship construction and operation.

Second, to meet the development cost challenge, the public sector needs to get involved in commissioning the development of a prototype. This can be justified in order to evaluate the public policy objectives to do with sovereignty, environment, resource development and social equity for northern peoples. One approach that could be used is the U. S. defense procurement process of funding two or three detailed proposals with the winner then selected to build two airships for
testing. A combination of public sector support, such as under the infrastructure program, and possibly some private investment under the military procurement offsets could be put together.

One major private sector role would be to operate one or two prototype airships in service in the real market. I am willing to offer my 5 million pounds of annual airlift as a test market for proving the efficiency of airships for goods transport to Northern remote communities. How could I ensure the reliability that would keep my customers happy? Well let me show you how. As you can appreciate, my *C46 Commandos* are pretty much fully depreciated after 63 years. I can afford to keep them on standby and switch to them whenever there is an airship problem, be it technical or regulatory.

So, in conclusion, I am offering to be the test market. Now we simply need the builders with the practical design and government support of development, as well as facilitation of regulation, to make Barry’s dream a reality. Let’s “Make It Happen”.

Session Three:
Logistical Challenges in Serving Remote Communities

Retail Logistics in the Arctic

Speakers

Jim Huggard
Manager Merchandising Division,
Arctic Co-operatives Limited

Lloyd Hillier
Manager Customer Service Department,
Arctic Co-operatives Limited

In this presentation we are going to discuss some of the uniqueness of the logistics to get products to the northern communities. Lloyd Hillier and I would like to give you a quick overview of our logistical challenges in the North. The job of Arctic Cooperatives Limited (ACL) is to procure and transport the required products to our customers. ACL is based in Winnipeg, but the customers we work for cover a very broad spectrum from the Northwest Territories to Nunavut. Our major competitor north of 60° is the North West Company. We have stores in every community from 100 people up to about 3500. A few of these stores have road access year round, a few of these stores have winter roads, but the majority receive their products on boats, barges, annual winter road resupply and by aircraft.
On the left is one of the NTCL barges, which we use to carry fuel, going on the McKenzie River. On the right is a winter road into Kapami Coop at Colville Lake which is a community of about 100 people. We also use Canadian North and First Air that provides the large majority of our cargo shipping needs. First Air has the food mail contract for a lot of our stores.

First Air transports about 11 million pounds of our products annually. They operate the Boeing 737’s and 727’s and the Hercules. They are still using the old Hawker Siddeley 748 in some of the Baffin communities and have brought on the ATR-4214. First Air uses combi-type aircraft to fly people and cargo on the passenger deck.

Trucks are used for moving inventories around in southern Canada to stage cargo for the barge and aircraft service. For example, we use Vitran to truck inventory from Federated Co-op in Winnipeg to Montreal. This year we put about 80 loads out of Winnipeg into Montreal for delivery to 18 northern co-operatives.

Another major hauler is Robinson Trucking (RTL) that is based out of Yellowknife15. RTL is our depot for Edmonton to transport products through the Edmonton-Hay River-Yellowknife lane. At

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14 The ATR 42 is a twin-turboprop, short-haul regional airliner that was certified in 1985. Built in France and Italy by ATR, the name “42” comes from the aircraft’s seating, which varies from 40 to 50.

15 RTL is also involved in the winter roads into the mines. Approximately, 12,000 truckloads go to the mines, yearly, on the winter roads, out of Yellowknife. There is so much traffic that they have set up twin lanes to separate trucks and limit speeds to lessen weight on the winter roads.
Yellowknife perishable inventories enter the food mail process. At Hay River product is trans-loaded from trucks to the Northern Transportation Company Limited (NTCL) barges.

During the freeze up and break up, ferries stop running. The road to Yellowknife is out of commission until the ferry service returns. RTL is unique in that they will shuttle product across the McKenzie River with a helicopter. The helicopter takes 3 or 4 pallets at a time to other side where they are put back on a truck and continue to Yellowknife.

Inventories that are staged at Hay River go down the McKenzie River to northern points on NTCL barges. We have Co-ops along the McKenzie River and out in the salt water. A lot of our shipments are containerized.

We use Gardewine North to transport cargo and food mail from Winnipeg to Churchill via Thompson. Shipments go to Thompson by truck and then are trans-loaded to the train into Churchill. At Churchill, Calm Air picks up cargo and takes it further north by air.
Desgagnés Transarctik, (DTI) provides marine transport to 18 Co-operatives out of the port of Montreal. Arctic Co-op has a partnership with Desgagnés called Nunavut Sealink and Supply Inc. (NSSI). DTI transports products in ocean-going ships for the Government in Nunavut, mining companies and other northern businesses. They just brought a new ship on line, (42 million dollars). I had the privilege of going down and seeing it in Quebec City. Everything is either containerized or crated. Cranes lift the product on and off the barges. Our containers are painted red with a Co-op label. DTI carries everything from pre-fabricated houses to cranes. Large forklifts are used to unload the barge that delivers loads around to communities. DTI can unload 30 containers at our communities in about 11 hours.

Food mail, was referenced a couple of times today\textsuperscript{16}. It is an extremely valuable program for the communities in the North because it subsidizes inbound freight. The freight rate subsidy program is provided by INAC and administered by Canada Post. The 42 million dollar food mail subsidy applies to 14 million kilograms of perishable product that is shipped annually into the communities.

Depending on the size of the community, they may have twice weekly food mail delivery. Between Val D'or, Quebec and Iqaluit there are 7 jets a week taking product into Baffin Island. Their capacity is 80,000 lbs. which provides a picture of the volume moved.

There are four entry points of which we utilize three. The lane into Edmonton, Alberta takes products to Yellowknife, Northwest Territories where cargo enters the food mail system. The Churchill food mail system port of entry has been moved to Winnipeg, Manitoba, but it still goes through the Port of Churchill and is flown out by Calm Air. At Val D'or, Quebec we utilize a company out of Amos, Quebec. If certain standards are met the product moves into the food mail processing system and is delivered into communities on a weekly basis.

\textsuperscript{16} Fred Petrie, \textit{Logistical Challenges in Serving Remote Communities}.
It is a continuous process to supply the requirements of our co-operatives who serve the communities of the north. We have two types of transportation requirements: weekly and annual. We need weekly service of X number of kilograms into 32 communities, and we also need yearly requirements of fuel, construction materials, etc. It is the same 32 communities, but the difference is one is big lift versus many smaller lifts on a regular and continuous basis.

Question 1 - How much of the transported goods is actually based on air?

Answer 1 – Approximately 60 percent of our volume goes on aircraft and 40 percent goes once a year. There is a huge difference for us to be able to fly bananas on a regular basis versus taking in carnation milk. One is shelf stable and can be stored for long periods while the other one has to be replenished every few days.

Question 2 – What is the impact of the food mail supply on food prices?

Answer 2 – That one is so easy because we get that question asked all the time. A 4 litre jug of milk weighs about 10 lbs. When you add all of the numbers in for the food mail system you will pay about 60 cents per pound to get the product in. This is $6.00 in freight for a jug of milk. If the food mail system were not in place? At the top of the Baffin, freight is $11 dollars a kilogram. That jug of milk would cost you $5.50 a lb or $55 dollars in freight. Food mail is an excellent program to move perishable foods north.
Question 3 – Do you support the idea of creating a new generation of airships?

Answer 3 –. We will always support anything that will get product into our communities in the most economical way, but we are not going to build an airship, that will be up to the Airship Companies to supply us that service.

Question 4 – How many shipments per year can you do with sea lift?

Answer 4 – Out of the Port of Montreal, we work on 3 sailings during the year: the end of June, the end of July and the 1st of September. We have some stores that will get 3 ships and some stores that get 2 ships and some stores that get 1 ship. It is all delivered out of the Port of Montreal directly to those communities.
Session Four:
Logistical Challenges in Project Freight

Building Construction in the Near North

Session Moderator
Graham Starmer
President
Manitoba Chamber of Commerce

Speaker
Jerry Pokrupa
Architectural Technologist,
Keewaytinook Okimakanak

I would like to commend ISO Polar for all this work during the last 4 years and, in particular, Barry’s sticktoitiveness. This is amazing. I have known Barry for a few years and when I received notice that there was this Airship Conference I sent Barry an email and said hello because we had not been in touch for a few years. Over the next few years, I kept sending Barry bits of information dealing with winter road freight. Then the next thing I know Barry is asking me if I would like to give a presentation on building construction in the remote communities. I have been in Northern Ontario since 1999 with the Keewaytinook Okimakanak, (Northern Chiefs Council). Six First Nations communities pooled their technical resource dollars and formed a Technical Services Organization (TSO).

TSO provides advisory services, technical services, and project management services, to the communities that we work for. TSO advises the Chiefs and the Council on their negotiations with contracts, dealing with Architects, Engineers, INAC, and Health Canada, to ensure they get a fair deal from the Contactors, that their interests are protected and that contracts are a bit in their favour. TSO gets involved in project management in the contract tenders, contract formats, hiring architects and engineers and transport contracts for the delivery of a building. TSO also makes sure
that the communities get a fair share of local labour, local materials, and that the contractor stays in a local motel.

TSO gets involved in housing community projects and building inspections. The communities are, Fort Severn, Balmertown, Red Lake, (which is TSO home base), Poplar Hill, MacDowell Lake, North Spirit Lake, Deer Lake and Keewaywin.

All these communities depend on winter road access. Typically contracts end up being supplied out of Winnipeg and material comes in to either Red Lake or Pickle Lake to access the winter roads. Some materials are railed from Winnipeg to Moosonee and then go by barge to Fort Severn. The alternate route for Fort Severn is the winter road across into Manitoba. It takes three seasons to construct a building at Fort Severn using a combination of winter roads and barges.

On the winter road network into Keewaywin, material comes from Winnipeg to Pickle Lake and up and around. The distance from Winnipeg, by land, is about 1800 kms round trip. By air it is only about an hour and fifteen minutes. The transit time by truck is about 3 days each way with the drivers sleeping in their vehicles.

The communities start building winter roads at the end of December, sometimes January depending on the ice thickness. TSO starts hauling freight, depending on conditions, from February to the end of March. It has always surprised me how long it takes for the ice to build up. They have to push the snow back to let the ice form better. They drill holes to flood the ice and build up the road. Unlike the twin lane roads used by the diamond mines in the Northwest Territories, they are lucky to get one lane traffic roads because time is very tight, machines are breaking down and snow storms have to be cleared.
When TSO prices out a job, we automatically assume air freight. If the contractor gets that building in on a winter road, that is his bonus because the roads have become completely unreliable. Last year into North Spirit Lake, the winter road only provided 10 days of service. At Poplar Hill, the trucks were getting struck, but they got in there. The other communities had to use air freight.

Imagine what the First Nations communities are up against. The winter road season is getting shorter and shorter every year. Some of the communities automatically price in air freight. It costs a couple of hundred thousand dollars just to bring fuel in by air. This is why we have such an interest in airships.

TSO tried different ways to stretch the dollars for housing. Some communities decided to buy modular units. The ice roads over the lakes are fine but there is always lots of damage on the roads between the lakes. It is an impossible task to get the insurers to cover this expense. The winter road overland is one thing, but late in the season the biggest problem is the shorelines. They start to melt right away and everyone gets stuck, right where the ice hits the shores.

From Berens River to North Spirit Lake is 116 kms. Last year they got started at the end of the November building the winter road, but because the weather was not cooperating hauling was delayed until the end of March. Even with an early start we only obtained 10 days of hauling into North Spirit last year (2006/2007). The year before, we had no road access. From North Spirit Lake to Deer Lake, (88 kms) they have two options: it's either community built or contractor built. Some communities can deal with it, some cannot. The TSO office has these records for a few years. In 1999 it was cold and they had a 4 to 6 week window. In 2001, a partial window again. In the
2004/05 season, a two week window. In the 2005/06 season, no roads. 2006/07 it was a 10 day window into North Spirit, and a one trip window to Deer Lake. The drivers just went in to Deer Lake turned around and came back out.

Air transported materials are shipped to Red Lake by road and then flown into the communities. Wasaya Air is the main freight supplier. The freight costs, typically, add 20 to 40 percent on to the materials cost on a house package. The pilot makes a flight decision depending on weather conditions. Some material can be stored at the hangar; sometimes it is left outside, and gets damaged. How do you replace what is damaged? In the North West Territories they crate everything. In northern Ontario they try to move it all up one piece at a time, quick as possible; hence we get damage.

This is an actual cost breakdown of a typical house built at Fort Severn; the materials package is $92,000, the rail freight, $19000, barge freight $34000, the total $146000. The cost of the freight was $1.68 dollars per pound. The freight adds 57 percent to the cost of material and in addition to the cost of local handling, local labour, and supervision. The typical house in Fort Severn costs $280,000. This is where it takes three seasons to build a house. The first season is site preparation, the second season is putting the house up to the enclosed stage, and the third season is doing the inside finishing of the house.
Olympic Building Systems, out of Winnipeg, have been quite good. When they first got into this they provided a foreman and trained local crews. Now the guys at Fort Severn can build these houses themselves and that is key.

The Nursing Station at Deer Lake is being renovated and expanded. We got some material ordered in last year at the tail end of the winter road season. The material shipped was 141,255 lbs at a cost of $67,000 for winter road freight. We loaded four storage vans in Winnipeg and welded the doors shut, and left them at Deer Lake. We had to pay for the vans but we had no choice. So the freight costs over the winter road and buying the vans cost us 32 cents per pound.

The communities are responsible for the winter road with a budget allocation from the Ontario Government. A couple of years ago INAC asked TSO to do a cost comparison of road and air transport because when the winter roads did not go through everyone asked for a subsidy. We did 7 communities including Keewaywin. A typical small house package, (40 to 50 thousand pounds), requires 6 or 7 loads. The winter road cost is 33 to 44 cents per pound. To Keewaywin by air freight for the same small house package worked out to $1.17 to $1.99 per pound.

We would be prepared to work with any group to provide detailed numbers for a needs assessment. We can show you exactly what it cost to bring the materials for a house up to our remote communities. We can also provide other information that you might need to sell the airship. Here is what we are up against with the winter roads. Working at night, cold temperatures, and one machine falls through the ice or gets stuck and you have to get another machine to get it out. These last few slides show the risks that we run into on a daily basis when driving and working the winter roads.
Question 1 – Do you have a record of the costs to build the winter roads?

Answer 1 - The Province of Ontario website lists how much money each community gets to build their portion of the winter road. North Spirit Lake in this case gets $182,700 to build 116 kms of road. Sometimes there is not even a road. This year we only got 10 days use of the road. This money is spent every year and the Government is on the hook.

Question 2 – How many houses do you build each year?

Answer 2 – This year we have 5 houses going to Fort Severn, 7 into Deer Lake, 3 in Poplar Hill and next year we are planning for 7 into Keewaywin. We build 12 to 16 homes every year. There is an acute housing shortage. We have identified communities where we could use 25 houses immediately. We have families where you walk into a bedroom and there are 4 kids sleeping on mattresses. The homes cannot be condemned because there is nowhere else for the people to live.
Observations on the Airships to the Arctic

Speaker
Mayor Michael Spence
Town of Churchill, Manitoba

Thank you for the opportunity to address the Airships to the Arctic Symposium 4. This is a quite interesting topic to the northern communities. One of the challenges that we all face in the North is the high cost of transportation. We all share the same vision that airships are the future. We have seen the progression from tractor trains to C46s, DC 3s, 737s, the Heres, and now to airships. It was interesting to hear the many challenges of the resource extractors. Both mining and forestry face many challenges because of the cost the high cost of extracting product and getting it to market. Doing business in the north is expensive.

It was interesting listening to the many challenges BBE have in terms of doing business and providing opportunities for the folks that they serve. The opportunity is northwards. Where are these precious metals? Where is the Boreal forest? The North is the future, so the vision has to be airships. How much time is it going to take? Is it 10, 20 years away; we hope not because the remote northern communities cannot wait that long.

The Honourable Ron Lemieux indicated that the Province of Manitoba is very interested in the next generation of transportation. We have to educate the people that are not aware of what is really happening today. Climate change is a big part of the problem. In my community the polar bears are a tourist attraction. We are seeing bears coming off the ice two weeks earlier and getting on the ice two weeks later. A whole month is huge for these animals. We need to address the issue of climate change because the challenge to the transportation sector is real.

At Churchill we have the benefit of not being totally isolated. Sure, the price of milk is expensive, around $6.00 a jug but, the high Arctic pays about $13.00 for a jug of milk. The Port of Churchill is land connected by a rail line from the south. From Churchill product is shipped by tug and barge operation and also on an ocean going vessel. Transportation companies were trying to use climate
change as a benefit in terms of extending the marine season. Through the Port of Churchill, the shipping season used to end just about Thanksgiving Day, in mid October. Now we're still trying to ship goods North past the end of October. We have to be very careful because we are treading on very thin ice.

Today’s presentations were very informative. They hit home, but as I said, and as Dr. Prentice continues to say, the vision of Airships is real, now let’s make it work because it needs to happen.
Airships to the Arctic IV Banquet

Dedicated to the Entrepreneur
Hubert Kleysen

Conference Chairman – Dr. Barry Prentice

Each year at the Airships to the Arctic we dedicate the Conference to an individual and to an area. This year the dedication is to the Entrepreneur and the Entrepreneur in question is Hubert Kleysen. He will be introduced more formally but I just want to read a little bit about why we chose Hubert. The theme of the 4th Airships to the Arctic Conference is Making It Happen. Thus it is most appropriate that this Conference is dedicated to the Entrepreneur. History is made by those who had the courage of their convictions to try something new and different. When they are successful Entrepreneurs improve and enrich all of Society because they grow the economy and the choices for consumers. Hubert Kleysen is being recognized for his contributions to Manitoba as a preeminent Entrepreneur in the field of transportation. The work he has done in building a successful enterprise, his vision of WinnPort and his many selfless charitable endeavours have garnered him national respect.

The advancement of airships has been held back by a lack of confidence, even though the market is ready for the technology. Without Entrepreneurs to make it happen, a terrible alternative often occurs. Nothing is done. This conference, is therefore, respectfully dedicated to the spirit of Entrepreneurs, such as Hubert Kleysen, who make such a marked difference by their personal energy, enthusiasm and creativity.

I am not an expert on Entrepreneurs, but fortunately on the campus of the University of Manitoba we have a Professor of Entrepreneurship who researches and teaches in this area. I would like now to ask Professor Reg Litz to come to the podium and say a few words about, “What is an Entrepreneur”.

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Good Evening. Mr. Kleysen, congratulations this evening. Barry Prentice called me in the last few days and asked if I would explain in a nutshell, what an Entrepreneur is. I have my students do all kinds of different exercises. A number of years ago one of my students wrote a poem about Entrepreneurs. One line, I would like to read to you from that poem goes like this. “He sits alone with vacant mind in his hand; his psyche distorted his vision in an indefinite land.” An Entrepreneur is about, envisioning, what might be. It is about taking the steps, toward the question mark, and seeing if indeed, the answer you think is there, in actuality is.

Peter Drucker, Management Guru, who passed away recently, wrote a book called “Innovation in Entrepreneurship”. The essence of the Entrepreneur, he said, is one who perceives and responds to opportunity. In that book he identified all kinds of different opportunities, such as the unexpected. How many remember what happened November 10 or 11, 1989? An unexpected event happened in Berlin, Germany. The Wall came down. We will talk more about that in a moment. Opportunities come from the unexpected: from incongruities, from process needs as changes in the industry and market structure, demographic changes, changes in perspective, development of new knowledge. Drucker said - it is about responding to opportunities.

Joseph Schumpeter is the other name I just want to mention briefly. He said the essence of the Entrepreneur is to respond to opportunities by enacting new combinations. He wrote a book called the Theory of Economic Development in the 1930s. One chapter deals with entrepreneurial profit. He says in that what an Entrepreneur does is enact new combinations; and what is an airship but a new combination. A new way of delivering a product, a new better service, a new method of production, a new market, a new supply of raw materials, a new form of organization, some new combination. This is why creativity is so closely related to entrepreneurship.

Creativity, Neller says consists largely of rearranging what we know in order to find out what we do not know. Hence, to think creatively we must be able to look afresh. A new perspective at what we normally take for granted and there are all kinds of different ways to combine this new form of organization, new market supply of raw materials, better service.
A couple of days ago I bought a cardboard box. Inside the box there is a brochure with a map of Berlin and a little velvet pouch. Inside the pouch is a piece of concrete. This used to be part of the Berlin Wall. In November 1989 when we were all watching the Wall come down an entrepreneur thought somebody on the other side of the world, in Winnipeg, was willing to pay money for a piece of concrete. This is an example of an Entrepreneur.

Well, just to bring it all together, there is a piece written not too long ago that nailed it quite nicely. They said the essence of what an entrepreneur or what entrepreneurship is about is the examination of how, by whom and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited. That is what you are here to recognize tonight. Mr. Kleysen, congratulations on being an entrepreneur and leading the way.

**Dr. Barry Prentice, Chairman**

It is now my pleasure to introduce Bob Cunningham, the President of Cunningham Business Interiors, who will introduce Hubert Kleysen. Bob has been in the office furniture business for over 43 years. Approximately 42 years ago, a lady by the name of Margarite Kleysen arrived at the Cunningham showroom to purchase a typewriter table that was on sale for $89. She asked to speak to the owner. When she was introduced to Bob she advised him that the price was too high. Bob and Mrs. Kleysen struck up a business relationship that surely stood the test of time. I do not know if she received a discount or not, but I will leave that to Bob to tell us. Bob later met her son Hubert Kleysen and they continued doing business for the next 25 to 30 years. During the past 12 to 15 years the tradition continues as Bob’s son Rob does business with Hubert’s son Tom. This is Winnipeg. The relationship between these two families is indeed unique as it now spans 3 decades. It is with great pleasure that I ask Bob Cunningham to introduce our guest of honour this evening.

**Bob Cunningham**

**President, Cunningham Business Interiors**

Thank you Barry, Head table guests, Ladies and Gentlemen, I am sincerely honoured to have been chosen to introduce, my good friend, Hubert Kleysen at a futuristic conference: the new use of old
technology to solve problems that have challenged entrepreneurs for a century. If oil and gas can successfully and economically be hauled out of the vast reserves of the Arctic by airship what a boom this will be for Manitoba and Canada.

This venue is perfect for Hubert because he revels in challenges and throughout his life he has always been ahead of the curve, seeing things not as they are, but more so, how they could be or should be. Hubert is a master of innovation and creativity which surfaced early in his career when due to the loss of his father in 1960 and at the tender age of 25 he was required to take over the management of the family firm, Kleysen Cartage, that Hubert’s dad, Harry had created in Toronto in the year 1930. By 1960, the company that had started with one truck had now grown to more than 50 trucks, tractors and more than 100 trailers. Reg alluded to Peter Drucker, what he has written "Innovation and creativity alone do not make a successful businessman. Successful businessmen either have it or they don’t or they buy it”. In Hubert’s case he was blessed with both business acumen and innovation.

Throughout his career Hubert has found ways to do things that no one has done before. While equally important, doing them in a profitable way and being intelligent enough to patent his ideas. Hubert has several patents. Kleysen Transport became one of the top five trucking companies in Canada with thousands of trucks and trailers hauling everything from mail to potash to gravel, nickel, sugar beets, cement and liquids of all kinds. It is difficult to drive anywhere in Canada or major roads in the United States without seeing the Kleysen logo. However Hubert did not limit his transportation interests to road transportation. He has involvement in railroads, airlines, road building, material handling and distribution centers.

Hubert realized the company had grown to enormous size and needed a strong leader to carry on the business into the future. His choice was his son Tom but in typical Hubert fashion, he did not want Tom to be a clone, having grown with the business and with Hubert’s tutoring. He wanted Tom to be his own man, so he asked Tom to take a senior position with a large U. S. trucking company to ensure another perspective on running the business. When Tom returned to Winnipeg he became the President of Kleysen Transport and his dad Hubert became Chairman of the Board. Through all of his success, Hubert has steadfastly remained a loving husband, father and grandfather. He has strong religious beliefs that have carried him through many hardships as well as
a few disappointments. When faced with serious health problems he dealt with these challenges in the same manner as every other challenge he encountered in his lifetime. He relied on his strong faith, the support of his lifelong partner, Bernice, and his loving family. He refused to take the initial verdict of his doctors in Winnipeg and with the help of his Assistant Heidi, they did research until they found a doctor in Toronto willing to take the same risk as Hubert and thanks to his beliefs, and of course, his hard headed persistence, he is with us here tonight.

The one thing that Hubert never talks about is his unselfish desire to contribute to the community with no expectation of recognition. The same fervour and passion he displays in his business life is evident in anything in which he gets involved. Whether it is chairing and raising large sums of money for organizations like the recent Health Sciences Center $25 million breakthrough capital campaign, to helping organize the Grey Cup Light Parade in a way that it has never been done before. He also chaired the St. Paul High School “Paths of Discovery” campaign, the Desiree Foundation and countless significant contributions of all kinds, to these and other charities. Hubert has shown a willingness to share much of his success with many others. He is past director of the Manitoba Trucking Association, past director of the Manitoba Association of Roads and Transportation Canada, past member of Canada Post Business Council, currently he is a member of the Premiers Advisory Council, member of the Associates of the Asper School of Business, a member of the Knights of St. Lazarus, member of the Canadian Dutch Business and Professional Club, a member of the St. Charles Country Club and the Manitoba Club. He is a member of the Ocean Reef Club in Key West, Florida, and he is a member of the Ft. Garry, Roman Catholic Church, St. John Brebeuf.

In 2006 Hubert and Bernice celebrated their 50th Wedding Anniversary and in true Kleysen fashion it was first class. There are many people in this room who know Hubert and know what kind of person he is. It is my privilege to invite him to the podium and tell us about his career and some of his life experiences and following his presentation he will be joined by Barry Prentice of the Transport Institute to answer some questions. He will then be suitably recognized for his great contributions to the Industry. Ladies and Gentlemen please join me in welcoming Hubert to the podium.
Ladies and Gentlemen, fellow Entrepreneur/Dreamers, there is no difference between a pioneer and an Entrepreneur/Dreamer. They want to do something to make life better and are willing to take a chance. About 40 years ago natural gas was discovered on Ellesmere Island in the far north. When they found it, it was like the dog that caught the car. What does he do with it? A pipeline would not be feasible because, if they laid it on the ocean floor, the only place they could, the icebergs would come and scar the ocean floor down 200 feet and the pipeline would be ruptured. Then they thought of using freezer ships. Freeze the natural gas down to 50 below into a liquid form and take it out that way. I do not know if they have taken any of the natural gas out yet.

