

APPLICATIONS FOR NORTHERN TRANSPORTATION



AIRSHIPS TO THE ARCTIC

SYMPOSIUM

HELD AT WINNIPEG, MANITOBA ► OCTOBER 22-24, 2002

TRANSPORT INSTITUTE
THE UNIVERSITY OF MANITOBA

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TRANSPORTATION**

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PROCEEDINGS

Held at Winnipeg, Manitoba
October 22-24, 2002

Edited by:

Dr. Barry E. Prentice and Shelley Turriff

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Transport Institute, University of Manitoba

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Dedicated in memory of The Late Honourable Ron J. Duhamel

Ron Duhamel was first elected to the House of Commons in 1988 and re-elected in 1993. He has served as Parliamentary Secretary to the Minister of Public Works and Government Services from 1993 to 1994, and as Parliamentary Secretary to the President of the Treasury Board from 1994 to 1996. He was appointed Secretary of State for Science, Research and Development and Western Economic Diversification in 1997. He was appointed veterans affairs minister in 2000, and was appointed to the Senate in 2002. He chaired the Prime Minister's Task Force on 2030: Policy for an Aging Population, and was a member of the Working Group on Labour Market Training and the House of Commons Standing Committee on Finance. In Opposition, he was critic for Education and Literacy and for Secretary of State, and was associate critic for Official Languages and for Federal-Provincial Relations.

Mr. Duhamel held senior posts in the Public Service in Manitoba including Assistant Deputy Minister and Deputy Minister of Education. He also worked as a teacher, principal, educational administrator and professor, and is a published author. Mr. Duhamel received a Bachelor of Arts from Lakehead University and a Master's degree and a Ph.D. from the University of Toronto. He is survived by his wife and three daughters.

Forward

Dr. Barry E. Prentice
Director, Transport Institute
I.H. Asper School of Business University of Manitoba

This Symposium was conceived as a means of bringing together all interested parties for a first hand look at the use of airships for northern transportation. The original vision for the Symposium was expressed by the late Hon. Ron Duhamel, former senior Federal Minister for Manitoba. Mr. Duhamel recognized the potential of airships to fill many gaps in our transportation to the north. Sadly, he was not able to see the fulfillment of this vision, but we dedicate the conference to his memory.

The organizers of the Symposium had multiple goals. The first goal was to dispel the negative myths associated with Lighter-than-air (LTA) transport and to introduce information on the state of the art materials that make it possible to construct airships that were never before possible. A second goal of the Symposium was to establish the scope and strength of civilian and military demand for an alternative means of transport with particular reference to the northern markets. The third goal was to examine the passenger, freight and communications applications of existing and proposed airships, and to portray the supply side of the LTA market. Finally, the Symposium was designed to bring political attention to the opportunity to found an airship industry in Manitoba as part of this community's aerospace industry cluster.

I would like to thank all those who gave so generously of their time to assist in the organization of the conference and to the speakers, some of whom came considerable distances to participate in this meeting. I wish to recognize our sponsors whose financial assistance made the Symposium possible: Transport Canada, Western Economic Diversification, the Manitoba Department of Transportation and Government Services, the Manitoba Department of Energy, Science and Technology, the Manitoba Department of Aboriginal and Northern Affairs, Manitoba Hydro and Southport Aerospace. We also appreciate the in-kind support that we received from: Ironlink, the Manitoba and Winnipeg Chambers of Commerce, MTS, Clarion, and Sport Manitoba. I would also like

to recognize Mr. Hart Berger, former policy advisor to the Hon. Ron Duhamel, who made a major contribution to the organization and success of the Symposium, and to Mrs. Jill Dutka, who worked tirelessly to ensure that the Symposium was a world class event. Lastly, I want to recognize the help of my co-editor, Shelley Turriff, and all the speakers who worked with us to prepare these proceedings.

The entire proceedings were transcribed with the exception of the speech by the Hon. Steve Ashton, Manitoba Minister of the Environment. Mr. Ashton spoke in a different room, and did not have a written speech. The remarks of Mr. Ron Browning, Lockheed-Martin, were transcribed, but have been withheld at the request of the author.

TABLE OF CONTENTS

Dedication	i
Forward	ii
Table of Contents	iv
Welcome – The Hon. Scott Smith, Minister, Manitoba Transportation & Government Services	1
SESSION 1: AIRSHIPS: THEIR TIME HAS COME ... AGAIN	3
Moderator – Barry Rempel, President & CEO, Winnipeg Airport Authority	3
Richard Van Treuren, Astronaut Changeout Technician, United Space Alliance	4
David Barlow, President, TCOM, LP	15
SESSION 2: RESUPPLY AND RESOURCE DEVELOPMENT IN THE ARCTIC	
Moderator – Andrew Horosko, Deputy Minister, Manitoba Transportation & Government Services	23
Paul Smith, VP Information Services, The Northwest Company	23
Brad Thiele, VP Meadowlake Project Development, Cumberland Resources Ltd.	28
Clifford Abraham, President, Northern Transportation Company Ltd.	31
LUNCHEON KEYNOTE SPEAKER	
The Hon. David Collenette, Minister of Transport, Government of Canada	42
SESSION 3: NORTHERN MEGA-PROJECT CONSTRUCTION	
Moderator – Jim Thomson, General Manager, Ironlink Transportation Management	47
John W. Markowsky, Manager of Major Projects Planning, Manitoba Hydro	48
Ian M. Goodwin, Mine Manager – Ekati Diamond Mine, BHP Billiton Diamonds Inc.	52
John Skalski, Manager Gas Pipeline Technical Services, Enbridge Pipelines Inc.	57
SESSION 4: SECURITY AND EMERGENCY RESPONSE IN THE NORTH	
Moderator – Al J. Phillips, Professional Associate, Transport Institute	68
Walter Parker, Chairman, Arctic Council Circumpolar Infrastructure Task Force	68
Charles J. Hunter, Director CORA, 1 CAD/CANR HQ	72
Lt. Col. Mike Woodgerd, Transportation Corps, Center for Army Analysis, U.S. Army	80
LETTER TO THE CONFERENCE BANQUET	
The Hon. David Anderson, Minister of the Environment, Government of Canada	96
SESSION 5: PASSENGER, SURVEILLANCE AND ADVERTISING BLIMPS	
Moderator – Dennis G. Wright, Coordinator Environmental Affairs, Oceans & Fisheries Canada	97
Rudy Bartel, Engineering Manager, American Blimp Corporation	98

Scott Danneker, Airship Pilot, Zeppelin Airships	107
Lei Harris, Species at Risk Biologist, Oceans & Fisheries Canada	117
SESSION 6: HEAVY-LIFT AIRSHIPS AND HYBRIDS	
Moderator – Glenn Beach, President, Paradigm Technologies LLC	123
Gordon Taylor, Director of Sales & Marketing, Advanced Technologies Group	124
Gennady Verba, President, RosAeroSystems	128
Fred Edworthy, VP Programs & Business Development, Worldwide Aeros Corp.	135
KEYNOTE SPEAKER	
Gil Costin, CEO, Millennium Airship Inc.	140
SESSION 7: HIGH ALTITUDE AIRSHIPS	
Moderator – Kerry Boucher, VP Engineering & Quality, Standard Aero Canada	146
Steven L. Krause, Unmanned Systems International Program Director, The Boeing Company USA	146
Ronald G. E. Browning, Director of Business Development, Lockheed Martin Company: presentation withheld at speaker's request	
SESSION 8: DECISION-MAKERS' PANEL	
The Hon. Scott Smith, Minister, Manitoba Transportation & Government Services	151
Mike Spence, Mayor of Churchill	153
David W. Faursehou, Opposition Transportation Critic, Manitoba Legislative Assembly	154
The Hon. Jon Gerrard, Manitoba Legislative Assembly and Leader of the Liberal Party of Manitoba	156
CLOSING REMARKS	
Dr. Barry E. Prentice, Director, University of Manitoba Transport Institute	159
List of Speakers and Participants	161
Speaker Biographies	165
Symposium Sponsors	180

**The Honourable Scott Smith
Minister
Manitoba Transportation & Government Services**

It is a pleasure to be here on behalf of the Government of Manitoba and our premier Gary Doer, and it is nice to join you here this morning. Premier Doer regrets that he could not be here today, but does extend his best wishes to everyone. I would like to commend the organizers of the symposium: Barry and the folks at the Transport Institute for putting together a very interesting and timely agenda.