I thought of transporting it out by airship. I talked to my children and Tom did a project at school, on transporting gas from the North by airship. I did not research it, but I thought a lot about it. My idea was which is why I called it Entrepreneur/Dreamers, to have an airship with an inner bladder. Fill the inner bladder with air in the South, fly north, pump the inner bladder full of natural gas and push the air out. Reverse the process when you got to the mainland.

The cargo could be transferred at Churchill where there could be a pipeline or bring it further south to Winnipeg or Gimli. Also being a trucker and wanting a two way haul, we could strap containers underneath them and on the way north drop the containers off at the little settlements or take them all the way to Ellesmere Island. While we never followed through on this, I have had an interest in airships for a long time and I am very happy to see today there is such an enthusiasm for the airships.

This gets on to a different subject, but I think I will tie it together. A number of years ago we studied the possibility of making Winnipeg a Northern Hemisphere Distribution Center. We soon came to the revelation that it could be a very solid venture, bringing goods from Europe to Winnipeg, by air, distributing all over North America by truck and small airplanes. For example freight could land in Winnipeg, clear customs and trucked to Los Angeles. It could be on the streets of L. A. faster than by air direct from Europe to L. A. where it would confront a congested airport. The same logic could apply for shipments from the Far East.
Another possibility was to ship European cars by air to Winnipeg. It would save the car companies a fortune in inventory. Instead of having thousands of cars all over Canada and the U. S., a customer could decide on a certain car model, place the order and have it delivered to him within 7 days. The savings would be unreal. Now for Winnipeg, what that would have done is start a massive amount of small cottage industries. Soon the cars would come with no floor mats and some local person could be making floor mats, or headlights or rear view mirrors. It was unending on the amount of things we could do.

G. M. was building a Buick Assembly plant in China. We looked into the possibility of gathering the parts up for the assembly line from Texas, the Carolinas, Detroit and Windsor. Then from Winnipeg ship them to China via air. The cost savings on inventory would be huge. It takes 6 weeks to get the goods from the factory, overland and by ship to China. By our method it would be 3 days. The biggest saving for manufacturing in the last 20 years has been the adoption of the Just-in-Time system.

We did run WinnPort for a short while to and from China but did not enough backing to keep it going. We had a very large backer that got into trouble, with the Russian currency squeeze at that time. When the Russian ruble went way down, the financier backed out of the deal. So we voluntarily shut the operation down. He was going to come up with money in six months but we did not have deep enough pockets to keep it going for that length of time. The WinnPort business plan, to my idea, was a solid plan. With the possibility of airships it could be revised again and Winnipeg could become the Northern Hemisphere Distribution Center by airship.

The reason I think that airships are better than cargo planes is their buoyancy. A ship can sit in the water, does not cost anything. A truck can sit on the side of the road, and trains can sit on the tracks, does not cost anything. A 747 costs 80 gallons per mile to keep 100 tons in the air. By comparison, trucks can move 400 ton for a mile with one gallon of fuel - quite a difference.

What does it cost to push a large airship through the air? You are not paying 80 gallons per mile to keep it in the air. A 747’s fuel consumption would heat 100 houses. In just one day in the U. S., airplanes are consuming 104 million gallons of fuel. Now what does 104 million gallons of fuel
mean? Well if we relate it to homes, it would heat 130 thousand houses for a year which is about the size of Winnipeg. Airships would certainly consume less fuel than a 747.

Apparently when the U. S. grounded its air traffic over the U. S. for two days after 9/11, the atmospheric temperature went down 2 degrees. If the research in this article was accurate we should definitely be more concerned with global warming and using renewable energy. This is why I think airships should be considered in moving airfreight and possibly even passengers in the future.

I listened to part of the conference today, where you were talking about the northern communities. It is a wonderful idea to ship to the northern communities by airship, especially out of Winnipeg. An airship can come right into the community, not like in some places where the airstrip is on an island and the village is somewhere else. These little villages, up north, could have cottage industries, like in Japan, where they have sampans going up the river to a village with a bunch of wires. The village people make wire harnesses and send them back. We could do a lot of this in our northern communities. Let the people live where they want in their communities but bring them work.

I have invented and patented a hurricane tamer. I have been working on it since 1993 when I saw what Hurricane Andrew did to Southern Florida, especially Homestead. For miles everything was flattened. A hurricane warning to evacuate in central Florida costs two hundred million dollars, never mind all the hardship on the old, the young, and the people on the beach that had to move. Katrina cost billions and it is still costing millions of dollars a day. On the flip side though, the U. S. needs hurricanes. They need it to supply water to all the southeast part of the U. S. This year that has had no hurricanes there is massive drought in Florida, the Carolinas, Georgia, Tennessee and all through that area. So hurricanes and tropical storms are needed. This is why we do not want to kill a hurricane; we only want to tame it.

They pretty well know where Hurricanes start and when they start. My idea is to get into the path of a Hurricane and cool down the surface of the ocean. Hurricane taming is based on using a decommissioned Iowa class battleship. They weigh 60 thousand tons, the length is 900 feet and the width is 100 feet with 210,000 horsepower. My idea is to mount a 30 by 50 by 300 foot long scoop on each side of the battleship. Bring up water from a hundred and fifty feet down that is 70 degrees.
At twenty miles an hour it could scoop up 60000 cubic feet of water per second. Hurricanes grow at 80 degrees Fahrenheit. If we can lower the water temperature by 1 to 3 degrees we could tame it, we do not want to kill it. My idea is we find a hurricane, someplace near the coast of Africa, and stay in front to keep this in a one or two category hurricane. Let it hit the coast where it wants to. There would be enough water in one or two hurricanes to supply all the water they need. The extra water from stronger hurricanes just runs off in massive floods.

The people from the Hurricane Center say what, you want to tame a Hurricane. One of them asked me, what are you going to do? Train it next. You want to stand in front of the hurricane - the last person that I heard could walk on water was a long long time ago. Oh, you want to be on a battleship. What do you intend to do? Point the guns at the hurricane and say stop in the name of the law. Sounds like a good idea they say, we will think about it and call you. No, we do not need your number. Oh, please do not call us, we will call you. Generally that is what the conversation is on the phone, sometimes it is click. So I am still trying to get to people who will understand it. The CBC had a long program on hurricane taming or killing. I did get some names from that program so maybe I will pursue this further this winter when I get rid of these crutches.

I appreciate the opportunity to speak and I certainly appreciate the words that Reg, Barry, and Bob said about me. I guess in certain ways I am an entrepreneur. I have built a lot of things, have a number of patents, have had a lot of failures, but I always looked at it this way. If you got more in the front yard that works than bad ones in the backyard that do not work, you are still ahead. Unless we try, what could we gain? After 350 failures of the light bulb, Edison was asked are you discouraged? He said no; I know an awful lot of ways not to make a light bulb and am that much closer to having a successful light bulb.

What can be done to open up the door for airships to get fuel out of the North and to help all these small communities with year round steady transport service? I had an airline that I flew north for awhile. You could not get into communities without a runway for a month in the spring or a month in the fall. We used float planes in the summer and skis in the winter. With the warming temperature our winter road season is cut back, so far that it hardly pays. We used to be able to get into the winter roads in early November and then sometimes stay right to April. Mind you we stayed too long once and lost a truck up there. Nevertheless the season is shrinking and shrinking. We are
not hauling on winter roads anymore but when we did it was a tough ride. So to get airships to run back and forth, is a marvellous idea and certainly worthwhile for entrepreneurs go after.

There is definitely enough work, in the north, to support airships without Government subsidies. It is like the movie, “Field of Dreams” If we build the airship, it would go to work. There is the need for something to improve transportation to communities in the North where they are starving for goods coming in and out on a regular basis and at a price that is affordable. Bring down their costs compared to bringing in freight on the C46, a 60 year old airplane, or by truck over the ice roads that no longer work. So, to everyone who is involved in this, I think you have a super idea. Thank you very much, I will be here if you want to ask me about some of those dreams or nightmares that I have.

Dr. Barry Prentice, Conference Chair

Thank you very much for joining us tonight Hubert to bring us your remarks and for relating your creative ideas. Taming hurricanes makes the return of airships sound like an awfully conventional, conservative idea by comparison. I can say for all of us that your words are inspiring and that you have been an inspiration to the community in general.
AIRSHIPS TO THE ARCTIC IV:

Day Two
Airships to the Arctic IV: Day Two

Welcome

Mayor Tim Johnson
City of Thompson, Manitoba

I want to thank the Isopolar Airships Association and in particular Dr. Barry Prentice for hosting this Conference and extending an invitation to the City of Thompson to participate. I along with my colleagues on council appreciate the opportunity to address the Conference and I want to extend greetings and welcome to all of you. The City of Thompson has a keen interest in pursuing discussion on lighter-than-air technology, in an effort to address the challenges facing our northern communities regarding transportation and economic development. I appreciated sitting in the audience yesterday and hearing about some of those challenges firsthand from other communities around northern Canada. It is our belief that Thompson can and is able to assist you, the delegates, industry, and Government in making it happen in Canada. I want to discuss some ways in which we can be of assistance. I am very pleased to say that I have had the opportunity to attend this conference previously as a delegate representing community economic development in northern Manitoba. I am excited to speak to you as the Mayor of the City of Thompson and share some information regarding our city, the region and to speak specifically to transportation winter testing. I also want to acknowledge that I am joined today by Mayor Michael Spence of the Town of Churchill who has been a huge advocate with respect to transportation in northern Manitoba and northern Canada.

The City of Thompson is a dynamic growing community of approximately 15,000 people located in a resource rich and centrally located geographic region of northern Manitoba. Thompson was originally developed in the late 1950’s around an INCO nickel deposit. One of the largest nickel belts in the world. Thompson has experienced steady growth over recent years based on mining, hydro, aboriginal economic development and the emergence as a service center for education, health
and transportation. Indications are that this growth will increase over the next years with projections easily leading us into 2027 and beyond.

Historically, geographic location and weather have been seen as detriments to our growth. However, these are emerging as our greatest strengths. I attribute this change to two things: first, technology and second, attitude. I would suggest that technology and attitude may also be critical to the growth of airships.

As a part of our growth, the region will see increased mining exploration in and around Thompson, including the communities of Wabowdon where a new mine is currently being established and Snow Lake where new deposits have been located. As well as a potential for three major hydro projects on the Burntwood/Nelson River system of which the first project, Wuskwatim, is currently under construction. The last project, Conawapa, will be one of the largest construction projects in the world, when it proceeds, likely, within the next 10 to 15 years. These projects will require tremendous capital investment and infrastructure development. Thompson is ideally positioned to support these developments. The growth we will experience as a community and a region provides tremendous opportunities for the growth of airships.

Central to our ability to act as the hub of the north is the tremendous transportation links to our community. Thompson has road access from the south on Hwy #6, 739 kms from here to Winnipeg on a fully paved surface that accommodates regular passenger traffic as well as bus and freight services. Hwy. #6 has recently been approved by the Province of Manitoba for extended length transport trailers on a pilot project basis and that is in place as we speak. Access north is via Hwy. 280 to Gillam in terms of hydro development and 391 to Leaf Rapids and Lynn Lake with respect to mining. Thompson has rail service with VIA providing customer passenger service to and from Churchill with respect to tourism. Hudson Bay Railway also provides freight service on the same line.

Most importantly to those in this room is the Thompson Regional Airport, owned and operated by the independent Thompson Regional Airport Authority. By air, Thompson is served by daily scheduled flights between Winnipeg and Thompson (including the addition of Boeing 737 service)

I also want to introduce Mr. Curtis Ross who joined me from Thompson to attend the conference.
as well as charter service all over northern Manitoba. Here are a couple of quick statistics on the Thompson Regional Airport. It is the second largest airport in Manitoba. We average approximately 32,000 movements per year, (landings and departures). Approximately 3,000 medivacs are made per year. The Thompson Regional Airport will see one hundred thousand passengers this year, which is quite important. This year we will finally match the same numbers that we saw in the early seventies. We are growing again. We are the hub to twenty-three of the twenty-six northern airports. A discussion took place yesterday, with respect to access to airports, we are the central location. Currently, the airport is the only 100 percent reliable means of transportation on a seasonable basis into all northern communities in our region and beyond.

Transportation is an important industry to the City of Thompson. The city has emerged as a major distribution center for moving freight into northern Manitoba and beyond. Of the twenty industrial sites we had available for sale in 2007, 17 have been sold, all relating to transportation warehousing and movement. This is tremendous growth in one year. It makes sense that Thompson is an ideal location for airships from a transportation perspective.

One of the most successful economic development stories in Northern Manitoba and indeed the Province of Manitoba and Canada has been the emergence of the City of Thompson as the premier winter testing site in North America. Earlier, I spoke about our geographic location and weather being two of our greatest strengths. With respect to winter weather testing it is what makes it all possible. Our accessibility resulting from our transportation infrastructure and our unique weather pattern resulting from our proximity to Churchill and Hudson Bay provides a unique weather pattern that we have been advised is only duplicated in Siberia. It is truly unique. Winter weather testing can support airships in two ways. Providing a location for testing of airships themselves and components of airships and secondly by providing opportunities to move products for testers.

One of the largest testing companies in Thompson is the Ford Motor Company of Dearborn, Michigan. They move vehicles constantly between November 1 and the end of March to and from Thompson. Right now, there is not a Ford product with a blue Ford nameplate that has not been signed off for winter weather testing in Thompson Manitoba. In addition, Ford owns a number of other auto companies including Volvo, Saab, Land Rover and Aston Martin. The latter vehicle from the James Bond movies was in Thompson Manitoba being tested on a frozen lake. All the major
auto manufacturers are located or have a presence in our community including GM, Hummer, and Chrysler.

We have also moved into snowmobile testing and we are on the verge, I hope, of announcing a major jet engine testing facility located in Thompson for North American and worldwide testing. When the National Research Council did a review of 50 communities across Canada for the best winter testing location Thompson was number 1. We received a call, yesterday, asking us to forward pictures to Ottawa, because yesterday in Montreal where their meeting was taking place, the temperature was plus 15 and we were -4 with snow. Sometimes it pays to be in the North.

I am extremely excited about the future of Thompson and northern Manitoba. Even though you may see it as a small region, the economic activity that is taking place in northern Manitoba has worldwide significance because the product goes all over the world. Most of the nickel produced in Thompson finds its way to China.

I have one last story on transportation. Five years ago when INCO had some concerns with respect to the future of its operations, it started to move concentrate from Australia to Thompson Manitoba for production as nickel. Mr. Kleysen, if you looked at his bio brochure, was one of the entrepreneurs that provided the transportation network to move that nickel. Every day on Hwy 6 you were constantly passed by Kleysen trucks carrying concentrate from Australia and nickel back from Thompson. I am very pleased to be here today. I thank you for the opportunity. I believe that together, the City of Thompson and the airship industry can work to Make It Happen in Canada.

**Dr. Barry Prentice, Conference Chair**

Thank you very much Mayor Johnston, we appreciate your words of welcome. Those who are interested in using airships in the Arctic know that these vehicles must survive the cold temperatures, the snow, and other challenges. We appreciate the invitation to come to Thompson and do this testing. I know the people have taken note. Thank you very much for coming in and opening up the day.
Session One:
Pushing the Envelope

Session Moderator
Vic Gerden,
Executive Director,
Manitoba Aerospace Association

The Aerospace Industry is vibrant in Manitoba. There are 37 members to this Association and about 5,000 people working in the Aerospace industry in this Province. The annual revenue is in the order of 1.5 billion dollars. There are four sectors. Manufacturing covers the entire range from a small company that builds the autopilots for micro UAVs around the world, to a few larger companies, like Boeing that has a composites manufacturing facility that employs 1,500 people. The Winnipeg plant is making components for the entire range of Boeing products. They are also designing as well as building components for the 787 Dreamliner of which some 750 have been sold before the airplane has ever flown. Also in the large company category is Magellan Aerospace Corporation that builds parts components for A380 aircraft and satellites. Three satellites have been built, two are in space and another will go shortly. So the aerospace manufacturing sector in Winnipeg is quite a wide range of, primarily commercial, but also some components for military airplanes.

We also have quite a vibrant maintenance repair and overhaul segment to the Aerospace Industry in Manitoba. It includes the world’s largest turbine engine maintenance, repair and overhaul company, Standard Aero Limited. One of Winnipeg’s specialties is composites which may be of interest to those building airships. We have a Composite Innovation Center here in Manitoba which is a non-profit corporation sponsored by the Industry, as well as partly by the Federal Government and partly by the Provincial Government. They are a tremendous world-class facility that has an international reach. They talk to all the other internationally renowned similar research centers in composites materials and so they are helping us grow the composites industry in this province. We also have some initiatives underway to increase the infrastructure and to involve other companies in
various composites research projects. Finally the fourth segment is special services. We have the military flight training at Southport, which is about an hour west of here, as well as aerospace consulting, certification testing and special manufacturing processes.

We have a very vibrant industry in Manitoba and we would certainly welcome the airship folks to join our community. We have talent, experience and expertise to offer and we look forward to supporting Mayor Johnston in the bid to get an engine icing testing facility in Thompson Manitoba. It is been proven, as he said, to be the best place in North America to locate such a facility. We look forward to that and certainly the aerospace industry is indicative of an area sector that is high technology and that has a great “can-do” attitude towards everything we do. Our products and services reach six continents from this Province of Manitoba.

Our first speaker is the CEO of 21st Century Airships, Hokan Colting. He has been in aviation for most of his life. He started out doing military service in the Swedish Air Force. He has flown gliders as a hobby and he taught himself to fly hot air balloons. Since 1974 he has been designing, developing, manufacturing and flying balloons and airships. He has nine world records for airships and is an inventor with numerous patents.
Development of a New Sightseeing Airships

Speaker
Hokan Colting
CEO, 21st Century Airships Inc.

21st Century Airships is a research and development company. We have been in business since 1988. During that time we have built and flown 14 airships. We have been working on a number of projects ranging from high altitude airships, heavy lift airships and the latest project that I am going to talk about is the development of a 19 passenger sightseeing airship. Developing a new airship is part science, part art and a lot of trial and error. It is actually a lot like being married. It requires a lot of compromises.

We are going to take a look at a traditional airship and see how new airships differ from the traditional ones. Here is a little schematic drawing of a traditional airship.

The technology for most of the traditional airships operating today dates back to the 1940s. Steering and altitude control is achieved with rudders and elevators mounted on the fins. This works fine at high airspeed but when an airship is landing or taking off below 10 miles per hour, those rudders do not work. Consequently these airships require a large ground crew. Employing 10
or 15 people for ground handling an airship is just not economically feasible today. In our new design we have eliminated the rudders.

The next difference is the location of the engine. Most of today’s airships have the engines mounted on the gondola and there is some advantage to that location. There is short run for the cables. They are easy to get to for service, but they are very noisy for both the pilot and the passengers.

We have repositioned the engines on our new airship and the fins have no movable surfaces. The engines are far away from the gondola making the gondola vibration free as well as extremely quiet. In this particular airship we have an oversize gondola that is going to hold 19 passengers. The first airship will likely be flying by the end of 2009.

To develop this airship we have gone through many steps. First, we tested different shapes in the wind tunnel. The shape that we finally chose is not the absolute perfect shape from a streamlined point of view but it is not that much worse than the best shape. As I said from the beginning there are a lot of compromises and the shape we chose has a lot of advantages, too.
This is the first manned airship of this type that we have flown and that was quite recent in September 2007. We flew a 60 foot remote controlled model before that. This airship is extremely manoeuvrable. We can do vertical takeoff and landings and spin around on the axis. Steering and altitude control is by the means of the four engines that are located on the center line. The pilot workload for this particular airship is very light. All the controls are done with a fly by wire electronic control system. We had hoped to fly this airship early in the summer, but every control system on an aircraft needs a redundant system. It took us until the fall to get a redundant system that was acceptable.

The most usable measurement of an airship is the volume. The sightseeing airship is going to be 14,500 cubic meters in volume. This particular airship is 22 percent volume wise of the full size one. We have a slightly larger version which is 29 percent of the full size one. It will be ready to fly at the end of the 2007. We are going to do quite a lot of flying with a larger airship. The first version of this airship is going to be used for sightseeing rides, but it is a multi functional airship. We have also developed technology for a heavy lift airship.

Question 1 – What were the conditions during the test flight?

Answer 1 – There was very light wind on the ground. There was about a 50 knot wind up about 700 to 800 feet where we were flying.
Question 2 – Have you abandoned the spherical airships?

Answer 2 – No, we are still working high altitude projects with spherical airships.

Question 3 – What are the performance specifications for the sightseeing airship?

Answer 3 – The full size version is going to have a top speed exceeding 100 kilometres per hour and duration of over 12 hours with a full load.

Question 4 – Does putting the engine on the side change the ride of the airship?

Answer 4 – A good question. Traditional airships have engines on the gondola, far below the center line of the airship. Every time you pull up some power the airship is pitching up; when you pull the power down, the airship is pitching down. This airship is extremely stable as the thrust line is right on the center line of the airship.

Question 5 – What are your plans going forward?

Answer 5 – We are working right now on a demonstrator that is going to be able to lift one ton. I believe that the technology that we have developed for the heavy lift airship is scalable to at least 40 to 50 tons, but it will likely take 4 to 6 years until we have done it. It depends on how much funding is available.

Question 6 – What are the dimensions of the sight-seeing airship?

Answer 6 – 240 feet long, 14,500 cubic meters in volume, and 60 feet in diameter. The airship that we showed was 135 feet long and 37 feet in diameter.

Question 7 – How many crew members do you need on the ground?

Answer 7 - One or two people on the ground. It is extremely manoeuvrable; it is manoeuvrable from 0 to full speed.
Question 8 – How long does it take to inflate the airship?

Answer 8 – It takes about 1 to 2 days, but after you inflate the airship you leave it inflated unless it is just a test vehicle. Normally an airship is left for a couple of years, until it needs to be inspected. This is a question of airworthiness.

Question 9 – What is the helium leakage rate?

Answer 9 – About 30 to 40 cubic meters per month.

Question 10 – Do you employ ballonets?

Answer 10 – No, we do not have ballonets. We have reverse ballonets. We have five helium cells in that particular airship that can expand and contract at will.

Question 11 – Did you come to Canada because of the regulatory environment?

Answer 11 – No, I came to Canada for a simple reason, my wife is Canadian and that is good enough, but Canada, I believe, is a good place to build an airship. We have Transport Canada that is there to regulate all air traffic. They are very easy to work with. A type certification of an airship is a very long process. We started last summer and I will be very happy if it is complete by the end of 2008. So it is more or less a three to three and a half year process

Question 12 – Are the propellers directly coupled to the engines or electrically driven?

Answer 12 – They are directly connected to the engines. We have worked with hybrid electric systems, we have diesel generators driving electric motor propellers but it is quite a complex system.

Question 13 – Is the aircraft going to be for sale?

Answer 13 - Yes and no. For the sightseeing operations we are going to run that ourselves. That will be a division of our Company.
Question 14 – What will it cost to purchase this airship?

Answer 14 – I do not have a price today, but I do take deposits.

Question 15 – What would happen if the engines failed?

Answer 15 – We have 4 engines so it is very unlikely that even one engine will fail, but, airships, in general are the safest aircrafts in the world. Let's assume that all four engines or all engines on an airship fail, you do not fall from the sky. You get down because every airship has helium valves. You can open the helium valve to descend slowly, usually you have emergency ballast that you can drop. If you are floating in an airship absolutely level and you drop a couple of handfuls of sand you start to climb slowly. It might take you a couple of minutes after it happened, but it will happen.

Question 16 – Do the passengers have to stay in their seats the entire time?

Answer 16 – The whole purpose of that big gondola that we are building is that passengers can walk around in the cabin. Passengers have to be seated during takeoff and landings but they will be able to walk around, walk up to the bar, and walk to the washroom.

Editor’s Note:
At the fourth Airships to the Arctic conference, Hokan Colting announced his intention to fly his new airship from Ontario to a remote First Nation’s community in Northern Manitoba. In July 2008, he made a unilateral decision to cancel his attempt at this record setting flight.
Session One:
Pushing the Envelope

Development Geo-Physical Survey Applications

Session Moderator
Vic Gerden,
Executive Director,
Manitoba Aerospace Association

We have with us Michael Schieschke the Chief Operating Officer of Zeppelin. He has held similar positions in the aerospace industries in Germany for several years. Before encountering the aerospace world, Michael Schieschke was heading the legal and HR department of a leading mechanical seal manufacturer and distributor. He is involved in a couple of Zeppelin projects including a geographical survey in the Kalahari Desert for the De Beers Group.

Speaker
Michael Schieschke
COO, ZLT Zeppelin Luftschiffftechnik GmbH & Co KG

Barry told me that we have a little longer time this morning due to a schedule change. I proposed that I could show the audience a video on the Zeppelin NT.

Editor's note: The next section is a transcript of the Zeppelin video.

Video commentary

Friedrichshafen, on Lake Constance, it was here, at the beginning of the 20th century, that the pioneer, Ferdinand Graf Von Zeppelin, developed and built his airships which then conquered the world. The legendary Graf Zeppelin was the most successful airship of its time. With almost 590 flights covering about 1.7 million kms.
After the Second World War only non-rigid airships, so called blimps, were built worldwide. They are often mistaken for Zeppelins. The major difference is the fact that blimps have no rigid internal structure. The aerodynamic shape of the envelope can only be maintained by constant over pressure similar to a balloon. Since the engines are mounted to the gondola the manoeuvrability is very limited and flight performance is thus relatively poor.

In 1993, with the founding of Zeppelin Luftschifftechnik or ZLT, a new chapter of airship history at Lake Constance was opened. On the 18th of September 1997 a completely new type of Zeppelin airship performed its maiden flight. Besides, great media presence even the remaining veterans of the era of the silver Zeppelins also witnessed this first flight of the L Z N07. After about an hours flight the new technology Zeppelin airship landed at Friedrichshafen Airport.