As a newly appointed Minister of Transportation and Government Services, I am pleased to participate in this very prestigious event. The transportation industry is a significant contributor to Manitoba's economy. When we were on the way over, the Deputy Minister Andy Horosko, and I were wondering what year the hotel that we are in was built. It was probably about the same year that a lot of the vehicles that we are talking about here today were in full-fledge use. Obviously I have been reading the newspaper clippings and the reports of the major changes that we have seen.

The potential for airships is certainly strong as a very viable form of transportation. Our mid-continent location as a transportation hub provides unlimited trade opportunities in the region and global economies. During the next two days the discussions around the challenges and possibilities of airship transportation are sure to be very interesting.

The history of airships precedes the Legislative Building in Manitoba and this hotel. The Hindenburg tragedy, I was pleased to read this morning, was not caused by the hydrogen that kept the ship afloat; it was caused by the burning of the skin and static electricity. The fixed wing aircraft surplus that the military had after the Second World War out shadowed the airships that we had at that time. Airships were viewed by most people as slow, inexpensive and dangerous in transport. Today there is a new generation of cargo ships that are being developed using the technological advances of the last 60 years of accumulated scientific knowledge. Lightweight fabrics and the superior structural strength of composite materials allow larger cargo loads.

There is a great potential of this emerging airship technology, particularly in northern remote areas. Airships have the capacity to move oversized freight directly to remote locations and northern mega projects that Manitoba certainly intends to develop over the next few years. This would eliminate the need to disassemble and reassemble large freight on site. Airships could be used in mining operations, reaching areas inaccessible by roads. The development of passenger airships could open new eco-tourism opportunities as well as offer remote communities affordable, year round cargo and passenger service. These are just a few ways the airships could be used to lower the costs, improve services and open new areas of commerce.

Airships are environmentally friendly. They are unobtrusive, quiet and emit relatively small amounts of greenhouse gases, which fits very well with Manitoba's vision.

In Manitoba, there exists great potential for manufacturing, maintenance and operation of new generation airships. Winnipeg could become the global crossroads for airships and airship operations. An airship company located in Winnipeg would find that it has all the trades and needs from the existing aerospace industry. Our existing education and training infrastructure at Red River Community College, the University of Manitoba and Southport can incorporate the requirements for airship pilot training. The challenges can be met, will be met and it is just a matter of time.

We are pleased to support this symposium and look forward to the discussions that I know you will be having here today. It is encouraging to know that there are people with vision. On behalf of Premier Gary Doer, we are very supportive of the airship industry in Manitoba and we wish you well on moving this project ahead. Thank you very much for having me here this morning.

Session 1: AIRSHIPS: THEIR TIME HAS COME ... AGAIN

Barry Rempel (Moderator)
President & Chief Executive Officer
Winnipeg Airports Authority

Good Morning everyone. Thank you Barry. I understand last evening you had an overwhelming response to the opening of the symposium. Barry and his team have put in a lot of work. I am going to take just a brief moment and step outside the bounds of what had originally been asked of me and just to personally thank Barry for his tireless efforts. Certainly speaking as an old fixed wing guy, he has been most persuasive in the discussions that we have had around the opportunities that we have had for airships. We have a lot of believers in town in large measure because of Barry and that is probably why Barry is wearing a rose this morning just to stand out. Thanks.

My role is quite simple here today: *Ve vill keep you on time*. As your documentation has referenced and as the minister has already alluded to, airships have been around for a long period of time. In the decade prior to 1937, airships were working routes along the Atlantic that had been thought just impossible in other ways. The speakers today will be addressing the facts, myths, and the reality of the first generation airships and the technological advances that have brought us to where we are today, and why we believe now is the right time to look towards airships, their time having come again.

Our first speaker, and some of you have had the fortune to meet and discuss some of these things with him already, is Richard Van Treuren. Mr. Van Treuren was born in Ohio. He served in the US Navy and in 1979 joined the space shuttle contractor team. Today he is an astronaut changeout technician and I am looking forward to actually having a private conversation with him later to find out how you change out astronauts. He works today with the United Space Alliance, a joint venture of Lockheed Martin and Boeing, and as you all know he is a long time airship history fan. He has produced a number of books and videos on dirigibles. With that I give you our first speaker, Richard Van Treuren.