This unique, semi rigid airship is 19.5 meters wide, 17.4 meters high and 75 meters long. The rigid framework weighs approximately 1000 kilograms; a light weight with great stability comprising triangular carbon fiber frames and 3 aluminum longerons. All the main components of the airship such as cabin, empennage and engines are mounted on this rigid structure. This arrangement ensures that the airship retains optimum manoeuvrability even with a loss of envelope pressure. Non-flammable helium gas in an envelope made of high-strength multi-layer laminate fabric generates the necessary lift. Air ballonets inside the envelope provide an internal over-pressure of five millibars. Optimum safety is thus guaranteed in all flight conditions.

The gondola is 10.7 meters long and provides space for 12 passengers and two pilots for sightseeing operations. The large panorama windows and the comfortable seating make every Zeppelin flight a unique experience. More than 60,000 passengers have already experienced this gentle and smooth flight. The cockpit is a high tech work place equipped with modern avionics. Fly by wire flight controls operated by a side stick and a flight and a thrust vector propulsion system permit precise manoeuvrning and reduced pilot workload. The maximum useful load is almost 2 tons.

Thanks to the internal rigid framework, the engines are located where the propulsion vector will work to the optimum; namely, on the sides, and at the rear. Cabin comfort is not disturbed by propeller noise or vibration. The airship is powered by 3 Lycoming engines, each with 147 kilowatts equalling about 200 horsepower. Three propellers, each with a swivel angle of up to 120 degrees
and one lateral fan additionally driven by the aft engine allow extensive manoeuvrability and ensure unrivalled smooth and efficient flying. Similar to a helicopter, the airship can take off and land vertically, hover on the spot and even fly backwards. This ingenious propulsion system thus allows missions to be flown under adverse conditions.

The entire propulsion system of the airship consumes approximately 70 litres of aviation fuel per hour at a cruising speed of 80 kms per hour and at an altitude of 300 meters above ground. The maximum airspeed is 125 kms per hour. Depending on ballonet volume, a maximum altitude of 2600 meters above sea level can be reached. With a fuel capacity of 1200 litres, a range of 900 kms is possible. For special missions, the payload can be appropriately reduced to allow a maximum endurance of 24 hours.

For landing, the pilot the manoeuvres the airship only with propeller thrust into the desired position. To move the airship, only the nose line is then attached to the pull in line and the Zeppelin is then drawn towards the mast. The Zeppelin NT thus does not require the infrastructure of a large airport. It can operate out of any certified airfield. The optimized take off and landing characteristics offered by the swivel propellers means that, in normal weather conditions only a three man ground crew is required. The advantages of this are limited labour costs and vastly reduced turnaround times. As is generally the case in aviation an airship must undergo an annual inspection. The complete inspection takes about 4 weeks and is carried out in ZLT’s Zeppelin Hangar at Friedrichshafen Airport. Minor repair work or checks such as demanded every one hundred hours can even be undertaken in the open as shown here in the South African Steppe.

At present, one Zeppelin NT airship is involved in diamond exploration for De Beers in Botswana.

The DZR (Deutsche Zeppelin Reederei) is the operator of all the airships from Lake Constance. The company is a 100 percent subsidiary of Zeppelin Luftschiffftechnik and can be compared to an
airline company in the conventional air traffic sector. DZR is also responsible for the marketing of the over dimensional advertising space of almost 2000 square meters available on the envelope. Flexible advertising opportunities, such as interchangeable banners or permanent lettering turn the Zeppelin NT into a flying crowd puller. The combination of advertising and sightseeing and event marketing for Companies exhibitions and large events is particularly effective.

A maximum flight endurance of 24 hours and unique flight characteristics, such as low vibration hover and stand still permit airship missions which cannot be undertaken by helicopters or aircraft. This argument also convinced the Nippon Airship Corporation. The purchase contract for a Zeppelin NT was signed in the spring of 2004. The airship was loaded onto a special dock ship at the end of the year for the transfer to Japan. At present, this airship is being used for large events and advertising purposes.

The Zeppelin NT is the ideal research and mission platform, the variable cabin layout ensures fast and easy conversion for different missions. The spacious cabin offers room sufficient for a flying laboratory. Even highly sensitive measuring equipment can be installed due to the virtually vibration free gondola. During environmental missions, research on the troposphere or the search for mineral resources, data collected can even be immediately analyzed on the spot.

The watchful view from above offered by the Zeppelin NT makes it an ideal monitoring platform. For example, it can serve as a relay station, part of a telematic system or as a control center during large events, rescue operations or surveillance missions. Numerous special missions have already proven the concept. For example, Soccer, the traffic research project of the German Aerospace Center or TLR. During the Soccer World Cup, 2006, an airship supplied up to date traffic data to the Police of Cologne for their traffic control system. In addition to flight endurance, the low noise levels of the Zeppelin NT and the positive experience gained during the Pope’s visit during the World Youth Day, 2005, were decisive. Previously, the police had employed helicopters during similar events but due to high noise levels, helicopters tend to appear aggressive.

Due to the unique performance capabilities of the airship built by Zeppelin Luftschifftechnik, De Beers, and ZLT agreed on a diamond exploration mission in southern Africa. De Beers and Zeppelin signed a two year contract. The main task of the Zeppelin is the exploration of diamond
deposits in southern Africa. The fact that even in difficult weather conditions, the Zeppelin NT can fly precisely at low altitudes along a given grid was decisive for this mission. Since the middle of 2005 the airship has been searching for new diamond deposits in Botswana with very promising results.

The Zeppelin is back; its technology and its capabilities have exceeded, by far, the expectations of customers and designers alike. Vertical takeoff and landing capabilities, exceptional flight characteristics, excellent manoeuvrability, great safety standards with a smaller ground crew, a multi-mission airship for the future. **End of video**

**Michael Schieschke**

**COO, ZLT Zeppelin Luftschifftechnik GmbH & Co KG**

The movie gives you quite a number of technical specifications and details. I am very pleased to be here to give you a detailed look at two special missions that we have been conducting in the past two years.

The Zeppelin NT offers several unique features that distinguish it from other contemporary airships. These features allow certain scientific missions to be performed that are outside the capability of helicopters and airplanes. We have chosen two specific missions for our presentation today. One is called the Airlift project. A German Institute for atmospheric research analyzed the chemical composition and photo chemical reactions of the lower atmosphere using a Zeppelin NT airship. The second mission is the De Beers Project, a gradient gravimetry performed in southern Africa to detect below surface mineral deposits.

**Zeppelin NT Design**

The airship is called the Zeppelin NT which stands for “new technology.” Why do we call it new technology? Because of the redefined rigid structure for outstanding safety is an aluminum and carbon fiber hybrid structure. A multi layer composite envelope is manufactured by L. C. Dover.

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18 The Institute of Chemistry and Dynamics of the Geo Sphere
The NT has an automatic envelope pressure system, thrust vector flight control system, fully fly by wire flight controls and complete lightweight construction.

Here you see a drawing of the inner structure.

![Diagram of inner structure]

**The Zeppelin NT: Re-Definition of the Semi-Rigid Airship Concept**
- Comprises 3 longerons
- Connected via 12 triangular frames
- Engines, passenger gondola and empennage attached to rigid structure.
- Envelope attached to the structure
- Increased total stability through helium inflated envelope

We re-defined the semi rigid airship concept. The original Zeppelin airships were pure rigids in which the outer envelope was actually shaped by the structure. In the NT system the shape is given by a constant small over pressure in the envelope and the rigid structure inside. The internal structure is comprised of 3 aluminum longerons from the rear connected by twelve triangular frames made of carbon fiber which are interlinked by aramide cables for additional stiffening.

The engines, passenger gondola, envelope and the empennages are attached to the rigid structure. The structure increases total stability through helium inflated envelope. In case of a helium pressure loss the structure ensures the controllability and the manoeuvrability of the airship itself. There is no loss of manoeuvrability as the engines are directly mounted to the structure.
The thrust vector flight control system consists of 3 independent engines (left-hand side, right-hand side, and rear engine). The left and right hand engines can be swivelled up to 120 degrees. The rear engine comprises two fans, one lateral and one horizontal. The horizontal fan can be swivelled from 0 to 90 degrees. This makes it possible for the airship to take off and land, to hover on the spot, to turn on the spot. It makes it possible to steer by using the empennages while in aerodynamic motion. Due to the propulsion system, only 3 ground crew are necessary for handling the airship.

Dimensions of the current airship are 75 meters long, a maximum width of 19.5 meters and a maximum height of 17.4 meters. The maximum gross and the volume is 8,400 cubic meters with maximum ballonet volume of 2,200 cubic meters. The surface area is 2,630 square meters. The maximum take off mass is almost 8 tons; the useful load almost 2 tons. It is powered by 3 Lycoming IO 360 engines with 200 horsepower each. The maximum flight speed is 125 kms per hour, the range, 900 kms., and the ceiling height is up to 2,850 meters.

The maximum endurance, in theory, is 24 hours, but that is limited by payload and pilot duty times. The NT cabin is a two plus 12 seat arrangement. Two pilot seats, but a single pilot certified during passenger operation. The left hand seat is for the Captain and the right hand pilot’s seat is for the flight attendant. Cabin length is 10.7 meters and the cabin volume is 26 cubic meters.

We call the NT a utility airship; a platform for special missions. What are the general advantages? Low flight speed is possible. It is capable of hovering on the spot and precisely holding position in the air. The NT can fly at very low altitudes from 80 to 300 meters above ground and we have attained 14 hours of endurance. It has low operational cost and a useful load up to two tons and very low exterior noise emissions (only 69.4 decibel).

One of the mechanical support features of the NT is the hard points for front cameras weighing up to 65 kgs., and a nose boom attachment. A top platform attachment can carry up to 450 kgs of payload and there are several envelope attachment points and an external load hook via a cabin hatch. An advantage of airships is that exterior installations are possible with almost no aerodynamic protrusion.
What are the system support features? We can supply a electrical mission power of 5 kilowatt ampere, and an additional 8 kilowatt ampere with a third generator that can be attached to the rear engine. There are interfaces to the airship’s avionics to navigation, including the GPS system, the communication system and the air datum attitude system. Heating and air conditioning are options.

What are the cabin support features? There is a large cabin floor hatch with two wide doors for entering cargo and large windows. There are two photography openings in the windows. Up to thirteen seats and 6 equipment racks are possible.¹⁹

The NT has very low interior noise and interior vibration levels. The graph shows data given to us by the De Beers Company. The upper line shows the measurement of cabin vibration levels in a Cessna Grand Caravan and the lower line represents our Zeppelin NT during a test flight. This measurement was decisive for utilizing the Zeppelin NT for the De Beers mission in South Africa. The vibration level inside the Zeppelin NT gondola is significantly lower than in the Cessna Grand Caravan. The graph is exponential. The vibration level rises significantly during the landing and takeoff and landing configuration of the engines. During usual operational flight you would find the vibration level on the spectrum of the lower line.

The NT also has a comfortable toilet which is necessary for endurance missions.

¹⁹ The NT also has a comfortable toilet which is necessary for endurance missions.
Air Lift Project

The Air Lift Project was conducted in June of 2007. For this project the research institute had ordered us to develop a top platform for the airship to hold the mission payload. The operational profile was a special mission with flight speeds from 0 to 115 kms., per hour. The operating altitude was 20 meters to 2600 meters above ground. The range was up to 1100 kms for a measurement. The scientific payload was up to 1.3 tons including the payload in the cabin and on the top platform. The scientific mission profile was the “entrainment of trace gases in the convective system”. The experiment investigated the chemical development of a plume originating from a city and vertical profiles of H O X radicals and trace gases throughout the daily cycle.

Why did they choose the NT as their research platform? The measurement of locally limited phonometer is possible. The NT is able to stay at a fixed position allowing the observation of the development time of an event. The Zeppelin NT is able to fly at low speed allowing the resolution of small scale patterns over highly structured source regions. The NT’s climb rate is 5 to 6 meters per second and allows fast measurements of vertical profiles. The Zeppelin NT is able to drift with the surrounding air mass and, of course, the long operating time allows for the determination of a complete day and night cycle of chemistry and meteorology. The decisive factor was that the Zeppelin NT is able to carry a top platform which allows us to take measurements of the atmospheric gases without being polluted by engine exhaust.
The atmosphere has a planetary boundary level and then the free stratosphere. The boundary level is up to about 1000 meters above ground which was mostly the region where measurements were taken. Pollution can come from a lot of different sources: cities, agriculture, volcanoes and tropospheric air travel. The boundary level is not a very well researched part of the atmosphere. The contract runs until 2013 with regular measurements over the coming years.

The top platform rides almost on top of the airship across from the gondola. The ship has two triangular frames and the major cross beam. The major crossbeam is the connection between the right hand and left hand engines. A special cross beam has been developed that is attached to the top longeron through the envelope. The top platform is attached to the cross beam.

The top platform can be reached to check or calibrate the payload. The operator climbs the mast ladder to the event ladder that leads him on to the envelope. The space on the envelope between the attachment ladder and the top platform is covered by robust fabric to protect the envelope while people are walking on it. Of course there is a man line.

The top platform is basically an aluminum longeron with a structure that has standard seat rails to mount measurement packs. It is surrounded by a cover of envelope material. The top platform is 10 meters long.
Inside the gondola are 4 operator seats. Of course they needed a toilet for the 14 hour flight and they had 3 equipment racks for experiments. The power distribution was through the autonomous electrical network. They had AC 220 and DC 28 volts at 4.2 kilowatt plus the additional 8 kilowatts through the third generator mounted to the aft engine. The experiment was very successful and the contract was prolonged to 2013. We hope to carry out missions every year for about two to three weeks until 2013.

De Beers Flights

The second example for a special mission utilizing the NT is the geo physical analysis in southern Africa conducted for the De Beers Company. I had said previously that the decisive factor for utilizing the NT airship was the low cabin vibration level. The flight portfolio for the geological survey is a flight level 80 meters above ground, flown at night, precision flight with a 3D tolerance of only 15 meters, right, left, up, down. During the two contractual years, 1255 productive flight hours were flown. The data quality is excellent. Numerous targets were found and the first kimberlite was confirmed and verified on June 13, 2007.

The airship in southern Africa, as you have probably heard, was destroyed in a weather incident on September 28, 2007. We had a lot of work sorting out the damage, the insurance and all the other things that are encumbered with an airship incident. Discussion with De Beers is
already ongoing and they have asked for a replacement airship. De Beers is assessing the extensive data they have taken within these 1200 flight hours. It will take 1 to 2 years just to assess data and confirm and verify targets. The next window of opportunity for flying measurements in southern Africa will be the winter season of 2009. Winter in Botswana is our summer season, so, it is a year and a half ahead of time. There is a chance that a replacement airship will go to southern Africa.

The implementation of the Bell Geo Space Gravity meter on the airship provides data that are significantly better in quality than produced by a Cessna Grand Caravan. The cost benefit of utilizing the airship was decisive for De Beers.

The gravity field of our planet shows anomalies which occur when very dense material is buried under the surface. A ground gravity measurement to verify targets is done by personnel who walk on a line with a meter. Every so many meters they take a measurement which is a very time consuming process to retrieve that data. This is the reason the mining companies are interested in aerial gravity surveys.

Differences in resolution are influenced by the sheer size of the kimberlite and the depth of burial beneath the surface. An area was covered utilizing a Cessna Grand Caravan. Only the very large kimberlite was found and actually wrong targets would show up. These are the four targets that De Beers was hoping to find when using the airship or the fixed wing. The same area covered by a Cessna Grand Caravan has data quality and resolution that is far from ground gravity.
The same area covered again with the airship produced results almost as if done by ground gravity. According to De Beers the productivity of the airship is forty five times greater than utilizing traditional ground gravity measurements.

A comparison between the Zeppelin NT, a helicopter and an airplane was made for parameters like intensive presence, vulnerability, passenger comfort, noise and emissions, fuel consumption and speed. The NT outperformed the helicopter and the airplane in endurance or the intensive presences (14 hours). The very small noise levels inside the passenger cabin contribute to greater passenger comfort (20 decibels). Fuel consumption is very low (50 kilograms of aviation fuel per flight hour).

The Zeppelin NT and a Eurocopter 155 B1 both have 12 plus 2 seats. The useful load of both aircraft are comparable from 2.3 tons to 2 tons. The helicopter can fly higher and faster, but speed is not what the Zeppelin NT wants to sell. The biggest difference is in fuel consumption. It is 350 kilograms per hour for the helicopter versus 50 kilograms for the airship.

The endurance is 4 hours for the helicopter and 14 hours for the NT. Noise levels are 89 decibels for the helicopter and only 69 on the airship. The noise level in the cabin while in flight is significantly different again in favour of the NT. The vibration levels were the decisive factor for
the De Beers mission. The maximum vertical acceleration level on the helicopter is 0.1 G and on the NT the maximum was 0.02 G.

In terms of yearly utilization the flight manual of the helicopter provides a utilization of 357 flight hours or 45,000 nautical miles per year. The Zeppelin NT is currently utilized up to 1200 flight hours per year or 55,000 nautical miles. Every one hundred hours a check of the engines has to be performed and there is one annual inspection of the internal structure.

Question 1 – Have you thought about scalability, when are you going to build an airship that can carry a lot of weight?

Answer 1 – There has been a development plan for the NT 14 which would go from 8000 cubic meters to 14000 cubic meters. This is presently on hold due to change of management. We have decided to utilize the NT 07 to the full extent before we make a decision on further investment in developing a new or larger airship.

Question 2 – Can you give us an idea of the cost of an airship?

Answer 2 – The NT 07 currently has a system price of ten million euros.

Question 3 – You mentioned that the airship can stay on station. Is there an active feedback system for that auto pilot or does that rely on pilot feedback?

Answer 3 – It is pilot feedback.

Question 4 – With regard to the structure on the top, is there a destabilizing effect?

Answer 4 – The pilots were worried about that, but they came back and said it handled even better with the top platform mounted.

Question 5 – Being that airships generally operate in a lightning zone what has been your experience with lightning?
Answer 5 – We have not experienced a lightning strike yet. There is lightning protection for every system. It has been developed to that standard but we have not experienced any lightning strikes yet.

Question 6 – Can you discuss the weather event that occurred in Botswana that destroyed the NT?

Answer 6 – The ship was moored on the mast in a salt pan in the middle of the Kalahari Desert. It was about three flight hours away from the hangar which is located in Gaborone, the capital of Botswana. The NT was properly moored to the mast. The crew on the ground saw a mini tornado approach. Whirlwinds are common in Africa in the desert. What are the odds that this whirlwind or mini tornado’s path will cross right over the mooring site? The storm ripped it off the mast, dragged it along for around 250 meters then crashed it to the ground.

Question 7 – Did you have a problem with the temperature changes from day to night, in Africa, affecting the helium?

Answer 7 – A helium management system was installed. We could take helium out automatically during daytime and refill before landing to provide more expansion room for the helium inside the envelope.

Question 8 – Is a hangar required for the NT?

Answer 8 – A hangar is required for annual maintenance. The annual maintenance is conducted without the helium inside the envelope so it needs to be suspended from a hangar’s ceiling. Of course the hangar is always value added as a weather escape.

Question 9 – It is our understanding there is a possibility of Zeppelin NT coming to North America. What would be the plan?

Answer 9 – I can confirm that there is a plan to bring a Zeppelin NT 07 to North America. You might have taken that from the press already. It was announced in June of 2007 by Custom Airship Ventures of San Francisco. The plan is for the airship currently under manufacture to be finished in
the second quarter of 2008. Third quarter would be the transfer quarter. Start of operations in San Francisco would be in early October 2008. There are two options to transport this ship from Europe to U. S. The option that has been performed twice so far is shipping it on a dock ship. This was done for the transfer to Tokyo and the transfer to Cape Town. Another possibility currently under study is a transfer flight from Germany by Spain and Portugal, to the Azores to Newfoundland down to New York and then a transcontinental transfer from New York to San Francisco.

Question 10– Have you done any cold weather testing?

Answer 10 – We have done testing on sample parts but the ship itself was never cold weather tested.

Question 11 – You said that the storm was approaching and you could see it. Was there ever a chance to put the pilot on board and try to fly away?

Answer 11 - No, the salt pan had a diameter of about 1 km. and even though you could see the storm approaching, there was no time to fire up the engine and escape. It happened at 2 p.m. which is the time of the biggest thermal activities so it was a non-flyable condition, at that time.

Question 12 – Let me ask a question regarding the difficulty of flying in the north vs. the south. We tend to think of warm climates as being pretty benign vs. the cold of the Arctic, but my understanding is the desert is actually quite a difficult area. One of our colleagues is here from Australia and he might be interested in knowing of how difficult is it to actually operate in the Kalahari Desert?

Answer 12 – The restrictions are twofold. During daytime there is thermal activity over a land mass. Helium contracts and expands by heat and air pressure. Africa had the second disadvantage with Botswana being quite elevated above sea level. We had to take 3 of 4 ballonets out of the ship to fly. Most of the operation was flown during the night because the temperature was lower and there was no thermal activity. If you would fly the airship in the North there is a temperature problem around the freezing point. Moisture freezing on the envelope contributes to weight. But below freezing lift
would be excellent as a lot more helium could be put into the envelope. Snow storms and snow accumulating on the fins or the empennages could be a risk for the ship.

Question 13 – At what point is the wind prohibitive for flying under safe conditions?

Answer 13 – Depends on the ship you are flying. The NT airship is certified for up to 45 knots wind speed. For passenger operation we usually cut operation at 25 knots wind speed. Over 25 knots the ride becomes a little rough for the passengers and they are paying a premium price so we want them to fly very comfortably.

Question 14 – Can you comment on when we could expect either Zeppelin or perhaps airships in general, to be of the size and range that would provide regular reliable cargo service to Northern Manitoba?

Answer 14 – Before joining the Zeppelin Company, I had a position as CEO of a fixed wing manufacturing company. From that I know that the regular development time of a commercial aircraft is between 4 and 6 years and that always depends on funding. That could apply to airships, as well; if the funds are there a development time of 4 to 6 years would be appropriate.

Question 15 – What size of ship range would you see in 6 to 10 years?

Answer 15 – I really do not know. Just for comparison, the old Hindenburg was 250 meters long, had a volume of 190,000 cubic meters of hydrogen, at the time, and that would probably be the size you would need to have around 80 tons lift capacity. So, it would be a major step, to go from 8000 cubic meters to 200,000 cubic meters.

Question 16 – Could you describe the operation in Japan?

Answer 16 – The NT 07 in Japan has been operating for two and a half years. It was an aircraft sale to NAC, so Zeppelin Luftschifftechnik is only giving customer support in the form of spare parts and sustaining engineering or special labour services for annual inspection. They have been operating for special events and advertising. NAC received a commercial passenger flying license in June 2007, and I am happy to announce that the first commercial passenger flight will take off in
Tokyo on November 23, 2007. Ticket sales started a week ago. The first season is six weeks long and it only took two days to sell all available tickets.

Question 17 – Could you comment on pilot training and the requirements for airplane pilots to get an airship endorsement?

Answer 17 – Very easy. There is a type rating for the Zeppelin NT. For a commercial Zeppelin pilot, we require either a commercial helicopter pilot license or a commercial fixed wing pilot’s license and a thousand flight hours as Captain. The training program consists of about 90 hours theoretical training plus 40 hours in the ship.

Question 18 – What does a ticket cost to ride on the airship?

Answer 18 – Friedrichshafen offers tickets from 30 minutes flight duration to two hours. The cost ranges from 150 euros to 700 euros, or approximately $200 to $1,000 per ticket.

Question 19 – Are there plans to build more Zeppelins for other places in the world?

Answer 19 – We only manufacture on order, so one of my jobs is to find customers in the world. We see a market for up to 10 of the NT 07’s in the world to keep the exclusivity as it is.

Question 20 – How long does it take to build a Zeppelin?

Answer 20 – The building time, at the moment is 18 months.

Question 21 – At what number of airships, say in North America, would you start to have facilities here as opposed to simply an operator with a hangar?

Answer 21 – The one airship coming to San Francisco will not make us invest in a local facility. If there are more coming to North America we would be heavily looking into building up a partner for assembling airships because the transfer is quite a heavy workload. So you could say from the second airship on we would be looking into partnering.
Question 22 – So are you looking for venture capitalists?

Answer 22 – Always.

Question 23 – Can you tell us a little about the certification experiences? Obtaining the Type certificate and your experience with the FAA and Type certification for the U. S. operation?

Answer 23 – As the previous speaker said the Type Certification (TC) is a heavy workload for airships because there are no certification rules. The certification of the NT 07 prototype took almost 3 years because Zeppelin Luftschiffttechnik had to write all the standards and the provisions. The FAA certification is ongoing and we hope to receive the TC from the FAA by the end of 2007.

Question 24 – Can you give me an idea of the cost of setting up at a commercial airfield?

Answer 24 – We do not need a commercial airfield, we just need a flat surface with a diameter of 300 meters, and whatever passenger handling facilities you need could be mobile container buildings. We would appreciate a hangar. The hangar in southern Africa was priced at 1.5 million dollars. For a remote operation we suggest having two mast vehicles to be remote from either end. A mast vehicle costs approximately 600 to 750 thousand euros. There is significant investment necessary, but it does not need a commercial airfield.

Question 25 – From the first prototype till now has there been any design modifications besides the addition of the toilet?

Answer 25 – Actually the toilet was designed from the very early days. Of course, there are improvements. There is an ongoing design process. The major design improvement we did from no. 3 to no. 4 is increasing the life term of the structure from 14000 flight hours to 25000 flight hours.

Question 26 – How often do you have to change the envelope and do you keep the structure of the ship?
Answer 26 – We have never had to change an envelope so far. The envelope in Botswana was exposed to extreme U. V. radiation and sandstorms. It had been on the ship for 10 years when we had a test sample sent into ILC. It had no strength loss over the 10 years. So we are extending that life time, as well.

Question 27 – Can you elaborate on the market for sight-seeing airships?

Answer 27 – Let me go into the operation in Friedrichshafen. We have a limited season in Friedrichshafen due to weather from April to October. We regularly fly about 11 to 12 thousand passengers a year creating approximately 1100 flight hours and that is the basis for a viable business case. The business case in San Francisco foresees a season that is 2 or 3 months longer and that will create good revenue.
Session Two:
Keynote Presentation

Delivering Value with Buoyant Aircraft

Session Moderator
Dr. Jon L. Smith,
Director,
East Tennessee State University

Speaker
Dr. Robert Boyd, Hybrid Lift Portfolio Manager
Lockheed-Martin Aeronautics
Advanced Development Programs (or Skunk Works)

When Barry asked me to speak at the Airships to the Arctic Conference, he asked me to address what Lockheed is doing and my observations about how we get there. How we enable this industry to grow. I have worked on a variety of things. I have been an academic, an individual entrepreneur, I ran my own business, worked for some others, and now, I work for Lockheed-Martin. Those of you who have worked for large corporations understand that controlling the message is quite important. So I have divided this talk in half. The first half discusses my thoughts on the airship industry and what is limiting the growth and position in the world of this industry. The second half is what Lockheed-Martin will allow me to tell you about the kind of programs we are working on and where we are going in a general sense.

The title of this presentation is delivering value with buoyant systems. I selected those words for a reason. Why is it that this industry has not grown more then we have in the last 10, 12 or 13 years? Why are we not getting the kind of response out of the customer and community that we would like to see? Why are we not attracting the resources to do these developments? It really came back to
how you define value, where are you driving value and making sure that business plans are looking to deliver value to your customers.

The first part is the observations of the business and defining value, which is my part. As a disclaimer, this has nothing to do with Lockheed-Martin; it is not a forward looking statement, etc. This is not the Lockheed-Martin portion.

Second portion is the Lockheed-Martin Buoyant Systems activities, which also has a disclaimer that states this part has been fully sanctioned by Lockheed-Martin, and thus will more likely pique then satisfy your curiosity regarding our plans, positions, directions or anything else related to Lockheed-Martin.

So what I am going to take off my Lockheed-Martin badge; I am just Bob Boyd, talking to my colleagues about the concept of buoyant systems. First, the term buoyant systems specifically avoids the label LTA for a reason. One of the nice things about being with Lockheed-Martin is that every week or so Generals walk through for a briefing, and we also have lots of commercial people come by. So I get to actually listen to what people say about the industry in a very broad sense. The same things are said over and over again about what we call the LTA industry.

The first comment comes from an aviation weekly report that says that “the LTA guys are a fun bunch. They work themselves to the bone to be highest or longest or first at something. It is great fodder for us, but probably not too helpful to their customers”. That is painful; are we in this for glory or are we in this for value? So think about it: why am I doing what I am doing, does it deliver a product that is useful or am I just trying to get my name in some record book? Nothing wrong with getting your name in the record book, but it is probably not going to help the industry as a whole.

The second quote comes from an industry insider. “The LTA industry is like the medical industry of the 1800’s. A few legitimate practitioners trying to advance the art amidst a sea of snake oil salesmen”. Now that one hurts. Who are the snake oil salesmen? What does a snake oil salesman mean? Where are you trying to take your profit? There are a lot of people in the financial industry that will not invest in this industry for exactly this reason.
The next quote comes from Goldman Sachs. “Invest in LTA, sure, well, except that idea reminds me of the proverb about a fool and his money”. The perception is that a lot of people have lost a lot of money investing in this industry. Despite the fact that some of the purveyors in this industry are doing quite well for themselves. How does that happen? Do you think that attracts more industry? Do you think that attracts more investment? Is that going to grow our industry or does that leave a trail of dead bodies?

The last quote is the one that hurts me the most because it comes from an Air Force customer. He says, “LTA, yes, to us that stands for less than adequate”. Now for anybody who is trying to deliver a product, that is about as painful as it gets. Less than adequate - what we are doing is less than adequate! Why is it less than adequate? What are we doing wrong? What are we missing? We all believe this technology will work. So why is it less than adequate? What are we missing? First, to deliver value, we have to understand value. Lean Thinking is a seminal work\(^{20}\) that describes the subject of value, how you track value and where you deliver value. It evolved out of the production industry of the Japanese auto industry, but it is very applicable and general to the construct of value.

“The Innovator’s Solution” is another useful work that is very relevant to our Industry\(^{21}\). We are essentially, re-innovating, if you will, the market space. They talk a lot about competing against non-competition which is something that this industry really does. We are not really competing against each other; we are competing against people who are not consuming the products that we can produce. If we think about competing against non-competition then market spaces grow many folds versus growing a very small amount.

The most important concept, value, can only be defined by the customer. We, the producers, do not get to define value. We do not get to define the thing that we wanted to build, that we think is cool, that we think is fun, we do not get to do that. We have to look at value through the eyes of our customers. From the customer’s standpoint, the only reason we get paid is because we are delivering the value that is important to them, not the value that is important to us. How much


have you worked with your customer to try to understand what their values are? What is important to them? Where are they driving things?

From that value concept, there is something called the value stream. This is simply the flow of value that allows you to get through all of the necessary steps, to deliver that value to the ultimate customer.

The Japanese have a wonderful word for waste that is *muda*. Waste is defined as processes or activities that are really not valuable to the customer. Some of things are necessary *muda*. A good example that always shocks people is paying your employees. Paying your employees, “oh I got to do that, it's important, it's valuable”, No it is not. Your customer could not care less if you pay your employees. What your customer cares about is that they provided the product. Now you have to pay them in order to obtain their services, but customers really do not care about the fact you are paying them. There are a lot of things that you do, and working at Lockheed-Martin and working at the Government, there are a lot of things we do, that are *muda*; waste that does not actually add value to an ultimate product. For example, activities like storing reserve inventories in case of a production problem do not deliver value. Avoid the things that do not have value. Focus on what your customer’s values really are.

What is the intrinsic value of helium? In my view helium is not a lifting gas, it is a structural material. The lift from a buoyant system does not come from the helium contained; it comes from the displacement of air. The lack of atmosphere is what creates the lift. Helium just happens to be a convenient way of keeping the boundary from collapsing. Helium is a structural material and is tracked as a weight. It goes in once and it stays there. If you think about helium from the eyes of the customer it is a structural material.

What are the good points and bad points of helium? It is safe to operate, development costs are low, etc. Where we short ourselves, is that a significant number of the briefings on airships, stop right there. We are good, it is all great, and everything is great. Airships are good. Do you really think that any customer buys that? Do you think that they do not realize that there must be some bad points about this system and will not find them? Is it better for you to explain them to your customers, or is it better for them to find out after you have left? I guarantee that before they give
you millions of dollars, they will find out. So you might as well go ahead and attack the bad points. Explain why the bad points are, or are not, a problem for the particular piece of value you are trying to deliver to that customer. The question is whether the bad points really outweigh the bad points of an alternate solution to deliver the same value? The alternate solutions that we are competing against are usually not another airship.

We spend a lot of time arguing over whose airship is a little better than whose airship. The reality is we are not competing against airships; we are competing against every other method of doing the jobs that we are trying to do. It is really the efficiency of deploying the intrinsic values that determines how valuable a product is to your customer. As we heard over the last two days, there is a tremendous amount of need, especially here in Manitoba and Canada to move cargo in remote areas. We know there is a market for moving passengers.

There are other missions for airships like carrying sensors. If the market is out there for airships and we are not getting it, how did we miss it? What are we doing wrong? What have we not done right? We are not thinking about the value stream.

First start with your value stream: make a list of good points and bad points. Let’s take an example of the Zeppelin NT. They continue, to sell out their airship every year because, they are working on value. They are not building airships; they are running a passenger airline. Their mentality is, what do customers want? So if we took those values and said what does that mean? Well we know we are stuck with slow air speed. Everybody wants to go faster. But if you look at passengers who do not really want to get somewhere in a hurry, it is a good market. But if they are far away from where they need to go, that will not work because it will take too long to get there. You probably cannot run a tour that takes a thousand miles to get there.

Second, if we can keep our cost structure low we can address a lot of markets. We can go into markets where maybe there is not a lot of revenue and still make money.

The next one is weather, which is more difficult. How do we deal with that? How can we get value out of this platform, with a limited schedule, limited application, and maybe limited locations? We have to be careful about how we choose where we go and what we do. If we are going to carry
passengers, we are probably not going to carry them in really unpleasant weather. So that means a scheduled service, where passengers want to get there every day is probably not a very good answer. We cannot get away from insurance costs unless we have a better safety record. The longer we go without a loss, the better the insurance costs are going to get. This is hard but that is something we all have to focus on, because right now, if you buy a 747 you will pay about a quarter to a half percent, per year of hull value. For those who are operating airships, you will know that the number is 10 percent. If you are good insurance gets down to 5, if you're bad it goes to 15. Ten percent of hull value per year is a staggering number to pay for insurance. Why is it high? Because the loss rate is high. This is something we need to work on. There is technology we can use to help with that. Every once in a while we are going to have a disaster as unfortunately we had with NT07 this year. But guess what, fixed wing aircraft have accidents regularly also. But, there are so many more of them that the one accident every once in a while does not affect people the same way.

Large volume is good, because we can have a large space for passengers. They can be more comfortable, walk around and see things. This is an advantage because we are not competing against other airships, we are competing against ground modes where what we want to do is see a mountain or a valley. It could be done by walking around, but looking at it from the air is better. We are competing against helicopters where you cannot move at all. You are trapped in a seat with head phones on. Airships can do better than that.

Airships need a lot of space, but maybe that is flexible. Airships do not need an airport which is a huge benefit in most of the world. Most of the world does not have a lot of airports. So if you look at the rest of the world this is a tremendous benefit. How do we take advantage of that? How can we actually optimize that characteristic?

Fuel efficiency is nice, but is that really a big driver? It drives cost to some extent but does it drive it more than the other things on this list. Most of the modern ships have worked towards reducing ground crew, because labour is a key cost that drives the costs of current airship operations. Can you reduce that? Can you make that better?

Endurance and being observable are positive attributes. Endurance could matter for the military, but for passenger operation, maybe being observable is more important, because we will sell more
tickets every time someone sees it fly over. Airship operators can also sell advertising. It turns out that things that sometimes are bad are not necessarily bad, depending on the mission. So, really from this summary, passenger carrying is a reasonable mission. If you are going to carry passengers for tours comfort is important and the location must be relatively close to wherever they want to be. The question is how many places around the world can be profitable? Can you find a different way to carry passengers that is even better? Can you find a way to enhance the value so passengers will pay more, or so more people will get on board? The numbers of people who are getting on board airships are really small.

The next step is mapping the value stream. It must always end in the continuum where you have found the end. A continuum means a very large number of consumers. In other words, our continuum, if you were to build an aircraft, is not selling it to the airline, our continuum is actually the passengers or cargo that is going on that aircraft, because that is the continuum. We only sell a discreet number of aircraft. You need to figure out what the value stream is for the large number.

My example is gathering and delivering actionable intelligence. This is one of our favourite subjects on the ISR side. The idea assumes that you work for an Intelligence Agency and your job is to deliver a report, usually, twice daily to a senior decision maker whose going to use that report to make decisions of import. This is your job. So, what is the value to you if you use an airship to do it? We go get the airship, we put it together, we fuel it, we figure out where we are going to fly. Then we take off, we stabilize at altitude, we get it levelled off, we transition to where we want to go and then we start taking data. This is good; we are taking data, which was the goal. Wait a minute; we need to get the data, from the airship. We need to send the data down to the ground and then we are going to store it somewhere. Okay, now we have the data, because remember, our job is actionable intelligence so we need data, we do not need an airship.

Maybe we want to change what we are doing. Oh wait, we’ve got to watch the weather because airships are sensitive to weather. So, we monitor the weather, we are going to re-task the ship, we are going to fly around and gather data in different places. It is kind of a hassle but we can do that and eventually we are going to have to bring it down, return to base, land, refuel and then we go through the whole cycle again. This is our value stream if we are an airship operator and we are going to go do this.
Well, let’s put on a different filter. Let’s put on the filter, of not the airship purveyor, but the person who is trying to deliver actionable intelligence. From the standpoint of actionable intelligence I have three colors. I have green which is something that is really important, I have yellow which is something that is not really valuable but I have to do it, and then I have red which is something that does not really add value. Which do you think is red? This is the thing we miss. To the customer, the only thing that really matters is where the data are being gathered and that the data are being gathered and that they get it. The rest of it is muda; they do not care. So, if we are going to put an airship up to do that, then we better minimize those things in red and maximize the things in green. The ultimate goal of the ISIS program (stratospheric airship) is to do exactly that. The idea is to be on station for a number of years, take data, and not come down. It is worth the technological leap because it eliminates all those things in red.

Where the output is actionable intelligence and the input was a task order, the airship looks like a hassle. It may deliver information but does it deliver it, in a value added way? The other technology that has a bunch of red on it is the U A V’s because they have the same problem. They are very difficult to operate and handle. They are working it, but that’s where it stands. If your job at the top...
level is to deliver intelligence, gathering the data from the air is a real pain. Gathering from ground sources is relatively straightforward. Even gathering data from existing manned aircraft is easier because they are flying patrol missions for another reason. If we are going to insert ourselves on that value stream, are we focusing on the right things? How are we going to get there? A lot of people wonder why DARPA is spending all that money on ISIS. Why would they spend millions of dollars building a giant airship when we can do it so much better with an existing airship? The reason is that any existing airship is not going to get away from those red blocks. It is not going to be able to get away from the ground and flight operations that are required in order to support something that has to come down every 10 days. Again it comes back to that value equation.

If you know your customer, if you know what your customer wants then it will drive your value equation. There are a lot of customers that do not mind as much. Not that it is valuable to them they just do not mind it so much. A good example is the NT07 flying for De Beers. The value for them was getting better data, and it was worth the hassle of having to deal with an airship. They may have preferred not to deal with airship operation, but, the NT07 works well. It is fairly easy to operate and it gives them great data. So they looked past the red things and focused on green and that is what gives them value. So the concept of value is critically important to delivering where we are.

So, the next question: is there really value space for buoyant systems? Well, consider these numbers. There are about 27,000 aircraft flying in the world today, less than 50 airships (about two tenths of a percent). There is market space. Two hundred billion dollars a year is spent globally in advertising. In airships advertising is a huge fraction of our market but we get less than a 150 million of that 200 billion which is less than a tenth of a percent of the market space. Even in what we think we do well, advertising, it looks like we can even grow a little bit more. More than 4000 aircraft are operating in surveillance modes. Aerostats, which are the most common surveillance mode buoyant systems, number around one hundred. This is less than 2 percent and yet at the same time they are the lowest cost option for doing fixed based intelligence gathering, so why are more of them not used? They pay thirty thousand dollars per flight hour for fixed wing aircraft. The cost is easily under a thousand dollars per flight hour for an aerostat. Why would anybody pay thirty times more to do this same job? What is driving this? It is the value stream. All around the world, eleven
thousand people take an air tour flight (not a commercial flight) each day. The vast majority is on helicopters. Less than a hundred and fifty will tour by airship.

More than 200 million ton miles of containerized air freight moves daily around the world and absolutely none of it moves by airships. We talk about airships having a future and value in cargo but right now we have nothing. So, is there market for people to actually grow in this space? I think so, and as an industry, if we spend more time focusing on growing market share and less time worrying about whether my airship is better than yours, we will find there is plenty of space for growth. There is more growth than anyone in this room, anyone in this entire industry can actually stand, right now. This is the untapped growth. It is the non-competition. We are competing against the people that are not currently using airships and we need to do a better job.

Hopefully these are valuable thoughts on the part that is just me. The first question is how much do you know about what your customer values? How much do you really ask them? When you asked them did you actually listen or were you just trying to figure out how you were going to sign the contract? What is it that they actually want and why did they want it?

The only way this industry is going to grow is by growing long term value. Are you committed to delivering that value for the long term? Are you committed to having people actually want your product for a long period of time? If you really look at the history of the airship industry, especially, in the last 20 years, the sustaining value comes from those who are focused on what their customer wants.

Have you mapped a value stream? How is your return structured, does your customer control your return or are you just going to get a signing bonus and walk off and go do something else? I can guarantee you that no one is going to invest significant amounts of money if you, the one who is the passionate one about this, is going to take a short term profit, because they know you will probably not deliver anything. It has happened over and over again and that is the view of the financial markets. You have to have long term value and you must present a business plan that has long term value. You will get a lot more interest than if you present a business plan that has a really nice signing bonus for yourself.
How do you plan to sustain that long term value? What is going to bring value to the customer in a continuing sense? An excellent example is what Hokan Colting is looking at with the beautiful view. You have a 360 degree view, people can get up and walk around, that is enhanced value over what is now available. When you understand your market, you will understand how to deliver long term value.

What will each of you do to actually improve this industry? I probably know half of you, and everyone here is passionate about what they do and everyone believes in this industry. Are we focused on making the industry better or are we focused on ourselves? I will put to you that if you focus on making the industry better, making the products better, delivering more value, we will all succeed. If we focus on us, making us better, making us in the news, making us personally wealthy we will continue to go through with fits and starts that we have had for the past 25 years in this business. I came from fixed wing aircraft and did not know anything about the airship industry 10 years ago. Watching, listening and observing the airship industry is hard. Somebody joked that I am giving a tough love lecture. Maybe I am, but it is difficult seeing ourselves and how we work. If we look at it in the context of our customer we will all be much more successful. So with that I will go over to the Lockheed-Martin part of my presentation.

Obviously, we have a lot of people working on a lot of different programs, virtually all of which I cannot talk about, as a Lockheed-Martin person. At Skunk Works, we spend a lot of time and energy on what we call IRAD or internal research and development. A lot of which is with the Government focused on delivering Government value. We also work on programs for other people as they pay us to. We spend a lot a time working on a lot of research items and we generally do not tell much to anybody about them, except the customer. The purpose of demonstrations is to prove to ourselves that the technical capabilities are in place to move to the next step, which is the contracted research and development or the actual platform development phase. At that stage, we move into developing specific platforms for specific activities. At the end of this phase this turns into a seminal demonstration of a major product. The follow on is the actual move into production. But at Skunk Works our involvement usually ends right about the end of the IRAD stage. We think it up, we make sure that it can be done, we demonstrate it in a demonstration prototype, and then

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22 Hokan Colting, 21st Century Airships
we hand it off to someone else to produce. The F 22 and the X 35, the JASSM missile, all those programs followed that same pattern, so this is why we exist.

Really the question is what is the advantage of buoyant systems? Why does Lockheed-Martin spend time on it? Where do we see the value? The biggest one is cost. Airships are less expensive to develop and they are significantly less expensive to operate. If you look on the right hand side those are operating costs for fixed wing platforms versus buoyant systems. Tethered and un-tethered systems are 5 to 10 times less per flight hour in operating costs and can sometimes lift 4 or 5 times more than the fixed wing platforms. The fundamental goal is that you have to deliver value through cost savings. Somewhere that cost savings has to show up in your customer’s hands.

On the lift side this is a curve from Gabrelli and Von Karmen. They both invented the same thing at the same time. The left axis is a specific power which is a surrogate for cost per ton mile, the bottom axis is speed. Essentially all transportation systems can fit somewhere on this curve. As you go faster it costs more.

A hybrid lift system fits right in the middle. You have to drive that cost as low as you possibly can to make it be adoptable or interesting to a customer’s value proposition. From a standpoint of freight in Canada, access is a problem, getting somewhere that has no airport, but, so is cost. So you have to balance cost and access. In other places around the world where access is not quite as challenging, cost is incredibly important. How are we going to deliver that cost value and where is the most valuable space?
Trucks and trains require infrastructure. They require tracks and roads that are in good working order. Imagine that you were somewhere where they did not have trucks or trains. Not too hard to imagine here in Canada. What's does this curve look like? All of a sudden, the hybrid ends up being right in the middle of the curve between marine and aircraft. Of course, if you can provide access into areas like this it is a tremendously valuable product. We know that and we understand the interest in Canada. I have been wandering around, talking a lot to potential customers, and it is certainly a problem that this aircraft seems to address well.

Hybrid lift is a combination of buoyant lift and aerodynamic lift based on the aerodynamic shape of the platform, and direct lift. Add those three combinations and that is really it. So the question is, the balance between the ship’s shape, its aerodynamic properties and its thrust properties. How do you match those things too the ideal goals of your customer? You may have a customer base that is diverse. Some want more of one or more of another.

It is going to cost millions of dollars to develop this platform. How are you going to develop a platform that serves a lot of needs? Where does it actually fit? This is a military oriented chart but
there are non military applications of this technology. The customer does not have to have an airport or runways. This creates the access interest from the areas like central Canada.

Second it is one step shipping, directly from a source to an end point. In both military and commercial spaces transloading or multiple transloads are needed to get a load from one point to another. For example, from Ft. Louis, Kentucky to the middle east, the equipment gets cross loaded four or five times and personnel get cross loaded three times. To go from one point to another, they have to get off and get on and get off and get on and get off and get on. This is not a big a deal for passengers who can walk, but for 30 million tons of freight it is a lot more difficult.

Transloading is time consuming and costly. Direct point to point moves would have a significantly reduced cost. Same thing for the commercial front. How many times is cargo transloaded to get to a First nations area?

We see a lot of applications for the Integrated Sensor Restructure (ISR) Technology, from tactical cruise missile defense, communication relays, fleet defense, and a variety of military missions. There is also commercial missions, some which have already been flown on airships. The root question is
can we not only capture these kinds of missions, can we create missions space that currently does not exist?

One project that I can talk about is the ISIS program. I am going to run the DARPA video that covers the topic.

**DARPA VIDEO**

A thousand feet is closer than ever. Leading DARPA’s efforts in stratosphere operations is the Integrated Sensor Restructure program known as ISIS. The future of ISIS is now. Progress continues in the development of next generation hull materials, lightweight antennas and regenerative power systems that bring DARPA ever closer to the goal of direct system integration into the functional structures of a stratospheric airship. This functional integration, radar with airship functionality is the key enabler to achieving true surveillance persistence of the battlefield.

Like a space based sensor, the advantage of altitude allows ISIS to see further without the limited viewing time associated with satellites. ISIS provides theatre-wide tactical surveillance without the extremely long distances to the target. ISIS crosses the boundary between satellites and aircraft achieving the larger sense of the battlefield, while preserving the basic signal requirements of an aircraft. DARPA’s goals for ISIS are no small matter and at a length of 320 meters and a diameter of 100 meters neither is ISIS. At these dimensions, ISIS will occupy a space of 1.4 million cubic meters at a weight of nearly 80,000 kgs. The advantage, of course, is the ability to deploy a persistent surveillance platform that boasts a radar antenna the size of a 15 story apartment building. The resulting surveillance ability is approximate to 400 global hawks, 80 JSTARS or nearly two ISATS. Size notwithstanding, ISIS requires a constant flow of power to maintain its position above the battlefield. During the day, power is supplied by a 7500 square meter solar array. At night, the airship will rely on regenerative power systems and other forms of energy.

The ISIS airship is designed to operate in the relatively well behaved winds at seventy thousand feet. However these winds can grow dramatically for short periods of the year. Intimately tied to the airship’s structure, the radar antenna is no longer protected from the platform movements and is subject to all external forces the airship sees. Complex structural nodes across the face of the
antenna are measured using onboard metrology. Once on station, the radar will calibrate and form coherent beams. ISIS’s highly dynamic radar is capable of performing multiple radar and communications activity. Non traditional spatial and temporal resource management is the key to this unique design. The antenna is divided into separate radars operation independently of one another. Spatially divided across the aperture for optimal mission performance. This change also occurs in time, functions of the ISIS radar operate using time division multiple access. T D M A provides a specific time interval for each needed function. Assigning specific times for each platform function enables the ISIS to properly manage power usage, delivered dated to the user and maintain radar performance. Processing at such speeds as to make these functions appear to operate simultaneously. Using the flexibility of the antenna with the incredible line of sight from operating in the stratosphere, the unprecedented knowledge of moving targets on the ground and in the air makes ISIS an invaluable asset for solving big problems.

Consider the following scenario, a swarm of cruise missiles launched towards U. S. troops embedded approximately 600 kms., from the launch site. Time is short, approximately 5 minutes is all the time allowed for threat detection and the launch of intercept missiles in order to protect the embedded troops. ISIS is able to detect and track the individual threats of this swarm with near ideal precision, in fact ISIS provides fire control guidance on target, at the horizon, equivalent to a modern missile seeker in the end game. Such precision allows the army to engage with interceptors using advanced, low cost, seekers, such as the extremely low cost, all weather, radar seeker developed under DARPA’s low cost cruise missile defence. Exploiting monolithic microwave integrated circuits (MMIC) the LCCMD seeker has achieved a cost estimate of less than 40 thousand dollars when purchased in quantities of 3000 units or greater. Sitting in the stratosphere, DARPA’s ISIS provides the war fighter with exquisite knowledge of the world around him and the necessary information to turn knowledge into action. Today, DARPA’s ability to deploy a persistent surveillance platform at stratospheric altitudes is closer than ever. ISIS is scheduled for completion in fiscal year 2011 with deployment, following a standard transition to service.

END OF DARPA VIDEO

I show that video because it was partially made by DARPA. This is DARPA trying to sell this program to their customer. Did you notice they did not talk much about the airship? They talk
about the radar, they talk about what the radar does, and they talked about the data flow. The only reason for the airship is because it is the only vehicle that has a prayer of carrying something that large. If you see where we are in the value space, you see why this might be valuable to the customer. If you could cover all of Iraq with one airship and know everything that is moving on the ground and in the air, all the time with one asset, how much is that worth to you if you are the U. S. Government? This is why they spend money on that platform. As we go forward think about everything from a perspective of value to your customer. In summary, delivering value is the message. We are continuing to seek value for our customers, a wide variety of customers, both military and non military missions. We think there is value in this technology, it can be done.

The value of the industry is up to all of us. A lot of you have great ideas. A lot of you have much more knowledge of your customer’s missions then we do. Let’s all do this together; let’s grow this industry, let’s “Make It Happen”.

Question 1 – I am interested in the applications of airships in international trade. Is the international shipping of cargo a market application that you have taken interest in?

Answer 1 - We certainly have looked at cargoes in a variety of applications. Originally, about 10 years ago, we actually started in this business working with FedEx looking at moving cargo across the ocean in international trade. There are some really large market spaces there. The key is to make that technology work and get the confidence of the markets to be willing to support that technology at the fairly large dollar risk value of implementing it. The markets do exist.

Question 2 – The ISIS program has interesting technological challenges. Are there technologies coming out of the ISIS program that might actually be applied in freight operations?

Answer 2 – Yes, you will find that there is a lot of interesting technologies in the ISIS program. There has been a tremendous amount of work on atmospheric research. We have also done quite a bit of work on advanced fabrics, moving the soft structure business a little farther forward so we can actually go into a much higher level of stress at lower weights. We have also looked at innovative bonding technologies for things like solar panels and flexible structure on the insides. There are
some interesting techniques coming out of the airship portion. Airship operations techniques and the weather have probably been highlights and then structure is also interesting.
About a year ago I was asked to change divisions in SAIC and do some support work for our Center for Atmospheric Physics. We have, weather scientists, who were interested in whether they could take some of the work they have developed over the last 15 to 20 years in weather modeling and weather predicting and adapt that for creating weather optimized airship routes. I would like to provide an insight into some of that work. This presentation was co-developed by our weather expert, Dr. Ananthakrishna Sarma.

As everyone knows, airships are particularly vulnerable to weather, especially winds. So, we want to examine the typical weather hazards that can threaten an airship. SAIC has designed a methodology to find the most “efficient” route between two points given the input of reliable weather forecast data. We will look at issues relevant to finding efficient routes for airship operations and the results of the recent testing we have done with this methodology.

Airships are vulnerable to weather due to the following reasons:

1) They are large
2) They are slow, with typical speeds less than 100 knots.
3) They fly at low altitudes, typically less than 10,000 ft.

Weather affects the airship in many ways. Headwinds and tailwinds are the most obvious threats. Winds aloft that are as fast as the airship’s cruising speed are not uncommon at the altitudes where airships generally operate.

Temperature extremes can be a problem when it comes to buoyancy control. There have been instances in which an airship could not land because it could not descend through an inversion layer.
that had set up while the airship was in the air. Precipitation and icing can also add weight to the envelope. Even a small amount of water can translate into a substantial load due to the large surface area of the envelope.

For airships that will primarily be operated in remote or low-infrastructure regions, it is important that the airship be able to carry as much fuel as possible for the mission. However, any savings in fuel that can be achieved during the flight will translate into an increased payload capacity and that is of great value.

Over long transit distances, the airship will encounter various wind regimes. Large weather systems will pose significant head and tail winds. The head winds will reduce ground speed and increase fuel consumption, whereas tail winds will increase ground speed and reduce fuel consumption. Hence the task of weather optimizing an airship’s route primarily involves seeking regions of favourable winds. Though this task sounds simple enough, the problem is made complex because the weather along the route is constantly evolving throughout the transit of the airship.

In the absence of any wind, the great circle route provides the minimum distance between two locations, and hence will be the optimal route. However, strong winds and adverse weather along a great circle route can make it an expensive and even an unsafe route to fly. The weather optimization of an airship route between two points requires finding alternates to the great circle route that are safer and more economical to fly.

For this study, a long-distance trans-Pacific route between Fort Lewis in the state Washington, and Pusan, S. Korea, was chosen. This route was chosen due to the numerous weather systems an airship is likely to encounter over the Northern Pacific.

Using the great circle route as the minimal distance baseline route, our hypothetical airship is set to cruise at 80 knots. Its actual ground speed will be determined by the amount of headwind encountered. A lateral correction may also be required to counter crosswinds along the route. This approach to route planning is no different than that conducted for a conventional airplane. But unlike the airplane case, the headwinds encountered by an airship can be equal to, or even exceed the airships cruising airspeed.
The study concept assumes a large cyclone is in the projected path of the airship. The red path shows the great circle route that will encounter strong headwinds for a significant portion of its length. It is not unusual to encounter winds on the order of 40-50 knots in a large cyclone at the cruise altitude of an airship. A more northerly route indicated by the dotted line is more favourable because the airship will be aided by tailwinds during part of the transit.

In this example, it is assumed that the airship is flying at a constant true airspeed of 80 knots, and the average wind in the cyclone is assumed to be 40 knots. Assume that the distance covered by track B is 50% more than track A. The time taken to traverse track A equals \( \frac{D}{(80-40)} \), yielding a 40 knot headwind. The time taken to traverse track B equals \( \frac{1.5D}{(80+40)} \), yielding a 40 knot tailwind. The flight time required for Track A is twice the time necessary to traverse Track B. The longer the distance traveled on Track B is more optimal than track A in this notional example.

The airship weather optimization methodology involves choosing an optimization criterion as well as a metric that defines optimum performance. The metric can be “total time of travel”, or “fuel consumed”, or any other factor of significance. For time-sensitive cargo, the metric may be “time of travel”. For fragile cargo, clear air turbulence or other undesirable flight conditions may be the
deciding factors. Once the metric is chosen, it is calculated for numerous “possible” routes generated between the departure site and the destination. The best route is then chosen as determined by the minimal or maximal value of the selected metric.

The metrics are compared against the Great Circle Route (GCR) which is used as a benchmark. Routes are generated as a collection of segments which are chosen at random. The segments create a route tree that branches in a recursive manner. To make the problem computationally tractable the branching is constrained by factors such as nearness to the destination. In other words, the heading of each segment is biased towards the destination in order to eliminate routes that would diverge away from the destination.

For testing the algorithm, a few assumptions were made. The route chosen, again, was from Fort Lewis, Washington, to Pusan, S. Korea. A static meteorology was used to span the duration of the traverse. The meteorological data were derived from the 50 year weather dataset analysis available from the National Centers for Environmental Prediction and the National Center for Atmospheric Research – also referred to as the NCEP/NCAR Reanalysis database. It was assumed that a true airspeed of 80 knots and an altitude of 5000 feet would be maintained. The routes were incremented and branched every 3 hours. Some tests were done with 1 and 2 hour values as well. As mentioned earlier, the route headings were biased towards the destination point. For the initial testing, the total travel time was used as the optimal criterion.
These figures show the great circle route in Figure 1; three randomly selected routes in Figures 2 through 4, which were derived from almost a million possible routes analyzed; and the final optimal route selected by the algorithm in Figure 5. The background color shows the wind speed at approximately 5000 ft above mean sea level. The meteorology used was from January 3rd, 1996. The NCEP/NCAR Reanalysis dataset that was used has a horizontal resolution of approximately 2 degrees. Note that for this test, the meteorology was held constant, which means that the weather patterns seen here did not change, as they would, under real conditions.

The great circle route is overlaid on all panels, indicated here by the nearly straight line. The others were picked randomly from the collection of all routes. Note that the optimal, or fastest route, is #5, which also happens to be longer than the other four routes.

In the initial test we held the weather constant, but we all know the weather does not stay constant. To take into account the dynamics of changing weather a new set of data files are read in at the appropriate times. Meteorological forecasts are provided as files of various fields at specific time intervals. Such models usually output these fields every hour, but when using archived data the outputs may only be available every 6 hours, as is the case with the NCEP/NCAR reanalysis dataset.
For this effort the meteorology again was held constant for a period equal to the output interval of the model. In other words, each model output at time “\( t \)” was considered representative of the time period \(( t - 0.5* \Delta t )\) to \(( t + 0.5* \Delta t )\) where \( \Delta t \) represents the output interval.

This next exercise looked at the additional impact of changing flight altitude on the “total transit time” of the airship. The same route analysis was conducted, but this time at four separate altitudes. The altitudes were chosen to match the layers at which weather data were available from the NCEP/NCAR reanalysis dataset. Time savings were calculated as (Best Time divided by Great Circle Route Time). Each of these tracks used a constant flight altitude. In a real case, the airship will change altitude to best use the winds. These are the results for the return flight that are very different from the previous set of results.

In this next test the cruise altitude of the airship was constrained between 3000 and 8000 ft mean sea level. The altitude check was performed every hour of the flight with the algorithm picking the best altitude (meaning the one with the most tail wind). Altitude changes are indicated by color changes along the tracks. This graphic shows the weather optimized route as well as the great circle route. Note that the optimal route saved almost 13 hours over the great circle route time. By adding the ability to change altitude to select for favourable winds we are able to further reduce the overall airship travel time.

The performance metric of “Computation of Fuel” has already been included in the routing algorithm by use of a nominal formula derived from an estimate for a hypothetical cargo airship with parameters provided by airship experts. Two additional modes of optimization were also considered along with the incorporation of the fuel usage metric:

1. Change the ground speed and maintain a constant true airspeed and;
2. Change the airspeed to maintain a constant groundspeed.

The second mode is used for the following study in which an arrival time is fixed based on the “expected travel time” and the ground speed required to achieve that arrival time is maintained.

\[ \text{23 The great circle route also allowed the airship to pick more favorable altitudes and winds.} \]
This mode is attractive for routine operations, so that ground crews and payload handlers can be available at the expected time of arrival.

**Optimal Altitude Changes**

*As the airship proceeds, the best altitude is chosen for each hop*

- Altitudes are constrained between an upper and lower bound
- For the tests, altitudes were constrained between 3000 and 8000 ft (MSL)
- Hops every hour with two tracks spawned with each hop
- GCR: 8421 km; 66.32 hrs
- Optimal: 9013 km; 53.60 hrs

As each route is calculated, the great circle route travel time is used to calculate the desired ground speed to match the arrival time of the great circle route. The airship fuel consumption is calculated at each point in the route generation analysis. The route that gets the airship to its destination at the designated time, while consuming the least amount of fuel will be the optimal route.

This graph shows the fuel burn rate as a function of time for the great circle route shown as (B) and the optimal route shown as (A). The dashed lines and + signs represent the fuel used to change altitude during the flight. Note that the optimal route burns a bit more fuel during the first 24 hours of the trip than is consumed on the great circle route. But, the fuel usage on the optimal route diminishes dramatically for the latter half of the trip.
This graph shows the true air speed for the great circle route, (B), and the optimal route, (A). The great circle route shows a constant true airspeed while the optimal route shows a near constant airspeed initially, then an increase in airspeed is required due to headwinds encountered at the 20 to 25 hour point, followed by a drastic reduction in airspeed as the ship encounters tailwinds. The
headwind and tailwind situation is better seen in the next graph. Note that the airship encounters headwinds after 20 to 25 hours for the optimal route. However, that puts the airship in a position to take advantage of tailwinds for the rest of the flight. This example displays the weather route optimization algorithm’s greatest strength.
This graph shows the cumulative fuel usage. Note that the optimal route uses slightly more fuel in the first 30 hours of flight than the great circle route does. But, the significant tailwinds in the latter half of the flight allowed the engines to be slowed down resulting in significant fuel savings.

Here we see the fuel usage curve for the return flight, which was dominated by westerly winds which provided a strong tailwind.

Similar analyses were performed for daily airship flights over a one year period. This chart shows the fuel savings distribution for flights to Pusan in blue, and the return flights in red. Approximately 15% of the weather optimized flights resulted in 40 to 50% savings on the return flight. There are a number of benefits that come from weather optimization of the airship route. The aircraft risks and flight delays from bad weather can be minimized through careful avoidance of unfavourable conditions.

The longer the airship transit the greater the fuel savings that is possible. The ability to plan flight routes that do not exceed the airship’s weather minimums, yields a greater utility rate because the airship can now be safely operated right up to the weather limits whenever possible. The route modeling technique presented here removes the guess work that pilots must go through in developing a flight plan based only on raw weather data and their own flight experience. By
modeling each flight well in advance there is less disruption to planned arrival schedules and greater confidence in making stated delivery times.

By knowing the amount of fuel that will be consumed on a given route the airship pilot can avoid the possibility of overloading or under loading the amount of fuel needed for the flight. This knowledge also allows the maximum payload amount to be carried, which maximizes the profitability of each flight.

Lastly, the increased confidence that comes from knowing in advance where the adverse weather will be, and that a route plan is in hand to enable the flight to avoid the bad weather, will give insurance companies good cause to relax their airship premiums; and thus provide an additional savings to the airship operation.

Question 1 – Is it possible to make the route plan three days in advance?

Answer 1 – Yes, you can know 72 hours in advance what the weather will be across that length of space. You can model, in advance, what the changes are going to be over those 72 hours. As you go into those 72 hours in real life, you are monitoring the actual weather data from all the weather collecting stations. The weather balloons go up twice a day. This adds more fidelity to the predictive forecasts that you handed the pilot when he got on board the airship to fly that 72 hour flight. During the flight we would give updates to that map to just add a little nuance to it. By and large, the modeling software we have, is extremely accurate.

Question 2 – Could you explain how your methodology improves weather forecasting?

Answer 2 - Most weather predicting systems are modeling systems that divide the planet earth into rectangles. Our system uses triangles and you can make as many or as few, or as large or small triangles as you need to characterize the terrain and the weather within those triangles. Some of the triangles fall on well known data points for collecting weather data every two days or twice a day or it falls within the information from the 5th year data set. The ability to overlay these triangles over the terrain gives you a better fidelity for the terrain influenced weather than using the rectangle
model. All this has the incremental affect of adding accuracy to the overall model because you are modeling the whole earth, and then you are looking at the little place that you want to analyze.

Question 3 – Where else are these weather models useful?

Answer 3 – These are dynamic models that continue to look at the information that were getting and updating the prediction and they have a great deal of credibility. They have tested these models in a number of scenarios. They have used this basic methodology when someone would say well “we need to look at the plume dispersion from an accident where there is a lot of chemicals put in the air, what's going to happen.”

We were approached a few years ago by someone interested in stratospheric telecommunications airships. If we knew what the weather was going to be in this one spot, day after day, we could move the airship a thousand feet here or change its altitude a little bit, and minimize the headwinds on a stationary airship where all the weather patterns are going by it. We were able to show that this technique could provide that accurately and provide that knowledge in advance as to what is coming your way.

Question 4 – What are the next steps for this research?

Answer 4 – We are trying to get a hold of the folks in conventional aviation. Maybe working with Dr. Prentice, we could start this modeling technique with existing aircraft operations in Manitoba. In that wonderful day when a transport airship comes into Manitoba to start operations we would have gained some experience looking at conventional aircraft in the operational weather of Manitoba and Northwestern Ontario. Maybe we can work together and all learn more about the potential application of this technology in northern Canada.

Question 5 – What are the other opportunities for this technology?

Answer 5 – Our guys have done landfall predictions for some of the more recent hurricanes, even, Katrina. The Chief of our Center was trying to phone everybody he could find the day before Katrina hit the coastline. He knew exactly where it was going to hit and he was trying to get
someone to listen to him. We have had a real challenge with “not invented here” syndrome, especially with the National Weather Service who said “thank you very much, we do not need your help, we have been doing this for a long time, we got a lock on this anyway.”

We are going down to the FAA, sometime soon. We have a meeting set up to speak to them about the use of this in saving fuel. If you can save fuel on a conventional airplane’s burn by changing their altitude, speed, etc., one or two percent, it is a big benefit. If I can show them where to fly where they are not going to create contrails and if it is a slight diversion, I can minimize the radiative forcing of contrails and that affects global warming. This is a very powerful tool and we are just starting to look at how we can utilize it.
Session Three:
Airship Developers Panel

Making Cargo Airships Happen

Session Moderator
Dr. Barry E. Prentice
President,
ISO Polar Airships Inc.

The third panel of the day “Making Cargo Airships Happen” has representatives from three different airship companies. They have been asked give a brief talk on their projects and then a series of questions will be addressed to the panel.

Speaker
Gil Costin
Founder and CEO of Millennium Airship

Millennium Airship has been at the Airships to the Arctic I, II, III and now IV. For the first three conferences, Millennium Airships was in the mode of many folks here. We had an aircraft design, we had a concept and a vision, and we were pursuing funding to develop that design and pursue the concept. Several things happened along the way. First, we began to realize the reality of the challenge. It would cost in the neighbourhood of 500 million and 750 million dollars to produce, to do con ops, and to do PDR, to satisfy all the regulatory caveats, etc. in order to bring this aircraft to fruition. This is a daunting task even for a Fortune 100 Company. We were a six man company at the time. Everybody got pretty excited that DARPA was going to sink ten million dollars into hybrid research and issue, perhaps, three contracts to do concept of operations work for a heavy lifter called Walrus. After phase 1 the Walrus project disappeared because of many things including the war in Iraq.
A lot of good things came out of the Walrus Project, at least for Millennium Airships. We developed a relationship with Lockheed Martin Corp. We worked under contract with them for the Walrus Project on a specific item. It developed into a pretty nice relationship that we still enjoy today. We also began to realize that if anyone is going to build something like this, it is going to be a major aerospace manufacturer, like Boeing, Airbus Industries or Lockheed Martin. We knew that Lockheed Martin had been working many years on a hybrid aircraft.

We were also talking to several people about the commercial aspect of this aircraft rather than the military aspect. It is still my conjecture that the American military will not buy one of these aircraft even if it is built. Instead they will be built to military specifications and go into civilian service. The military will pay these operators an annual retainer in agreement to have the aircraft ready and available within, let’s say, a 96 hour period if it is needed to haul troops, etc, to a military conflict.24

Between 2004 and 2006, Millennium Airships started to field a lot of calls for the heavy lift air vehicle. In January of 2006, we were invited to Lockheed Martin, (Skunkworks) to watch the P-791 fly. This was kind of a turning point for our company. A lot of the things that we were endeavouring to do with our concept, they had mitigated. I watched P-791 get pulled out of the hangar like any other standard aircraft would get pulled out of the hangar. It was a ten knot day. I watched it start up. I watched the ACLS System levitate the aircraft. I watched it taxi a half a mile, quartering cross winds to the active runway. I watched the engines go full throttle and I watched it fly. It flew all over the perimeter of the Skunkworks. The cars along Avenue P were stopped and the next day it was in Aviation Week and Space Technology. “Lockheed flies secret airship”.

I went back to our corporate offices and I talked to our shareholders. I suggested at that time that we get out of the business of building a heavy lifter and become an airship operator and marketer. If at all possible, we will be the customer for Lockheed. Nothing has been signed, we are just in negotiation phase. Lockheed Martin has not made a decision, even to build this aircraft. When they do though, we are going to be the first one at their door.

We made the corporate decision to change our company profile. We have not abandoned our design. We think there are many good ideas in it. Who knows whether some of those ideas will be

24 Standby contracts are common in the military for the contingent use of avian and naval assets.
incorporated in the ultimate air vehicle that leaves the ground. We decided to change our company profile and deal with the customer base that we seen to be rapidly developing. We wanted to be able to tell the customer that there is a darn good chance that this aircraft will be able to fly and we will be able to provide this aircraft but are not going to give any guarantees yet. We wanted to align ourselves, with a company big enough, powerful enough, with the infrastructure in place and the monetary horsepower to build this aircraft if they ever decided to do it. It will be a paradigm shift in global transportation.

Millennium Airships Sky Freighter Corporation formed Sky Freighter Canada Limited in March of 2007, because of increasing customer demand in Canada. We plan to operate out of Edmonton International Airport, to serve commercial entities in the Canadian North. We are actively seeking key individuals for that company which is embryonic at this time. I am greatly impressed by some of the people that I have talked to these last few days and by some of the operations that have been discussed.

Once the funding entities that we have been dealing with found out that we had changed the company profile, sustainable operating capital to carry us through until whenever this aircraft was built, did not seem to be too much of a challenge anymore. Especially, when we told them we wanted to do business with a major Aerospace manufacturer.

I told my shareholders a bend in the road, is not the end of the road unless you fail to negotiate the turn. We did that change and I wish all developers the best of luck in the world. There is more work, than CargoLifter can handle, than Sky Freighter can handle, than Varialift can handle, the transport market for LTA is immense. It has been substantiated, over and over again, by not only airship companies, such as us, but also companies who are in the business of validating business models and customer bases that are not in the Airship business. They have no vested interest. I hope that Airships to the Arctic V (2009) will have a whole different genre. I hope we will be able to say, we are close to being up and operating, or at least we are on the way.
We could not use the old CargoLifter Co. name because it still exists. Maybe some of you do not know the story of CargoLifter. Most of you probably know where it went but I know where it came from. CargoLifter was mainly built from the work of Carl von Gablenz, who was then also CEO. He worked at a University in the logistics sector and taught about systems of supply and logistics worldwide. He came across people from the industry, who said we have a problem with something that is heavier than X and wider than Y. He was not an airship enthusiast at that moment even if his father and grandfather had roots in the German air industry. But, he said, if you want to pick up things, move it, and put it down, you need something that is able to do so. A helicopter is limited by its means and physics. So, sooner or later you come to the point that something that can stay in the air without burning energy is the right way.

If you have the idea and you see the market, you have to raise money to do it. Carl von Gablenz told me how difficult it was to get the first 5000 marks to form the company. Siemens said go to ABB and ABB said go to Siemens. This is what you confront when you want to start something without funding. The story is that he attracted a lot of other people, mostly private people, over 72000 to invest in his company. He raised over 300 million Euro within a certain time, went public and became insolvent in 2002. We were very advanced in several things. Perhaps we should have taken several more years to have the CL 160 but we were advanced with our cargo exchange system.

I was one of the first shareholders of CargoLifter. I asked Carl von Gablenz what was the reason for the insolvency and where has my money gone? CargoLifter could have done some things really better, but there was no show stopper. I spent my money in the shares. I can leave it alone or continue in a better way. The money I spent before, is not burned but only lost for a moment. I have an interesting quote that I like: “there's one thing stronger than all the armies in the world and that is an idea whose time has come.”

It is very difficult to start with a large project again. The step was too steep, so my decision was we take less steep steps. We were approached by companies that deal with a problem of getting the
blades for wind turbines to remote areas. They told us about the cost, and their technical problems. We think that this would be a good application for the simplest form of lighter-than-air; that is the balloon.

A 500 ton lift crane is only capable of lifting its full payload of 500 tons eight meters from its mast. Beyond this reach its payload gets less and less. It is expensive to move large cranes maybe only 50 meters, to construct wind turbines. We thought it would be a good idea to replace them with a craning balloon.

Another craning application for balloons could be pipeline operations. The craning balloon could move with the building of the pipeline. An application for larger balloons could be air ferries. Wherever you have to cross rivers or valleys a balloon could be operated with winches. If you have to bridge larger distances, for instance, a lake of 1 to 10 kilometres a cable car system could be developed.
I am going to go briefly through the stages in the development of a Varialift heavy lift aircraft. The process started some five years ago, my personal history is in aviation. I have been in the heavy steel industry for 40 odd years, designing and building steel process lines and rolling mills. I have never had the luxury of having a large amount of development money to spend, so when I design a mill it has to work the first time, every time. That is the requirement of the industry. So from all that practice, I put all this expertise into getting answers for building a modern airship.

Varialift is protected by International Patent Applications

The airship I am building is manufactured entirely of aluminum. It is built more like an airplane than an airship. This is a line drawing of the center section of the Varialift Airship.

The variable lift is obtained by moving helium in and out of the two receiver tanks. Helium is compressed to one atmosphere in the receiver tanks for landing.\(^{25}\) The top tank is the variable lift tank. On the ground the white portion is air. The part which moves up and down that fits between the receiver tanks is a diaphragm or air helium separator membrane.

\(^{25}\) Just 14 psi or thereabouts
Starting from the heavy position, a valve is opened so the helium passes from the receiver tanks into the variable lift tank. This pushes the diaphragm down exhausting the air from underneath it, making the airship “light” and creating buoyancy. This process can be stopped at any stage and is fully controllable.

![Heavy Position and Light Position](image)

In order to reverse the process, the helium is pumped back into the receiver tanks. The slight differential pressure between this and the atmosphere will cause the diaphragm to rise, which makes the airship “heavy” and it descends. This simple design can be constructed entirely out of aluminum.

Half of the problem with helium is containment. In this model, all the containers are aluminum, apart from this diaphragm. Varialift is a new type of heavy lift aircraft. The lift capacity of Varialift depends on the size. It could have a lift capacity from 50 to 1000 tons, but up to 500 tons would be the norm because of vertical takeoff and landing. Varialift does not need a runway. It can land virtually anywhere that there is a suitable plot of land. The cost to manufacture Varialift is a fraction of the cost of a conventional airship. It is a totally fabricated structure that can be manufactured in just about any country.

Where can Varialift operate? Virtually anywhere, as long as there is clearance for it to land and take off. It is a point to point delivery system. The airship is heavy on the ground, so you can drive on, drive off, walk on, walk off.
A method of transport that will carry things from A to B without large expensive infrastructure is a great thing. This is what I think Canada is after. The ice roads have to be replenished every year at high cost. For Canada, we are talking about approximately a 15 ton capacity Varialift; nothing too large.

Here is a specification for the 50 ton maximum payload. The payload bay size is a 100 meters long and 50 meters wide. This gives it quite a large platform for loading and unloading. The construction is rigid, all aluminum. The maximum speed is subject to testing. Obviously, we will have to do wind tunnel tests. After the first proof of concept, which is being built at this moment, we will have more definitive specifications.

### Specification ARH 50

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<tr>
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<tr>
<td>Max payload</td>
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<td>Max Altitude</td>
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<td>Max Speed</td>
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<td>Lifting Gas</td>
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* Do to continuing development all specifications and data is subject to change at any time at any specification

The design length of the 50 ton Varialift is 150 meters, the width is 52 meters and the height is 40 meters. Gross weight is 200 metric tons and the gross lift is 255 metric tons giving a variable lift of 55 tons. The weight on the ground is 9 tons. So the Varialift sits down and it is ready for loading.

The picture on the left shows a receiver tank being constructed. It needs another sheet to complete the circle. There will be 19 of these, end to end, forming one tank. This will receive the helium at atmospheric pressure and be able to take a charge of 14 psi. In the picture on the right second section has been added to the receiver tank.
We hope to have the fabrication finished in 2008 where it will perform tests on static line. It will do the lift up, hover and down in a controlled way. It will be heavy on the ground. Its designed cargo weight is very small, (about 114 kgs.) but with that we will put strain gauges all over the aircraft. We will know all the stress and strains happening everywhere, and from that it will be downloaded into a computer and used for the construction of the next phase, which will be building a 50 ton lift airship. This will take two years plus, with CAA involvement, to end up with an airworthiness certificate at the end of the day.
Questions to the Developers Panel

Dr. Barry Prentice – Moderator

Obviously we have many good ideas in terms of a development strategy for the airship industry. I have asked the panel to consider why is it so difficult to move forward? I have three questions for each of the panelists to address and then we will open the session to questions from the floor.

I will ask Gil to address the first question which is:

Question 1 – How can small start up operations generate the necessary investment capital to pay for the initial stages of technological development?

Gil Costin
Millennium Airships

The team that I had seek capital is very talented. We have on our team, ex-Boeing personnel, very well versed in the aviation industry. We have people involved in transportation logistics, key personnel, most of them retired who just wanted to go ahead and keep active in what they were doing.

Initially you are limited in what you can extract from the investor. I can only speak for Canada and the U. S. for how corporations are set up. You cannot IPO immediately. It would be folly to even think you can IPO a company that has no revenue stream or track record. What you are going to look at is a limited equity sale. It is usually up to about a million dollars, and in the U. S., it has to be a sophisticated investor. Such an investor would be someone who has a net worth of a million dollars or more under the 504 regulations of the United States.

They have something called the Blue Sky law. It came to be because of people selling equity in their company. Basically they are selling the blue sky and that is why it has that name. They limit what
you can get and here in Canada it is the number of investors. I do not think it has a dollar value, it is 30 investors or something like that.

Secondary is private placement. You have to be squeaky clean to have a major funder, private placement entity. You have to be really squeaky clean and show some real promise to a private placement, such as, a group we deal with, such as Oppenheimer Funds and UBS. It is a monumental task. It takes lots of dollars just to get these guys to talk to you. Well, that is basically it. I wish you well in trying to acquire significant capital to keep your operation going and put your aircraft in the air.

Question 1 – How can small start up operations generate the necessary investment capital to pay for the initial stages of technological development?

Mirko Hoermann
CargoLifter

I can closely follow what Gil has said in regard to raising money. For small companies you have to attract the wealthy person or a lot of persons who spend a bit. This is definitely limited and I do not think CargoLifter will happen again. You have to have certain circumstances and it must be the right time to do so. Gil decided not to go on his own because it is too difficult. The large aerospace companies get the money from the military. Personally, I envy, America for the DARPA program. I would like to have something like this. A certain budget to spend for things people think are crazy, or which you only see in science fiction or at some web site. The problem is, their budget can be cut, like with the Walrus Project or the high altitude study, if the Government needs the money for other purposes.

Question 1 – How can small start up operations generate the necessary investment capital to pay for the initial stages of technological development?
Alan Handley
Varialift

My background is heavy engineering and that is a business I have ongoing at the moment. In order to finance up to the proving of the principle I have been able to draw on this business and write it off on my taxes. After they have proven the principle that is where the PLC Company comes in and we go to the public with a proven idea. We put a package together to convince investors to buy shares in the company.

As our previous speaker said, the idea is not just too build airships. It is to build and fly airships and use them for revenue. Our idea is to build a 50 tonner, get it certified, then fly cargo with it. While flying cargo with the first one, build a second one. After a couple of years to build confidence, people can buy them directly. This is the plan I put together that is the way I see it forward.

Question 2 – Other than investment capital what does the Airship Industry most need, to accelerate its development?

Mirko Hoermann
CargoLifter

Someone like you or Mr. Kleysen last evening. You need such people definitely. If we do not want to fulfill, seemingly, a natural law that every transportation innovation must go through a military application, then we need such people who have this will and vision. We would never have had an Airbus with German participation if we would not have a Prime Minister in Bavaria named Strauss. It was his vision and he organized 1.3 billion marks, at that time, to start up a commercial airplane manufacturer. They built an aircraft nobody wanted to buy. It had wide wings, wide fins, with no name on it because nobody wanted to buy it. He said, “We will continue”, and they found their first customer. They convinced them and then they got into the market. Sometimes you have to have such people who pave the way.

In this regard it is important that we have such meetings where the other side gets to know what the airship community is doing. As Dr. Boyd said, there is no competition. There is a competition for
the money, yes, but we have the market without competition because we cannot build the number of airships that are needed fast enough. The next thing we need is trained people. Everyone going through the University is trained, normally, for heavier-than-air. They are all “speedys”, not “spaceys”. The problem is you have to convince people to think in dimensions. They should not be too programmed in advance, for things that have come before, like heavier-than-air aerodynamics.

We need something like a lighter-than-air or airship academy. It is important to have LTA engineers in five to ten years when we need them, because this will be a resource that is very rare. The CargoLifter CL 160, design was 260 meters long, 61 meters wide and needed a hangar. Afterwards, people said look, why did you build the garage if you have not got a car? We spent 75 million euros, for the hangar. I think it was the right decision because you had to have the testing facility. We had other lighter-than-air vehicles and the balloon which had the width of CargoLifter that was planned.

Question 2 – Other than investment capital what does the Airship Industry most need, to accelerate its development?

Alan Handley
Varialift

I will come back to the ISO Polar workshop meeting that was about regulations. The regulations seemed to me, to be, extremely archaic and very difficult to interpret. We need user friendly ones, at least, in the airship business. In Canada, probably a flight corridor made available for experimental craft. So my Company, or any Company can come and prove to the Canadian people that the airship will work.

Question 2 – Other than investment capital what does the Airship Industry most need, to accelerate its development?
Gil Costin
Millennium Airships

What it is needed other than investment capital is very simple. You need a demand which has been identified over and over again. You need customers. If you have something to sell and you do not have customers, then it is done. Then you need, and this is very important, at least from our perspective, an established aerospace manufacturer, willing and capable of building that aircraft that will meet the customer’s needs. Once that is done, the flow of investment capital, I will not say it is a given, will be much easier to acquire.

Question 3 – Why do you think that the Airship Industry has not been able to take advantage of its inherent environmentally beneficial nature to generate public and private investment?

Alan Handley
Varialift

The real problem is that we have not got airships to demonstrate. If we can get airships in the air and demonstrate them as other members of the panels have said, the funds will flow. This is what we need in the airship industry.

Question 3 – Why do you think that the Airship Industry has not been able to take advantage of its inherent environmentally beneficial nature to generate public and private investment?

Mirko Hoermann
CargoLifter

Which airship industry? We are very fragmented. It is a small community, indeed. An airship group or lobby is much needed in this case. It relates to the question before. Why is the environmentally beneficial nature not recognized? Up to now mankind has not had this on the top of their agenda. I feel that, most private individuals have longer and better antennas in this regard, than organizations or governments. The attention of Government and institutional financing will increase because of
what happens in the north with the melting ice. Once this has their attention then environmental things with the airships will happen.

It is really obvious, that permanent roads are not too environmentally friendly. Taxpayers should decide whether to go with a billion dollars to build this road to Nunavut. It’s a lot of your taxpayers’ money. Why not try an unconventional way? Canada could put up some pot of money, like DARPA and say whoever has a good concept will get some money to solve our transportation and environmental problems. Maybe this is the solution. So let’s get some attention for the environmental advantages of airships.

Question 3 – Why do you think that the Airship Industry has not been able to take advantage of it is inherent environmentally beneficial nature to generate public and private investment?

Gil Costin
Millennium Airships

Currently, less than a hundred airships are operating in the world. Those companies are not saying, see how environmentally friendly we are. It just does not happen. Emerging companies, such as those here today, are not going to divert capital to an advertising campaign that says we are environmentally green. It has been said but it kind of falls on deaf ears. Once, God forbid, we have an event that is directly related global warming that scares the heck out of everybody they might listen to us. There may be a shift to something greener, like airships. But, until we have a lot of airships in the air, and we can show them the difference, I do not see where we can really take too much advantage of promoting the environmental benefit.

Barry Prentice,
Moderator

We will entertain questions from the floor.

Question 1 – What are the major applications you have in mind for the Lockheed Martin airship?
Gil Costin
Millennium Airships

I cannot name some of the customers because we are under non-disclosure agreements. There are multiple applications, Arctic supply and resupply in Canada is a major one. Dr. Boyd made it very clear; a sustainable operation is key for the lifeblood of an operation such as this. Customers coming to us are looking for that sort of sustainable ongoing operation. Operations without roads or very limited road access, are potential customers. We have two people at the Airships to the Arctic conference that are potentially customers of ours.

Question 2 – Returning to the subject of trying to make it happen, what would you like organizations such as ISO Polar, the AIAA, the Airship Association, etc, to do, that we have not done already to make it happen?

Mirko Hoermann
CargoLifter

ISO Polar just started and I can only encourage people to be a part of ISO Polar. The larger the critical mass rises, the more interest. It is the best thing. We have to teach people. Their idea of an airship is shaped by what they see in the media. We have to talk to the media because they can be either allies or enemies. We should work to make them our allies. This is very important and Barry does a great job with the media. He is keeping up the flag here. Hopefully he will be present, in the future with Hokan, bringing in an airship to Manitoba. This people will pay attention to; this is something flying.

The Associations, should work together. They should exchange ideas and have even more public meetings. We had the public lecture before the conference. There were less people than we have in the room now. We should be promoting these events more.
Alan Handley
Varialift

I am a member of the ISO Polar Association from London. I have been extremely encouraged coming here and seeing the amount of effort Barry Prentice and his team have put into this conference. With Airship Associations such as the one in London, I am sort of disillusioned. They claim them to be there to help newcomers and get things off the ground. But absolutely they are no help at all. The only help I have had is from some of the members. But that is an individual, the actual Association, when I want something published in their magazine, just ignore me. That is not a help to me and I do not think it is them doing what they are there for. All they seem to want to do is talk about history and just have meetings about this; never to actually get things done, which is the theme of this conference.

Gil Costin
Millennium Airships

I could not ask for a better organization then the AIAA. They have been phenomenal with us. The Airships Association, needs to start looking more at the future of this industry. The Airship Journal could have a whole section on heavy lift. How it is doing? Where it is going? Who is the new upstart? They can still address the standard operator of blimps, but I do not even like calling these new designs, airships anymore. They are aircraft.
Session Four:
Where’s the Gas?

Helium, its Recovery, Purification, Transport and Deployment as an Airship Lifting Gas

Session Moderator
Bill Zuk,
Executive Director,
Manitoba Aviation Council

Speaker
David Limb, Consultant,
David Limb Associates Ltd.

Abstract
Helium is a strange and fascinating substance whose well-documented unique properties find application in various fields. Just one such is in lighter than air (LTA) craft. Although abundant in the universe, economic access to helium on planet Earth is limited to a small number of helium-rich gas reservoirs. Recovery currently takes place at 14 plants in 12 locations. The recovery, purification and liquefaction of helium at one such location are described. This is followed by a review of helium versus alternate lift gases and a means of re-purifying contaminated helium is described. Options to transport helium from production plant to points of use are discussed and a brief review is provided of availability and the factors affecting the market. The final section provides a hopeful glimpse into the future.

Background
In the early 1970s the UK Company Petrocarbon Developments (now Costain Oil Gas and Process) was awarded a contract to design and build a plant in Poland to process a natural gas from wells with very high nitrogen content - up to 43%. The plant’s objective was to separate out, or reject the
‘inert’ nitrogen before pipelining the hydrocarbon gas to the point of consumption. The technology proposed for the nitrogen/methane separation was a double distillation column - very similar in concept to the traditional process for air separation. (See Figures 1 and 2).

This natural gas also contained an unusually high concentration of Helium of 0.4%. This does not sound a lot - until compared with atmospheric air which has only 5 parts per million (ppm). It was soon realized that the quantity of helium available from just half of the processed ‘lean’ natural gas would be enough to satisfy the European market at that time. Till then all helium was shipped over from the USA at considerable expense. The plant was designed, built and successfully commissioned in 1977/78. I was privileged to be involved in all phases of a unique project. The liquid helium product was distributed throughout Europe – a major user being as a Heliox diving mixture during the North Sea oil and Gas boom. The Odolanow plant is still operating today albeit with the original gas field in decline, and it is, to the best of my knowledge the only base-load helium extraction, purification and liquefaction plant in Europe.

The picture below shows the nitrogen methane separation plant installed as two parallel trains – with feed purification on the right hand side and the large double distillation columns left of centre. The cold boxes are to the left of these columns and the horizontal 35,000 US gallon liquid helium tank is at the far left.
In the 1980s, I became interested in semi-permeable membrane technology – as a separation process. It had been discovered that the Reverse Osmosis desalination membranes (e.g. Cellulose Acetate) – if carefully dried – could be used for separating certain gas mixtures. In particular, light gases like H2 or He easily passed through the membrane, whilst heavier gases like air were mainly held back. (See Fig 5). This was a very simple new development that could (and did) compete directly with the established cryogenic processes for gas separations, which were our ‘bread and butter’. My first visit to Alberta, about 1982 was to the Alberta Research Council in Edmonton where I met with Dr. C.Y.Pan, a co-developer of a membrane process to recover Helium from a natural gas feed containing 0.1% helium, and produce a product stream with 60% helium. This could be increased to 90% by including a further recycle stage and could then undergo final processing by conventional means. The process had been piloted and operated for a few years by an organization Alberta Helium set up in 1970 by Alberta Research Council with Trans-Canada Pipelines Ltd. and Alberta and Southern Gas Company. [1].

In the late 1980s my company (Costain Petrocarbon) was approached with a request to supply a skid-mounted plant to purify the helium from an airship. During flight – not only does some helium leak out, but air and water vapor diffuse in – increasing the density of the gas in the envelope and reducing its lifting capacity. Thus, although 80-90% of the helium may still be there – it is almost useless, unless re-purified. In response to the enquiry, we developed and patented a process to

![Figure 1 Double Column Nitrogen Rejection Plant [Ref. 8]](image-url)
achieve this and sold a few units [3].

Since the turn of the century, working in Alberta – mainly in the oil and gas industries, I became aware of the transportation challenges facing Northern Canada – lakes, muskeg, ice-roads, road bans. In 2003/4 whilst doing a small study in connection with the Mackenzie gas project, I had the idea of using helium dirigibles or airships to address some of these challenges. That concludes the background, but it is necessary that we now undergo a brief physics refresher – for which I apologize.

**Helium as a Lift Gas**

The performance of any lift gas is governed by its density relative to that of the air it displaces (Archimedes’ principle). Air has a molecular weight of 28.96 and a density of about 1.22 kg/m$^3$ at STP. (Standard temperature and pressure (STP) are respectively 15°C and 101.3 kPa = standard atmosphere).

The properties of helium are fairly well documented. Although it is the second most abundant element in the universe after hydrogen, its content in the earth’s atmosphere is only 5 parts in a million (ppm). It is inert – the lightest of the ‘noble’ gases, with a molecular weight of 4. ( Twice that of hydrogen).

It is the most difficult substance to liquefy having a Normal Boiling point of -269°C or 4.2K (4 degrees above absolute zero). At this temperature even the lightest element hydrogen would be frozen solid.

Helium’s density at room temperature and atmospheric pressure of 0.17 kg/m$^3$ is about 1/7th that of air. Since the gross lifting capacity of a gas envelope is the (volume) x (density difference), it is evident that 1 m$^3$ of helium can lift a little over 1 kg. $(1.22 - 0.17) = 1.05$.

Gross lifting capacity means the load includes that of the envelope etc as well as the ‘useful payload’. Some alternative lifting gases are compared in Table 1.
### Table 1 Basic comparison of Lift Gases.

<table>
<thead>
<tr>
<th>Envelope contents</th>
<th>Symbol</th>
<th>Temperature (°C)</th>
<th>Fluid Molecular weight (kg/kmol)</th>
<th>Fluid Density (kg/m³)</th>
<th>Gross Lifting capacity (kg/m³)</th>
<th>Percent of vacuum gross lift (%)</th>
<th>Envelope size per gross tonne (m³)</th>
<th>Sphere diameter (m)</th>
<th>Flammability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Vacuum</td>
<td>H2</td>
<td>15</td>
<td>288.2</td>
<td>0.0853</td>
<td>1.140</td>
<td>100.0%</td>
<td>816</td>
<td>11.6</td>
<td>No</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>He</td>
<td>15</td>
<td>288.2</td>
<td>0.1692</td>
<td>1.056</td>
<td>93.0%</td>
<td>878</td>
<td>11.9</td>
<td>Yes</td>
</tr>
<tr>
<td>Steam</td>
<td>H2O</td>
<td>100</td>
<td>373.2</td>
<td>0.5879</td>
<td>0.637</td>
<td>86.2%</td>
<td>947</td>
<td>12.2</td>
<td>No</td>
</tr>
<tr>
<td>Methane</td>
<td>CH4</td>
<td>15</td>
<td>288.2</td>
<td>0.6767</td>
<td>0.548</td>
<td>6</td>
<td>1824</td>
<td>15.2</td>
<td>Yes</td>
</tr>
<tr>
<td>Helium / Neon</td>
<td>He</td>
<td>15</td>
<td>288.2</td>
<td>0.7004</td>
<td>0.524</td>
<td>42.8%</td>
<td>1907</td>
<td>15.4</td>
<td>No</td>
</tr>
<tr>
<td>Ammonia</td>
<td>NH3</td>
<td>15</td>
<td>288.2</td>
<td>0.7190</td>
<td>0.506</td>
<td>41.3%</td>
<td>1977</td>
<td>15.6</td>
<td>Yes</td>
</tr>
<tr>
<td>Hot Air</td>
<td>Air</td>
<td>200</td>
<td>473.2</td>
<td>0.7459</td>
<td>0.479</td>
<td>39.1%</td>
<td>2088</td>
<td>15.9</td>
<td>No</td>
</tr>
<tr>
<td>Hot Air</td>
<td>Air</td>
<td>150</td>
<td>423.2</td>
<td>0.8340</td>
<td>0.391</td>
<td>31.9%</td>
<td>2559</td>
<td>17.0</td>
<td>No</td>
</tr>
<tr>
<td>Hot Air</td>
<td>Air</td>
<td>100</td>
<td>373.2</td>
<td>0.9458</td>
<td>0.279</td>
<td>22.8%</td>
<td>3584</td>
<td>19.0</td>
<td>No</td>
</tr>
<tr>
<td>Ambient air</td>
<td>Air</td>
<td>15</td>
<td>288.2</td>
<td>1.2248</td>
<td>0.000</td>
<td>0.0%</td>
<td>infinite</td>
<td>infinite</td>
<td>No</td>
</tr>
</tbody>
</table>

It is apparent that an envelope containing a vacuum provides the maximum lifting capacity but, because of the parasitic weight associated with structures required to maintain the shape of the envelope – this is unlikely to be a practical solution with currently available materials. Moreover an envelope containing a light gas (H₂ or He) under a small positive pressure is almost as good as a vacuum. Light gas-containing structures that in turn provide an envelope for a vacuum are not inconceivable.

After a vacuum, Hydrogen (H₂) is the next best lift gas, having 93% of the hypothetical lift capacity of a vacuum. This choice is discussed in Dr. Spaltmann’s presentation. Helium comes a close 3rd (or 2nd in reality) having 92.6% of the lift capacity of hydrogen, or 86% that of a vacuum. At this point it should be mentioned that the atmospheric density of a gas relative to air is directly proportional to its molecular weight and inversely proportional to its (absolute) temperature. Absolute temperature (degrees K) = °C+273.15.
Clearly hot air balloons depend on the second effect. Water vapor as a lift gas has a molecular weight of 18 (62% of air). To exert sufficient pressure to keep the envelope inflated, the steam must be at least slightly above its boiling point of about 100°C (373 K). This secondary factor \((288/373) = 0.772\) further reduces the density, giving an overall density of 48% of air. This is not exactly exciting as a primary lift gas – and requires constant addition of heat to offset the heat loss. However, it might find use as an auxiliary lift gas for trim or altitude control. Methane and ammonia are both flammable and although readily available have only modest lifting capacity.

Helium separated in small quantities from the air is contaminated with Neon –another noble gas, but with a molecular weight of 20.18 and density of 0.854 kg/m\(^3\) at STP. Thus Neon’s density is 70% of that of air and its lifting potential is very limited. If recovered from an Air Separation Unit (ASU), the mixture would comprise about 77.6% Ne and 22.4% He. This mixture molecular weight is 16.56 – about 57% of that of air. Again this is not very impressive compared with Hydrogen or pure Helium, and the quantities from even a large cryogenic air separation plant (ASU) are very small. Air contains 5.2 ppm Helium and 18.2 ppm Neon.

Separation of the Helium from the Helium-Neon fraction is feasible using either cryogenic and/or adsorption technology, but is expensive in relation to the small volumes recovered. For these reasons the main source of helium is from those few natural gas sources with a high enough content (0.2-0.3% or more) to justify recovery.

**Helium Extraction**

A brief overview follows of the technology required to recover helium from natural gas, as exemplified by the plant in Poland. There are differences in technical detail as a result of feed conditions and of engineering preferences, but the basic steps, are as shown on the simplified flow schematic in Figure 2.
The feed natural gas at high pressure is ‘sweetened’ and then dried using ‘molecular sieve’ desiccant. Any other components that would freeze out in the following cryogenic process – such as carbon dioxide and heavy hydrocarbons also have to be removed. The high pressure feed gas mixture is then cooled down in multi-stream heat exchangers to a temperature close to its liquefaction point (about -150°C), and then expanded to an intermediate pressure of about 25 bar and distilled in two linked columns to separate the nitrogen and methane. These two principal products are warmed back up to ambient temperature and this is usually more than sufficient refrigeration to cool down the incoming high pressure feed. Excess refrigeration can be used to make some liquid nitrogen for use elsewhere – see below. At the top of the first – higher pressure distillation tower, the light ‘non-condensable’ helium accumulates together with nitrogen. It is removed as a stream with about 10% helium and enriched further to about 85-90% helium by condensing out most of the nitrogen, in a special type of condensing heat exchanger called a ‘dephlegmator’ or a refluxing heat exchanger.

This so-called ‘crude helium’ is then passed to the helium purification unit. Small traces (100 ppm) of hydrogen in the feed natural gas build up to 2.5% and have to be removed by catalytic combustion. This is followed by drying to remove the water produced in the reaction. The dry crude helium is then passed to the purification cold box.
Most of the remaining nitrogen is condensed out from the crude helium using liquid nitrogen evaporating under vacuum as refrigerant. Boiling nitrogen at about 66°K and 0.2 bars absolute was used in the Polish plant. Careful control of the pressure is needed because at 63.5°K the nitrogen freezes, and - from experience - solid N2 is not a good refrigerant. After this step, the purity of the uncondensed vapor has risen to about 98% helium.

Most of the remaining 2% impurity is removed by high pressure low temperature adsorption, where the adsorbent can be activated carbon or molecular sieve – or a combination. The absorber vessel is usually kept cold by means of a jacket of liquid nitrogen. Two absorbers are used so that whilst one is in service the other can be regenerated – by a combination of heat and vacuum.

Figure 3 shows the helium purification cold box containing the low temperature absorbers and heat exchangers, nearing completion of the external cladding. The cold pure helium at 80K (-193°C) with less than 1 ppm impurity is then either passed to the Liquefier, or re-warmed and compressed into bottles (cylinders) for distribution.

After shipping to site, the internal equipment was leak-tested, and the box itself was checked for gas-tightness before being sealed up and filled with powdered perlite insulation. In operation the box is purged with a small flow of crude helium to prevent air condensing on the cold equipment surfaces.

The photo in Figure 4 shows the heat exchangers and other internals of a large helium liquefier. To minimize heat ingress, all equipment is suspended from the top hat. High speed turbines mounted in the top hat provide the required refrigeration at temperature levels of 30K and 10K. The equipment is wrapped in super-insulation.
(aluminized Mylar film) to cut radiant heat ingress. The suspended equipment is lowered into the vacuum jacket shell. Before cool-down the shell space is pumped down to a vacuum of 10-5 torr using a diffusion pump and a roughing pump in series. In the liquefier heat-exchangers, supercritical helium vapor is cooled down to about 6K (6 degrees K above absolute zero) and expanded into the 120,000 litre storage tank, whereupon some 40% remains as liquid, and the remaining vapor at 4.5K returns to the liquefier heat exchangers, where it is re-warmed and recompressed in a 1000 BHP 5-stage recycle compressor.

The storage tank also has a vacuum jacket and multiple layers of super insulation and in addition a liquid nitrogen-cooled radiation shield to intercept all incoming radiant heat above the 77K level. (Minus 196°C). The accumulated liquid helium is periodically transferred by gravity through vacuum insulated pipes into road tankers; flash and displaced vapour returning to the main tank and thence to the liquefier, to avoid any loss.

Like the static storage tank, large liquid helium road tankers (10-13,000 US gallon) also have to minimize the heat ingress, which causes boil-off and potential loss of product. Therefore they also employ multiple layers of super-insulation and a liquid nitrogen-cooled thermal radiation shield within the vacuum space. This is kept supplied from a small liquid nitrogen tank mounted on the truck, which in turn has to be replenished regularly.

It is apparent that extraordinary measures are employed to ensure virtually no-loss operation in the recovery, purification and distribution of this hard-won commodity.

**Recovery of Helium from Airship Envelopes**

When the helium reaches its point of use – it is equally sensible to minimize losses, and to re-use where possible, to minimize makeup costs.

In the case of Airships, the ‘partial pressure’ or concentration differential between the outside and the inside of the envelope causes air and water vapour to diffuse inwards, increasing the density and reducing the lifting capacity, and the ease of handling. This contamination process is akin to osmosis. Table 2 shows the impact of air ingress.
Table 2 Effect of helium purity (impurity assumed air)

<table>
<thead>
<tr>
<th>Envelope contents</th>
<th>Fluid Mol weight</th>
<th>Fluid Density kg/m³</th>
<th>Gross Lifting capacity kg/m³</th>
<th>Percent of pure Helium gross lift %</th>
<th>Envelope size per gross tonne m³</th>
<th>Sphere diameter m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>kg/kmol</td>
<td>kg/m³</td>
<td>kg/m³</td>
<td>%</td>
<td>m³</td>
<td>m</td>
</tr>
<tr>
<td>Pure Helium</td>
<td>4.0</td>
<td>0.1692</td>
<td>1.056</td>
<td>100%</td>
<td>947</td>
<td>12.2</td>
</tr>
<tr>
<td>1% percent air</td>
<td>4.2</td>
<td>0.1797</td>
<td>1.045</td>
<td>99%</td>
<td>957</td>
<td>12.2</td>
</tr>
<tr>
<td>5% percent air</td>
<td>5.2</td>
<td>0.2220</td>
<td>1.003</td>
<td>95%</td>
<td>997</td>
<td>12.4</td>
</tr>
<tr>
<td>10% percent air</td>
<td>6.5</td>
<td>0.2747</td>
<td>0.950</td>
<td>90%</td>
<td>1053</td>
<td>12.6</td>
</tr>
<tr>
<td>15% percent air</td>
<td>7.7</td>
<td>0.3275</td>
<td>0.897</td>
<td>85%</td>
<td>1114</td>
<td>12.9</td>
</tr>
<tr>
<td>20% percent air</td>
<td>9.0</td>
<td>0.3803</td>
<td>0.844</td>
<td>80%</td>
<td>1184</td>
<td>13.1</td>
</tr>
<tr>
<td>30% percent air</td>
<td>11.5</td>
<td>0.4859</td>
<td>0.739</td>
<td>70%</td>
<td>1353</td>
<td>13.7</td>
</tr>
<tr>
<td>50% percent air</td>
<td>16.5</td>
<td>0.6970</td>
<td>0.528</td>
<td>50%</td>
<td>1895</td>
<td>15.3</td>
</tr>
<tr>
<td>100% percent air</td>
<td>29.0</td>
<td>1.2248</td>
<td>0.000</td>
<td>0%</td>
<td>infinite</td>
<td>infinite</td>
</tr>
</tbody>
</table>

The last 2 columns show how much bigger the envelope would need to be to compensate for the contaminated contents.

Spent or contaminated helium from airships and other users may be captured and re-purified for re-use – thus cutting down operating costs. One such process developed and patented [3] in the mid 1980s using reverse osmosis membranes is shown in the flow-schematic in Figure 5.

One customer for the modular package was Airship Industries – acquired by the Australian entrepreneur Alan Bond in the 1980s. The rejuvenated company in collaboration with Westinghouse made a successful bid against Goodyear to supply Airships to the US Navy.

Compressed helium preferentially permeates through the membranes and low pressure, relatively pure permeate from the first stage is re-injected at the opposite end of the airship – or alternatively used to charge another airship. Permeate from the second stage is less pure and recycled to the compressor inlet. The non-permeate is mostly air and is vented to atmosphere. These compact units
can be skid-mounted and moved around by small truck for example to wherever they are needed.

Adsorption may also be used for purification of helium where the purified helium product is required at elevated pressure - for example to put into storage bottles.

To produce high purity helium, a cryogenic adsorption process as described previously would be employed.

However it is evident that high purity is not strictly necessary for airship use. But where shipped as liquid it is necessarily very pure as all possible impurities –including nitrogen, neon and even hydrogen will be frozen solid.

Transport of helium to market

In large deliveries in the order of tonnes, delivery as a liquid is the most practical means. A road tanker has a typical capacity of 12000 US gallons (approx 45,000 litres or 5.6 tonnes). The net weight is surprisingly low for a large tanker – because the liquid density is only 125 kg/m³, or 1/8th that of water. One tonne of liquid, when vaporized and brought to ambient temperature, will occupy almost
6000 cubic metres, a 750-fold increase in volume. Thus a complete tanker load would provide about 30,000 m$^3$ of gas at STP.

More modest quantities may still be delivered as liquid - where the cryogenic properties of helium are paramount. However, breaking up a shipment to transfill into smaller Dewars for distribution is more challenging than many other commodities, so high pressure ‘tube-trailers’ may be preferred where only gaseous helium is needed. Tube trailers have 8 or 10 horizontal tubes from 20 ft up to 40 ft long in a rack, which contain gas at a pressure up to 200 bar g. The contained volume of helium for the larger trailers is up to about 4200 sm$^3$. (Cubic metres at STP). It is normal to rent the tube trailer for say $2-3000 per month, and use it for on-site storage – swapping a near empty one for a full one as necessary. One company recently charged about $375/100m^3$, although costs are escalating rapidly with a current shortage.

Where liquid helium is shipped any distance by road tanker, the contents – initially at 4.2 degrees absolute inevitably gain heat, despite the vacuum and the special insulation etc. Rather than allow the helium to boil away and vent it off in order to keep the temperature and pressure constant, the pressure is allowed to rise during the journey. Once the liquid helium has warmed by more than 2 degrees, it becomes a supercritical fluid – no longer a liquid. The longer the journey, the higher is the pressure. Eventually if there are delays or perhaps on a transatlantic journey, or if the liquid nitrogen shield runs dry, the pressure may approach the tanker’s relief valve setting. Modern tankers costing about $700,000 can keep their load for up to 45 days without loss.

When unloading at the destination, facilities need to be available to first vent and recover the pressurised gas. Provided this gas has been warmed to around ambient temperature, balloons are ideally suited for this purpose. The gas may then be compressed at leisure into storage bullets. As the tanker pressure is brought down, the supercritical gas cools by isentropic (Joule) expansion and liquid is eventually formed again. After carefully cooling transfer lines, the atmospheric liquid can then be trans-filled to smaller Dewars. After unloading its charge, the tanker must refill its liquid nitrogen radiation shield, turn around with minimum delay and head back to the production source. It is frequently required to leave a liquid heel of a few percent helium to absorb the heat ingress on the return journey. Otherwise attempts to fill liquid helium into a ‘hot’ tanker will lead to huge volumes being vented, unless adequate capture facilities exist.
Helium Market and Sources of Supply

Helium is the second most abundant element in the universe and the atmosphere contains 3.8 billion tonnes but it is a finite resource on earth. The atmospheric concentration of 5.2 ppm helium is the result of a dynamic equilibrium between what is being slowly formed by radioactive decay in the earth’s crust and what is leaking away into space from the upper atmosphere.

Although helium and neon from the atmosphere can be concentrated together and extracted during cryogenic air separation, recovery in this way is not at present economic. It has been estimated that if the helium from all the major air separation units were retrofitted to capture helium, this would satisfy only about 1% of the current market demand. To recover helium from the atmosphere without necessarily separating the air is technically feasible but would require new developments and would be prohibitively expensive for the foreseeable future – because of the huge volumes of air that would need to be processed. Therefore the only current economic source is from those natural gases which bear helium.

The main known worldwide sources of helium are shown in Figure 6 that was published by Air Products in 2004, see below [9]. These total about 39.5 billion cubic metres, of which 8.5 billion are in the USA. About half of these (mainly the richer sources) are being exploited.

Figure 6 Worldwide Helium Resources
The Qatar source - producing in connection with the LNG plants is understood to have started operation in 2005. This is the main known reserve (about 10 billion m³) outside the USA. It was reported that both new non-US sources in Algeria and Qatar experienced start-up challenges.

Before German re-unification, the Salzwedel field was believed to straddle the border between former East and West Germany. There appeared to be a race in the late 1980s to develop it, but to-date nothing has been built.

Other producing sources exist in Russia and Poland but are probably now in decline. The plant processing the source near Odolanow in Poland was already described in detail. Southern North Sea gas with its maximum helium content of 0.12% was considered too lean to exploit economically for helium, and the fields are mainly now in decline.

The new sources developed in connection with base-load LNG (Liquefied Natural Gas) in Algeria and Qatar benefit from LNG production being a cryogenic process, so the additional steps to recover helium from such sources are easier to justify - even when the helium content is below the normal economic threshold of 0.3% (e.g. 0.17% in Algeria). Dubai has recently become a major distribution centre for the Middle East and Asia regions, based on production from Qatar.

Turning to the North American situation, which has more relevance for Canadian demand - existing and new planned production (2009) from Riley Ridge in Wyoming may be the most convenient US source for supplying Canada. There is - to date - no indigenous Canadian production from the reported reserves of 2 billion m³. This might change if the Mackenzie project regains momentum, as some NWT fields are believed to be helium-rich.

It is evident that the largest number of developed i.e. producing reserves is in the USA. Many in the Texas Oklahoma panhandle are connected by pipeline to the Cliffside facilities and the Bush Dome Reservoir as illustrated in Figure 7.

It is important to recognize that helium is produced as a by-product of natural gas, and not in its own right. As such, new reserves only potentially become available when new natural gas fields are exploited. Moreover many natural gas reserves with modest helium contents are being exploited, or
have already been exploited without recovering the helium – which is ultimately vented to the atmosphere. The US federal and private reserves in the Cliffside, Texas facility act as a ‘flywheel’ or buffer between supply and demand – since the US government in the 1996 Helium Privatization Act committed to drawing down the reserve over some 20 years to payback the debt incurred in building the stockpile. Companies involved with processing and distributing helium include the large industrial gas companies: Air Products, Air Liquide, Linde-BOC, Praxair.

Since 1998, the Bush Dome reservoir inventory has been drawn down from about 1 billion m$^3$ (including 125 million m$^3$ private stockpile) to about 680 million m$^3$ in mid 2006 [6], [7] (including about 17 million m$^3$ of privately owned helium). The 1996 act planned to reduce the Federal
stockpile to all but 17 million SCM or about 2900 tonnes by 2015. The purchase price to remove helium from the Federal stockpile was initially some 25% above the market price, so production tended to be from private sources. Scarcity of helium is raising prices and accelerating the intended drawdown from the Federal Reserve.

Helium Market

The helium market is unusually complex and not easy to predict. Last year global demand was reported as 170 million Sm$^3$. Growth in demand has averaged about 4% over the past decade but grew by 6% last year.

Although, as mentioned above, the price of crude helium may increase say 25%, in the coming decade, the end purchase price for users of pure helium is more dependent on fixed processing, shipping and handling charges and they should see a smaller increase.

Figure 8 presents a model, Cai et al [5], that shows the complex interacting factors.

Figure 8 Upstream and Downstream (inset) System Dynamics Representation of the Helium Market Status in 2007.

(Note: B in centre of loop denotes balancing (negative) feedback.)
Longer term, perhaps in the 20-30 year time frame, as demand steadily increases and as the USA’s Private and Federal Reserves decline and new sources become harder to find, the question arises—what is the future for helium and specifically for airships based on using helium as a lifting gas?

In the Canadian context, the natural gas fields contain about 2 billion m$^3$ helium reserves. If these were exploited and in just half of these the helium was recovered over say 50 years, this might make available on average up to 20 million m$^3$/yr. Only a small fraction of this would be needed to compensate for leakage losses from a significant fleet of airships. Larger airship envelopes with a smaller surface to volume ratio would transport more tonnes payload per m$^3$ of makeup gas. Thus, in the medium term – a few decades – it seems likely that there will be adequate supplies of helium to support the modest demands from a developing airship industry. The price we have to pay may depend on competing demand growth in other areas, and on whether we develop our indigenous reserves.

Longer term the possibilities appear to be:

- A (new) process to extract Helium from the air becomes economically viable.
- The challenge of controlled nuclear fusion is solved – helium is produced as a by-product (quantities may not be large).
- Hydrogen gains acceptance anew as a viable lift gas.
- New airship materials and structures become available – using hybrid lift gases – helium, hydrogen, steam, hot air or even vacuum.

The Future

It seems reasonable to assume that, although – like fossil fuels - helium is a finite resource, thanks to continued conservation, recycling technologies and more frugal (less frivolous) use, adequate quantities will be available to service an airship industry for many decades to come. At some point either new sources of supply or recovery from air will need to become viable – or other lift gases will find acceptance.
On the above basis, a possible transportation infrastructure concept could be envisaged: Conventional transport of goods, personnel and equipment by road or rail is used to reach the most northerly points – such as Fort McMurray or High Level in Alberta. Equivalent locations in the north of other provinces would act as similar ‘hub’ airship ports.

These Airship ports would provide the following facilities:

- Passenger terminal
- Freight transfer facilities.
- Large hangars for airship servicing.
- Low pressure, high pressure gas storage
- Liquid Helium storage and gasification.
- Airship envelope purification facilities.

Synergies could be envisaged by developing other helium use activities at or near the hub towns to share delivery costs. For example, low temperature physics research park, MRI / NMR scanning medical facilities to service the region. Recovered boil-off helium from these other users could be either re-purified or deployed in airships.

Supply of helium to these hubs would initially be from the USA by road tanker. Although the journey from Texas/Kansas/Oklahoma is considerable, a newer (second) extraction plant is Wyoming is scheduled for operation in 2009.

Later, the US sourced helium could be replaced indigenous reserves extracted from helium rich gas fields such as those in Alberta or in NWT feeding the Mackenzie pipeline.

Such extraction plants would be in remote and relatively inaccessible locations but could develop as recharging points as part of the helium distribution network. It may make sense to use balloons to convey helium itself – either as a liquid and / or within the envelope itself to the hub locations.

Hybrid heavier-than-air Airships, which generate part of the required lift dynamically, via the shape
of hull and wings, are on the drawing board. This concept appears to extend the heavy-lift scope for airships without the envelope becoming too unwieldy. However an apparent drawback is the need for a runway of up to a mile in length to reach the required speed for liftoff. One way to avoid this would be to use an auxiliary ‘shuttle’ airship to piggy back onto the hybrid and lift it to a sufficient altitude to start its engines and accelerate to the required speed off the ground. The shuttle would detach and be winched back to the ground.

References

2) Poland’s Natural Gas will Fuel Major Helium Build-up. Limb, D., Chemical Engineering. December 9, 1974.
Session Four:
Where’s the Gas?

Hydrogen Gas: Past and Future in Airships

Dr. Dirk Spaltmann,
Board of Directors of Initiative Zukunft in Brand e. V. ²⁶

Initiative Zukunft in Brand is a play on words. It refers at once to the site where the CargoLifter hangar was built and also means that the future is in danger if nothing happens now. I am going to speak about the perception of hydrogen to the public and the role that hydrogen played during the Hindenburg disaster. I shall tell you something about how safe hydrogen can be and finally about its advantages, if it is used in airships.

Hydrogen is the most widespread element in the Universe. It has been known to mankind for more than 200 years. It is the major resource in the chemical industry. Billions of cubic meters of hydrogen are needed to get rid of the sulphur in petrol. Hydrogen is needed to create ammonia. The U. S. alone needs more than 109 million tons of ammonia fertilizers per year. Hydrogen is also used to harden fat. If butter spreads nicely on your bread, it is hardened with hydrogen. In the semiconductor business hydrogen is used as a carrier gas.

All this is to say that hydrogen technology already exists. After 200 years its handling and storage are common knowledge. Berlin already has 14 buses running on hydrogen through its streets. No one complains. There are companies that use hydrogen in fuel cells and combustion engines. The

²⁶ (www.zukunft-in-brand.de)
equipment is perceived as clean and environmentally friendly. Hydrogen technology is considered a safe advanced technology, if used in cars.

So what happens if you use it in airships? Oh I know the Hindenburg that is what happens. The public perception is that hydrogen was the cause. I am researching from all the resources available, the role that hydrogen played in the Hindenburg disaster. We need to find out what caught fire first and how the fire was spread. Before I go on about this, we have to discuss the basics. There are three requirements for a fire: fuel, the oxidant and the ignition source. What happens if one of the requirements is missing? Nothing! Let’s carry on and see, if the inner structure of LZ 129 (Hindenburg) tells us something about where we could find the oxygen, fuel and the ignition source. What you can see is the aluminum framework with a center gangway and of course it contains air. The passenger compartments are at the bottom towards the front end, a gangway goes right up to the end where the crew compartments and the storage facilities are located. Between the hull and the gas cells is lots of space for air. So, there is plenty of oxygen.

Now, let’s see, if we can find more fuel aside from hydrogen in the carrier gas cells. The layers of protective paint on the envelope were not separated. The aluminum framework was coated with paint that was, unfortunately, insulating as well. The hull was made up of separate pieces that were knitted together by ramie cord, wood and wood wedges. This is all fuel. To give you a better understanding of what it looks like, this picture is from a mock up you can see at the Zeppelin museum. The ramie cord and the wood spacers are both very combustible.

There is a gentleman I have to introduce to you by the name of Addison Bain. He was in charge of storing and supplying hydrogen and oxygen for refuelling the rockets used in the Mercury program, the Gemini program and for the start of the Apollo program. If anyone knows hydrogen, he does. He had close links to the FBI because he was working with NASA. He got to see minutes of the Hindenburg disaster investigation of the sequence of events that happened in Lakehurst, NJ that had not been published.
There was a thunderstorm going through and it was wet which is very important. The hull of the airship was loaded still at high electrical potential. At T minus 4 minutes, as LZ 129 dropped its pull ropes, the frame went to ground potential because the ropes were wet and they were connected to the frame. The hull did not become grounded because it was insulated by the ramie cord, the spacers, and the paint of the aluminum structure.

At T minus 30 seconds, there was a gust of wind causing the ship to move. In order to compensate, port engine number 1 was fired. It had a short run and then backfired creating a plume. Addison Bain suggested the plume might have been charged and if it hit the already charged fabric of the hull that might cause electrical activities that were observed on the upper side of the airship hull near the upper fin. He said that an electrostatic behaviour occurred which then finally started a reaction in the paint of the hull fabric which created the fire.

The paint was said to be a poor conductor. If you have electrons flowing around they cause an increase in temperature. Whether or not, that was sufficient to start the reaction still has yet to be sorted out.

So that is the sequence that has been observed. There are two gentlemen who are in heavy discussion about it, mainly because, Addison Bain compared the paint to rocket fuel. Alexander Dessler is a rocket fuel expert at the University of Stanton (Texas). He does not suggest any cause that could have ignited any source of mixture, either the paint or the hydrogen. He simply assumes that the findings of the Investigation in 1937 were correct. Addison Bain actually suggested that negatively charged particles changed the potential. Alexander Dessler said he is wrong; there cannot be a discharge between panels because they are all linked. Secondly, he says, the only discharge you can have is between the charged hull and the grounded framework. He calculated that the energy is not sufficient to ignite the coating of paint. The gentleman is correct, but that was not the question. It is like you ask me how late it is, and I say today is Wednesday. I am correct, today is Wednesday but I did not tell you the time. So, what Addison Bain suggests is that within the panels you have a flow of electrons and that actually causes a reaction inside the protective paint and then, of course, sets the hull on fire.
What kind of reaction would be possible? As I said, earlier on, it is important that the fire started on the topside. On the top side you had the first coating with a solvent plus iron oxide powder. Then three more coatings with a solvent containing aluminum powder. The belly had no iron oxides, there were just 4 layers of a solvent containing aluminum powder. So possible reaction is iron oxide plus aluminum powder that converts to aluminum oxide, iron, and a massive amount of energy. This reaction is called thermite. It was used to weld railway tracks together. In this reaction, iron oxide is the oxidant, aluminum powder, believe it or not, is the fuel and it creates temperatures of 2200 degrees centigrade. It even burns under water. If you try to extinguish this with water, you are in an awful lot of trouble. It instantly disintegrates into hydrogen oxygen and accelerates the reaction. If that reaction has taken place, it does not stop until the fuel is gone.

For the record, there was another airship built after the Hindenburg, it was called LZ 130, Graf Zeppelin 2. The Zeppelin Company replaced aluminum with aluminum-bronze powder, containing only 9 to 14% of aluminum. There was another gentleman by the name of Max Dieckmann, he was head of the department which is a predecessor of the German Aeronautics and Space Society. He took original fabric from the Hindenburg, and original fabric from the Zeppelin 2, wet them both and applied a charge to them. He could always ignite the Hindenburg fabric, but the Zeppelin 2 fabric would not ignite. If one can determine whether the plume created by firing engine one is negatively charged or can change the potential, then Dr Bain has found a possible source of ignition in combination with the paint and the right weather conditions. Being wet and highly charged, a fatal accident was simply a matter of time. That is my opinion.

Now, the second question we wanted to answer was what caught fire first? Before we can answer that we have to see what the interior arrangement of the gas cells were.
It had 16 gas cells. Gas cell 1 (aft) and gas cell 16 in the bulwark were considered too small to have pressure relief valves. They simply had some interconnect to the bigger cells that had pressure relief valves. So assuming, that right around here, your fire starts (see sketch), it could heat up the hydrogen in cell number 1. If the diameter of the interconnect is not sufficiently wide you still could have a higher pressure in cell number 1 because only cells 2 to 15 were vented for a reduction in lift. If you heat a gas, it starts to expand. Now because of the large volume, it does not need a lot of pressure rise for the gas cells to rupture. If that happens you set free the hydrogen gas that can mix with the surrounding oxygen. If you have fire close by, then it does what a fuel is intended to do, it burns. So, at that point in time, the flames were rising 12 meters high above the fin and hydrogen and oxygen mixture became part of the whole disaster.

I was convinced that I knew it all, but two years ago I came across some experiments that Alexander Dessler carried out. What did he do? He cut a 10 cm. piece of cloth that had been used as fabric for the Hindenburg. Underneath one end he had a flame and he measured the time it took to burn the 10 cm of cloth. He burned a model of the original fabric, without any paint on it. It took 29.4
seconds to burn from one end to the other. The Hindenburg was over 200 meters long so it would have taken 16 hours for the burn to go from one end of the Hindenburg to the other. The Hindenburg burned up within 38 seconds. How does that happen? Well if you start applying paint to the fabric it burns even slower. If you paint it with solvent plus aluminum powder to simulate the belly of the airship, it takes about the same length of time to burn. If you add iron oxide and 3 coats of aluminum powder it takes even longer to burn. So how does that fit? It is because Zellu was used to make the coating waterproof. Its actual name is Zelluloseacetatbutyrat, but the engineers just called it Zellu. It is actually listed as UL 94 HB which means it is self extinguishing. So, how was the fire spread?

Let’s come to the picture again where we have the fabric attached to the frame and knitted to each other with ramie cord. Addison Bain suggests that the fire was spread along the ramie cord like sparks flying across treetops during a forest fire. Self extinguishing only means, if you remove the flame, it will eventually stop in less than 30 seconds. But if you still have fuel present in the hull then you are not removing your flame. There was lots of ramie cord throughout the Hindenburg along with wooden spacers. It had enough fuel and that is what happened. The fire spreads throughout and all of a sudden the whole thing burns.
At the Zeppelin museum I found there was more ramie cord used. In order to give the frame of the Hindenburg extra strength they had ramie cord running all across the ship. So, there was lots of fuel, even more then what was shown in the first slides. When you look at a picture of the Hindenburg being painted in the hangar with the sun hitting the frame of the ship you can see that the interior of the ship is zig zagged with ramie cord.

![Ramie cord shines through the fabric](image)

The aluminum powder was meant to reflect ultraviolet radiation. To accomplish this the aluminum powder was actually flaked. Aluminum powder also comes as spheres, but a sphere has the lowest amount of surface with respect to the volume; a flake is just the opposite. The larger the surface the easier is the reaction. I am not sure whether Professor Dessler used the right powder to model the Hindenburg fabric.

Next thing, once you have started a reaction that creates 2200 degrees C. any organic material, self extinguishing or not, would simply decompose and the carbonates set free will add as fuel to the reaction. Water even accelerates the reaction and the entire hull was still wet because of the weather conditions at the time.

Two seconds and 12.5 meters of the Hindenburg vanished; two more seconds, another 12.5 meters of the Hindenburg was gone. Is there any other mechanism that could advance that quickly? Well actually, Dr. Bain already suggests something could. If the fire that has already started, heats up the gas cells that are still intact, they eventually will rupture. They will be set on fire due to the fire
already burning that creates a domino or contagion effect which would cause the intact cells to pop, one after another.

What caused the fire? I am quite convinced that the plume created by starting engine 1 had initiated the reaction which then started the fire. Of course, I am convinced that the protective paint burned first. Nothing speaks against spreading the fire along the ramie cord, especially since there were so many kilometres of it throughout the Hindenburg. Other explanations involving hydrogen are all possible. The one question we have not asked yet is: Would replacing hydrogen with helium have saved the Hindenburg? I am convinced. No! The fire would have been slightly less vigorous because some of the fuel would have been removed. This brings me directly to the aspect of how safe is hydrogen? Let’s ask history for that answer. The only time there was a major amount of airships built was during the World Wars. During that time there were more hydrogen filled airships built than helium. During the war more helium airships were lost to fire than hydrogen airships. So, this does not suggest that helium filled airships are safer than hydrogen ones.

I received the following figures from the German Fuel Cell and Hydrogen Association and let’s go through the abbreviations.

<table>
<thead>
<tr>
<th>Mixtures with air</th>
<th>He</th>
<th>H₂</th>
<th>Methane</th>
<th>Propane</th>
<th>Methanol</th>
<th>n-Heptanes</th>
<th>n-Dekanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEL</td>
<td>-</td>
<td>4</td>
<td>4.4</td>
<td>1.7</td>
<td>6</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>LLD</td>
<td>-</td>
<td>18.3</td>
<td>6.3</td>
<td>2.2</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>stoch. mix.</td>
<td>-</td>
<td>29.6</td>
<td>9.5</td>
<td>4</td>
<td>12.3</td>
<td>1.9</td>
<td>1.3</td>
</tr>
<tr>
<td>ULD</td>
<td>-</td>
<td>59</td>
<td>13.5</td>
<td>9.2</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>UEL</td>
<td>-</td>
<td>77</td>
<td>17</td>
<td>10.9</td>
<td>50</td>
<td>6.7</td>
<td>5.4</td>
</tr>
<tr>
<td>AIE</td>
<td>-</td>
<td>0.017</td>
<td>0.29</td>
<td>0.24</td>
<td>0.14</td>
<td>0.24</td>
<td>?</td>
</tr>
<tr>
<td>SCT</td>
<td>-</td>
<td>833</td>
<td>868</td>
<td>743</td>
<td>728</td>
<td>488</td>
<td>478</td>
</tr>
</tbody>
</table>


Heptanes are similar to petrol, dekanes are similar to Diesel. Hydrogen is a fuel, but it is at least as safe as other fuels!
LEL means lower explosion level. This is the percent of gas needed in a mixture with air to set it on fire. Not oxygen, but air which is 80 percent nitrogen and 20 percent oxygen. Helium is a noble gas and does not react at all. We compare that with methane obtained from decomposition from organic waste. The LEL of methane (4.4) and hydrogen (4) is higher than propane (1.7) which is used in gas BBQ's. Heptanes (1.1) is close to petrol and dekanes (0.7) is close to diesel fuel. With respect to its explosive level, the fuels handled every day at a gas station are much more dangerous than hydrogen.

LLD means lower level of detonation. If you have reached the LLD level, it simply burns instantaneously, i.e., the mixture explodes. Hydrogen's LLD is the highest amongst the gases on the chart.

ULD means upper level of detonation. If you reach that level and go across, it will no longer detonate but it will still burn. The ULD of hydrogen is 59, while the next highest is methane at 13.5.

UEL means the upper explosion level. If that level is crossed, whatever you do, you cannot start a fire. Now, under hydrogen on the UEL line the figure is circled to highlight the seriousness of it. But methanol is not far off on the UEL line.

AIE means the average ignition energy. This is the energy needed to set the mixture on fire. It is again, for hydrogen, very low. These two aspects are the only ones that make it relatively more dangerous, compared to the others.

SCT means self combustion temperature. If you reach a temperature of 550 degrees C. hydrogen will start to decompose on its own. But, if you look at the other figure for n-heptanes which is close to petrol, you should not rise above 180 degrees C. and for diesel it is around about the same figure.

So, it is safer to store hydrogen then to store petrol. Hydrogen is a fuel, but it is at least as safe as other fuels, if handled properly.

Let's review the experiments carried out at the Federal Institute for Materials Research and Testing (BAM). This is to show you a sort of fail safe mechanism. Hydrogen is a bit more dangerous
because it has a very low ignition energy and it burns over a wide range. We used propane, stored in a container as liquid gas. We released the propane which stays close to the ground because it is heavier then air. It creeps into any sort of cellar or hole. This is really dangerous stuff, if set on fire.

What does hydrogen do? Hydrogen is lighter-than-air, it expands rapidly. It disperses quickly and if it goes below the 4 percent it is self extinguishing. First and most importantly, hydrogen is not an explosive. Only if mixed with oxygen or chlorine does it become like that. An explosive needs to have fuel and the oxygen already contained in itself. It is not self disintegrating. Acetylene, for example does disintegrate on its own at very low temperature and it is even more dangerous than hydrogen. Remember the figures here were 4 percent for the lower explosion level, and 77 for the upper explosion level. It is non oxidizing. What does that mean? If you have a cigar or cigarette and you insert it into an atmosphere of hydrogen, what would happen? It will extinguish because you have not got the oxidant. What happens, if you insert this cigarette into pure oxygen. It goes up in flames. Hydrogen is non toxic; it reacts into water, there is no carbon oxide, carbon monoxide, no soot, no nothing and it is not radioactive. It does not poison water. It is not cancer causing. It is not toxic, it is not contagious, it is not caustic, and it is not foul smelling so why not use it?

One cubic meter of helium can lift about 1.1 kgs the same amount of hydrogen can lift 7.9 percent more. Is it worth the trouble to use hydrogen? Let’s consider an airship of two hundred thousand cubic meters which is about the size of the Hindenburg. Let’s assume, give or take, that the weight of the airship is about 49 percent. Let’s assume that the crew and fuel come out at 35 percent operating weight. Let’s consider lift for the same airship, replacing the helium with hydrogen. With those figures in mind you end up with 223 tons for helium and 241 tons for hydrogen. Now reduce it by the amount of the airship weight and the operating weight and the weight left over is your payload. Replacing helium with hydrogen increases your payload by 85 percent. This is significant. The biggest disadvantage of helium is lack of flammability. A helium airship wastes an extra 50 tons of lift to carry the fuel. The advantage of a hydrogen filled airship is the dual use of the gas. The lifting gas is also the fuel. Using hydrogen for lift as fuel increases the payload by up to 200 percent.

In summary, I have shown you that hydrogen is widely used in chemistry; handling and storage are common knowledge. I have shown you that hydrogen was not the cause of the Hindenburg disaster
although it did contribute to it. Hydrogen is much safer than other fuels because it has a fail safe option built in. It simply vanishes, straight up into the air and does not stay on the ground as gas and other chemicals do. Using hydrogen in dual function you can increase your payload by up to 200 percent.

If you ever have the chance to come to Germany, visit the Zeppelin Museum. It has a breathtaking mock up of the passenger section of the Hindenburg. It is a place where you can experience the past and the future.

Question 1 – What was the official reason given for the Hindenburg accident?

Answer 1 – (Dirk Spaltmann) They say it was the hydrogen. The people were asked questions in an answer expecting way. “Don’t you think it was Hydrogen?” was a typical question that they asked. I have to make one point. Building such a large airship takes a lot of money and the Zeppelin personnel ran quite a bit short. They had to complete it in time to serve the South American line. So the hull and protective coating was not properly tested. There just was not enough time. The Hindenburg was insured for about six million Reichsmarks at that time. Now if you tell the Insurance Company that you did not have enough time to test something they would not pay.

Question 2 – Does the production of helium produce greenhouse gases?

Answer 2 – (David Limb) The only economic source of helium is from natural gas, natural gas is a hydrocarbon, so you have to extract natural gas and produce the associated greenhouse gas in order to get your helium. However, in the foreseeable future there is going to be a natural gas market, you cannot live without it, no matter how green you want to be. So facing reality I think you will have helium from that source. Longer term, you could recover it from the air, when the process is developed. It is technically feasible; it just is not economical. Just a comment on producing hydrogen. It is produced by steam reforming of natural gas, and that in turn, produces a lot of CO2, which is a greenhouse gas. So you cannot make hydrogen, at the moment, without producing greenhouse gas.
Comment from Dirk Spaltmann – I have to contradict you on one thing, you can create hydrogen without CO2.

Comment from David Limb – Yes, you can make it by electrolysis, but, at the moment, it is not economical to make in large quantities.

Comment from the floor – If we think about the future, we have to anticipate now, what we need in the future. We know that helium works because helium does not burn and it is a real resource. We saw how much effort has to be made to create it. I do not know how much energy is put into the system to gain this helium proportionally.

One question that was put to me was about the size of the airship Industry. If we have 50, 100, 200, or more airships flying around, what do you think is the limitation to have a fleet? Is it the technique, or is it the lifting gas?

The other thing is, do you want to rely on the same natural resources that we have now for fuel, like natural gas and oil? At the moment, hydrogen is produced with natural gas. But we are on the way to fuelling things with renewable energy. Why not use wind power to store the energy as hydrogen when the electricity is not needed in the grid?

Hydrogen is an energy carrier; it is not energy itself. You have to have a process to get the energy out of it. Hydrogen has some limitations, but you can do it with renewable energy and we are on the way. If you have an airship system circulating, then you have hydrogen for fuel or lift. That does not mean that we have to start with hydrogen but we should think about it. If we now take limitations like the FAA regulations that were made after an accident, we have stopped thinking.

A system that could really start an industry up that needs a lot of lifting gas whether it is hybrids or LTA. Can the helium supply meet the demand?

Comment from David Limb – I got some information related to different airship designs using modern materials and leakage is in the range of 0.1 to one litre per square meter of envelope per day.
If you work that out, it is not a huge amount. So whether it is hydrogen or helium the make up rates are pretty small.

The initial charge for some of these huge airships is big, but the operating cost for gas in terms of the business is not very large. We need to crunch these numbers before we get too excited about non renewable reserves. The available reserves will last for decades. In that time, there will be new technology available, maybe extraction from the air, maybe nuclear fusion, which can then produce helium without any exhaustible source. May be pie in the sky, but it is another potential source of helium.

Another wrinkle that occurred to me – you could introduce hydrogen into a helium envelope to the extent of, I guesstimate, about 6 or 7 percent. The hydrogen still stays outside of the flammable region and you could potentially extract it out as a fuel into a fuel cell. I do not know how easy that would be because you have a lot of inert gas getting in the way. You could even consider an external envelope with helium and an internal balloon with hydrogen. There are interesting potential compromises.

Comment from Dirk Spaltmann – I want to address the item about the FAA regulation. Early in the 20th century when automobiles were going to replace horses and carriages, a law was passed that said you could drive your car as fast as you want as long as a man with a lantern or a red flag walked 7 paces in front of the car. Regulations for airships can be changed when it is recognized that hydrogen can triple the payload while saving money.
Closing remarks

Dr. Barry Prentice
President, ISO Polar

When I am asked to comment on the number of airships that could be used for heavy cargo lift in Canada, I can easily find a market for 150 airships. A large number of those airships could be used by the mining industry, the petroleum industry, for retail distribution to remote communities, forestry, exploration and other areas. No need to dwell on the demand, as you heard in the first day of the conference the market exists.

More technological progress can be seen at this fourth international conference. The Industry advance may resemble the tortoise more than rabbit, but it is in the right direction. I sense that we are actually getting some place. I see more and different parties attending the Airships to the Arctic each year. The registration list suggests the wide diversity of interests. It ranges from the resource industries in Canada to input suppliers, and from for those interested in building airships and those who want to operate airships. There are representatives from Japan, Australia, Europe, Britain and all over the U.S. and Canada.

The next step is to move beyond talking and demonstrate more airship capabilities so the public can see what is happening. That could be the conference theme for the next time, and there will be a next time. Mark your calendar for two years hence (fall 2009), when we will convene the Fifth Airships to the Arctic. I am sure there will be more progress to report on at that time.

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27 Fifty tons equivalent airship size
Speaker Biographies

Dale Booth

Dale C. Booth specializes in the field of First Nations’ business, economic development and infrastructure. With more than 15 years experience he is known as a visionary leader, with special and tested talents for shaping productive and cooperative working environments, eliminating deficits and creating a successful corporate vision for the future.

Dale has held positions in the Department of Indian Affairs and Northern Development where he developed a PPP approach and philosophy that would be applied to the building of badly needed infrastructure in First Nations communities. During his tenure at DIAND he has developed a unique perspective on the factors critical to the success of First Nations economic development.

Recently, through Partnering First Solutions he has turned his focus to support the First Nations on designing, validating, evaluating and implementing housing and infrastructure service solutions through innovative partnering techniques. Dale has several First Nations communities as clients and is helping them realize their infrastructure and housing goals.

Dale was recently appointed to the National Aboriginal Economic Development Board on 26 April, 2007 for a three year term. Dale is married with three children and lives in Barrhaven, Ontario.

Robert R. Boyd Ph.D

Dr. Robert (Bob) Boyd is the Hybrid Lift Portfolio Manager at Lockheed Martin Aeronautics, Advanced Development Programs, or “SkunkWorks” in Palmdale California. In this position, he manages multiple programs including both internal development efforts (IRAD) and externally funded efforts related to heavy lift buoyant systems. During his tenure at Lockheed Martin, he has worked a wide variety of programs including low and high altitude airships, high speed concepts including missiles, aircraft and space launch systems, in-space architectures such as tethers, advanced unmanned aircraft and heavy transports. His leadership responsibilities represent more than $150M in contracted development work.
Dr. Boyd holds a Phd and BS in Aerospace Engineering from The Ohio State University, has authored papers, has four patents granted, and is a graduate of the DAU Advanced Program Managers’ Course. Outside of Lockheed Martin, he has served as Assistant Dean for Academics at the Ohio State University College of Engineering, Technical Fellow at NASA Glenn Research Laboratory, co-founded two independent businesses and served on several Boards of Directors. Most recently, Dr Boyd has been given the highest honour possible at Lockheed Martin, the NOVA award, for his leadership as Program Manager of the P-791 Hybrid Aircraft Demonstration program, the results of which you have likely seen, but not heard much about. Such is the way of the Skunk Works.

Hokan Colting
CEO of 21st Century Airships

Hokan Colting is the founder and CEO of 21st Century Airships Inc. – an innovative research and development company for lighter-than-air crafts. Colting has always had an interest in aviation and completed his mandatory military service in the Swedish Airforce. He flew gliders as a hobby and taught himself to fly hot-air balloons. Since 1974, he has been designing, developing, manufacturing and flying balloons and airships. Colting has set 9 world records for airships. In 2003, he was the recipient of the prestigious Santos Dumont Gold Airship Medal. He is also an inventor with numerous patents relating to airships. Born in Sweden, Colting has lived in Newmarket, Ontario with his family since 1981.

Gil Costin
Founder and CEO of Millennium Airship Inc./SkyFreighter Corporation/SkyFreighter Canada Ltd.

Mr. Costin was born in Ottawa Ontario, Canada. He was raised and educated in both Ottawa, Ontario and Eugene, Oregon.

Gil is an Honourably Discharged US Naval Vietnam veteran. He holds Commercial Fixed-wing and Helicopter pilot licenses in both Canada and the United States and brings twenty-seven years of
fixed and rotary-wing flying experience, including Arctic and Sub-Arctic flight operations coupled with approximately 18 years of top level business development experience.

Millennium Airship’s SkyFreighter air vehicle was made feasible by Mr. Costin's invention, development, and patent of the Integrated Thrust and Manoeuvring Management System (ITAMMS) and ThrustWing design. Once the general concept was conceived, Mr. Costin had the foresight and initiative to market his air vehicle to the U.S. Department of Defense, domestic and foreign customers, and investors. He has never lost sight of his goal and is now close to seeing it enter final design and production.

His wife Marilyn and he have been married for 35 years and have two children and four grandchildren.

**Eric Hinton, P. Eng.**  
**Golder Associates Ltd.**

Based in Red Lake, Ontario, Mr. Hinton is a mining engineer with nearly 30 years of underground and open pit mining experience. He has worked in engineering and operations including five years in research of underground mining innovation throughout the world. He currently works as a senior mining engineer with Golder Associates Ltd. His focus is micro mining and the start-up of small scale mines but also does work on larger projects globally.

**Ron Hochstetler**  
**Senior Systems Engineer, SAIC**

Mr. Ron Hochstetler has over 20 years experience in the operational analysis, and technical marketing of LTA vehicles. Ron began his LTA career in 1984 as a mechanic/assembler on the Piasecki Helistat program, which developed a hybrid airship/helicopter for heavy lift applications. In 1985 he joined Airship Industries, providing technical support on the US Naval Airship Program. He also flew as an airship flight test engineer, and supervised a commercial airship on tour. He joined Veda Inc., in 1990 to support the US Navy Airship Program office, and in 1998 joined CargoLifter as a Senior Project Analyst. For the past 7 years Ron has worked for Science
Applications International Corporation in northern Virginia where he continues to develop technical concepts for manned and unmanned airships. Mr. Hochstetler has a Masters degree in Technology Management from the University of Maryland and a Bachelor of Science degree in Aviation Technology from Purdue University. Ron is the former Chairman of the FAA Airship Working Group, a former Chairman of the AIAA LTA Technical Committee, and a current member of the Airship Association Council.

Jim Huggard
Manager, Merchandising Division, Arctic Co-operatives Limited

- Graduate of Queens University, Kingston Ontario
- Worked in the Co-op Retailing System for 28 years
- Has managed Retail Stores and worked with Federated Co-op on the wholesale side of the business
- Presently the Merchandise Division Manager at Arctic Co-operatives
- Has held that position for 5 years
- Married with two children and has been a grandfather for 2 ½ years

Tim Johnston
Mayor of the City of Thompson

Tim Johnston was born and raised in Thompson, the youngest child of Dr. J.B. and Joan Johnston, both of whom were community pioneers arriving in the late 1950s. Graduating from R.D. Parker Collegiate in 1980, he obtained a degree in administrative studies from the University of Winnipeg. After working in the not for profit and government, he chose to return to home in 1991. His decision was based on the unique opportunities and lifestyle enjoyed in Thompson.

Mr. Johnston has been employed as Manager with North Central Community Futures Development Corporation Inc. (North Central Development) since it’s inception in 1997. The community economic development corporation serves 17 Communities in the north central region, including, 7 First Nations, 7 Northern Affairs and 3 Urban Industrial. As a volunteer, he served two terms as president of the Thompson Chamber of Commerce, was a member of the 1994 Manitoba Winter
Games Host Society and, most recently, is a member of Thompson Community Foundation and serves as Past Chair on the Thompson Regional Airport Authority.

Mr. Johnston was first elected to City Council in the 2002 municipal election. He was an active and vocal member of City Council during his term as Councillor. In the 2006 Municipal election, Tim Johnston was elected as the 6th Mayor of the City of Thompson.

David Limb, P.Eng.
Consultant

David Limb grew up in Nottingham, UK. He obtained a B.SC., in Chemical Engineering from UMIST (Manchester) in 1966. Since then he has worked as a process engineer and as a commissioning engineer in various countries from the former Eastern Europe, to the Middle East, North and South America. A significant portion of his experience has been in cryogenics and industrial gases, natural gas processing and in the hydrocarbons sector.

David has obtained patents relating to cryogenic separation processes and to helium purification, and presented or authored over 25 technical papers and articles. For the past 6 years, based in Alberta, he has worked mainly in the oil-sands and encountered the transport challenges facing people and industries in Northern Canada.

David is a Chartered Engineer in the UK, Eur.Ing., M.I.Chem.E., and a registered P.Eng. in Alberta. He is currently employed as Air Separation Process Engineer by Opti Canada, Calgary where he is also involved in work with Fluor on evaluating concepts for CO2 capture.

Charles R. Luffman Aeronautical Engineer, Specialist in LTA Structures
LTA Solutions Limited

• Graduated from Salford University in 1972 with a degree (B.Sc) in Aeronautical Engineering
• Completed Apprenticeship in 1973 after 5 years with Hawker Siddeley Aviation, Chester
• Worked as an aircraft Stress Engineer – 1973 onwards
• Started Airship work with Airship Industries in late 1981 – ending (due to company closure) in 1990 as Head of Structures
• Continued airship work with Westinghouse until end 1993
• Reverted to HTA aircraft work 1994 – 98
• Worked for CargoLifter from end 1998 until its closure (July 2002)
• Continue in private as a consultant to the LTA industry working from home and developing own designs for new LTA aircraft

Ron P. Malashewski, BSc (Engineering), BSc (Physics)
President, Cliff Lake Capital Ltd

Ron Malashewski's professional career spans over 25 years in a technical, corporate, and investment finance environment. As President of Cliff Lake Capital Limited, he advises clients on matters of Business and Strategic Planning, Corporate Finance, and Investor Relations, primarily in the natural resources sector.

Prior to starting Cliff Lake Capital Ltd he was an Investment Advisor in Calgary with two major Canadian Investment Firms. Before entering the investment industry, he held Senior Engineering roles with a major Canadian municipal electric utility, and was involved with many aspects of Project Management, Strategic Planning, Operations and Maintenance and Corporate Management.

Mr Malashewski is a member of APEGGA (non-Practicing) an affiliate member of the CFA Institute, CFA Winnipeg. He holds an Ontario Prospectors License and is Member of the Prospectors and Developers Association of Canada and the Canadian Institute of Mining, Metallurgy and Petroleum (CIM).

David Owens, B.Sc. (Geology), P. Geo.
Canadian Contracts Manager, Major Drilling Group International Inc.

Mr. Owens has been working with Major Drilling Group International Inc. in Winnipeg, Manitoba for the past 2 ½ years. In his position, he manages Major’s Canadian diamond bit core drilling project operations and associated contracts with a highly varied portfolio of mining and exploration
companies throughout Canada. During his tenure at Major Drilling Group International Inc., he has worked a wide variety of programs utilizing shallow to deep core drilling rigs. The management of these programs involves the complex cost management of various remote located drilling projects and the intense and intricate utilization of conventional flight transportation utilized by all remote northern services: remote helicopter and/or fixed wing planning and transport. His leadership responsibilities represent more than $100M per annum in contracted drilling services.

Mr. Owens holds a B.Sc. in Geology from The University Manitoba. He has worked across Canada with various exploration companies in many northern locations across Canada as a field site geologist and more notably, 15-year tenure with Inco Ltd. in Thompson, Manitoba as an underground production geologist and project manager of underground exploration programs.

**Fred Petrie**
**Accountable Executive, FNT First Nations Transportation Inc.**

Fred Petrie is a transportation economist, as well as a consultant and entrepreneur, practicing as Navigator Services. Fred is also the "Accountable Executive" for First Nations Transportation Inc., a cargo airline serving the remote communities of northeast Manitoba and northwest Ontario. This assignment is to grow the company to a stable and profitable enterprise in order to transition it to aboriginal and employee ownership. Fred has been involved in FNT since its start-up in June 2003 and assumed General Management responsibility one year ago to implement this three year business plan. Fred is also closely involved with SASCO Ltd., a winter road trucking specialist. It is from the businessman's perspective, but with his forty year background in aviation and transportation policy, that Fred tackles the logistical challenges of northern freight transport every day.

**Jerry Pokrupa M.A.A.T.O. (Ont.), CT(Arch) Mb., B.E.S.**
**Architectural Technologist, Keewaytinook Okimakanak**

Currently employed with Keewaytinook Okimakanak (Northern Chiefs Council) ; a technical services not-for-profit organization providing services to six (6) remote First Nations member communities in Northwest Ontario. www.knet.ca
As an Architectural Technologist with the Public Works Unit, responsibilities include technical services (advising), contract administration, and project management for projects ranging from residential and commercial renovations, new construction projects, Health Canada projects, and new school projects.

All six of the member communities are “winter road” access only; and project responsibilities include; support to the communities in project implementation, delivery logistics, budgets, contracts, payment certification and cost control.


Barry E. Prentice Ph.D., MCIT
Professor, University of Manitoba

Dr. Prentice is a Professor of Supply Chain Management, at the I.H. Asper School of Business, University of Manitoba and the former Director (1996-2005) of the Transport Institute. He has authored or co-authored more than 250 research reports, journal articles and contributions to books. His scholarly work has been recognized for excellence in national paper competitions and awards. In 1999, National Transportation Week named him Manitoba Transportation Person of the Year.

Dr. Prentice has served on the Boards of Directors of several transportation organizations. He was instrumental in founding a major in transportation and logistics within the B.Comm. (Hons.) program at the I. H. Asper School of Business (fall 2003). Since that time a new Department of Supply Chain Management has been formed, and in 2006 a M.Sc. program in supply chain management was initiated.

In 2005, Dr. Prentice co-founded ISO Polar Airships Inc., a not-for-profit research institute, at the University of Manitoba Smart Park. ISO Polar is dedicated to encourage the development of airship technology for sustainable transportation and logistics applications in the Northern Latitudes.
Stuart Russell
Vice President, Business Development, BBE Ltd.

Mr. Russell moved north to Yellowknife, NWT in the autumn of 1971 and began a 35 year career in the transportation and logistics field. His work included oversight of numerous unique frontier logistics projects and many years in the corporate world of international airlines.

He spent 15 years with Pacific Western Airlines, in Flight Operations, Hercules Operations and Contract and Charter and 14 years at Canadian Airlines International.

Since joining BBE in early 2001 Mr. Russell renewed his relationship with the north and used his skills to help expand the BHP Ekati diamond mine supply chain from Yellowknife to Edmonton.

Michael Schieschke
COO, ZLT Zeppelin Luftschifftechnik GmbH & Co KG

Michael Schieschke is the Chief Operating Officer of ZLT Zeppelin Luftschifftechnik GmbH & Co KG in Friedrichshafen. He has held similar position in the aerospace industries in Germany for several years. Before encountering the aerospace world Michael Schieschke was heading the legal and HR department of a leading mechanical seal manufacturer and distributor. Michael Schieschke is a graduate of the Munich’s Ludwig Maximilians University Law school.

Michael Schieschke is involved in two outstanding ZLT projects, the geophysical survey operation in the Kalahari Desert for the De Beers group as well as the marketing of the Zeppelin NT 07 for a San Francisco operation.

Jon L. Smith, Ph.D.
Director, Bureau of Business and Economic Research East - Tennessee State University

Dr. Jon L. Smith received his undergraduate degree from Mississippi State University in Business Administration. After military service as a naval aviator in Vietnam, he studied at the University of
South Carolina where he earned a Master’s degree in Transportation and a Ph.D. in Economics with areas in Transportation Economics and Industrial Organization.

He has been a member of the faculty of Economics, Finance and Urban Studies since 1980. While at East Tennessee State University he has served as the Chairman for the Department of Economics and Finance and currently is the Director for the Bureau of Business and Economic Research.

Dr. Smith has published numerous papers and articles and has been involved with a number of grants. He has been involved in projects for the U.S. Department of Energy, the U.S. Department of Transportation, the State of South Carolina, the U.S. Department of Education as well as private foundations and municipal governments. He has served as the U.S. coordinator of the Transatlantic Business School Alliance, a consortium of 7 U.S. and European universities and has lectured in both the United States and Europe. He is an honorary faculty member of the University of Applied Sciences in Bremen, Germany. He is currently acting as either principal investigator or project director for three grants, one from the U.S. Department of Agriculture and two from the U.S. Department of Education.

Dr. Smith's current research activities are oriented towards transportation economics and international entrepreneurship.

Dirk Spaltmann Ph.D
Board of Directors of Initiative Zukunft in Brand e.V.

Dr. Dirk Spaltmann has studied physics in Aachen (Germany) and Cardiff (Great Britain) focusing on metal and semiconductor surfaces and interfaces. He was Director (1995-1998) for Production and R&D of a small but innovative German company and has filed 6 patents.

Dr. Spaltmann is now research associate at the “Federal Institute for Materials research and Testing” (BAM) which is the non-profit national chemical and materials technological Institute under the direct authority of the German Federal Minister of Economics. Dr. Spaltmann works in the fields of high frequency friction and wears protection via advanced coatings. He has authored or co-authored
more than 60 research reports, journal articles, and contributions to books as well as filed further patents.

In 2006 Dr. Spaltmann joined the German hydrogen and fuel cell association (DWV) and co-founded the Institute for new airborne transportation systems. Since 2005, Dr. Spaltmann serves on the Board of Directors of Initiative Zukunft in Brand e.V., the association of Cargolifter shareholders and supporters, promoting the re-structuring of the Cargolifter Company.

Graham Starmer
President, Manitoba Chambers of Commerce

Born and raised in southern England, Graham Starmer went straight from school into the Thames Valley Region police force, later transferring to the Regional Crime Squad for Southern England.

He immigrated to Canada in 1969 and joined the Bank of Nova Scotia as an accountant, later the assistant branch manager, of a branch in Toronto. Mr. Starmer returned to police work in 1970 when he joined the Royal Canadian Mounted Police. He spent the next four years on general detachment duties, mostly in Manitoba, before being selected for the RCMP’s Security Service, based in Ottawa. In 1984 he was transferred by the RCMP into the newly-formed Canadian Security Intelligence Service (CSIS), as an intelligence officer and project manager. Mr. Starmer resigned from CSIS in 1994 to take a position as an investigator with the Ombudsman’s office in Winnipeg.

He was selected by the Manitoba Chambers of Commerce in January, 1998 to be its new President. The Manitoba Chambers of Commerce serves as the umbrella organization for 74 chambers of commerce throughout the province, with a total of about 9,000 members, as well as 250 Corporate members.
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