Richard Van Treuren
Astronaut Changeout Technician
United Space Alliance

I want to thank Dr. Prentice and the team that put this together, as they have done a magnificent job.

Our demanding times suggest re-examining the directable buoyant aircraft, or “dirigible” airship. Manufacturers have more pressure, semi-rigid and rigid buoyant designs ready now than any time since the 1930s. We should again open our minds to civil and military applications for vehicles that simply displace air to work in our atmospheric ocean.

No means of transportation or wartime weapons system has been more underutilized or misunderstood, a tragedy not just for unsung heroes but also for lost capabilities. More than 80 years ago airships reached 22,000 foot altitudes; one flew 4,200 miles, without refueling, carrying a 30,000 pound payload. Seemingly unique media darlings, almost 100 rigid airships were manufactured in World War One; even non-rigids, or “blimps,” became routine when about 150 were manufactured in 1942-44. We must overcome our “Queen of the Skies” wonderment and evaluate the air displacement vessel for the niche they fill in our transportation and defense plans.

Safe above all, the airship is comfortable in the troposphere independent of speed or direction. Just being able to slow down or stop in the air when conditions are ugly is a lifesaving luxury long forgotten. Even as a balloonist is secure aloft in a planet-encircling gale that would exhaust or shred an airplane, the art of sailing the atmospheric ocean is a skill that can be re-learned. More tolerant of error, airship safety records compare favorably with “plane-a-day-in-Tampa-Bay” airplane losses in WWII that were greater than in actual combat. Buoyant craft are by their nature more survivable after propulsion and electrical system failures. Today’s airships are constructed of rugged, long-lasting nonflammable materials and filled with inert helium gas.

No energy is wasted overcoming gravity, so fuel is used only to augment or circumvent the drag of air currents. Mission times are measured in days, not hours. The unrefueled

flight endurance record set by a US Navy blimp has stood more than 40 years. Airships demonstrated sea anchorage, underway replenishment, and crew relief via winch basket from land or any fleet element. Interoperable with any waterborne or beachhead asset, buoyant craft are naturals for multi-agency responses and are particularly well suited to the challenges of “operations other than combat.” While long endurance contributes to their lower operating cost, it is not just with short-legged helicopters, but impossible-to-repair spacecraft assets to which airships compare most favorably. As the events of 9/11 showed, money spent obtaining snapshots while orbiting the ever-rotating ground below is of little value when the threat can be seen and dealt with right here in troposphere.

The airship's wide speed range encourages detailed surveillance missions. Airship design is conducive to large window openings for 360° observation, as well as side and floor hatches through which sensors or instruments have been directed. These qualities have also made it an ideal platform for deploying and recovering towed or even semi-autonomous sensor equipment. Oversize sensors are at home in the electronics-soothing helium envelope, and odd configurations can take advantage of the large hull dimensions for exterior mounting. All systems enjoy the lack of vibration and low G loads, as witnessed by identical systems in airplanes causing reliability problems in the 1950s.

Radar-transparent and already low in infrared signature, exhaust condensation-water recovery apparatus gives the airships' hotspots a natural infrared shield. If in harm's way, emissions and even engines could be secured, and potential attackers would be detected with the airship's oversize, sophisticated passive sensors long before any airplane offensive system could find a way to target its adversary. The helium containment is only slightly higher than atmospheric pressure, typically one to two inches water gage (about .06 PSI) so the airship is tolerant of envelope punctures even caused by small arms fire. Sophisticated projectiles would likely pass through both sides without activating firing sensors, but if severely damaged, airships suffer only gradual degradation, allowing crew escape.

One dream battled about for decades is a common, easily maintainable airframe that supports many different mixes of mission equipment. Low maintenance per flight hour and high platform availability is proven; design encourages many uses for the same tugboat-fashion hull supporting a detachable module design for mission changes. Let us re-examine some missions already long proven:

Coast Guard - Maritime Patrol Airship (MPA)

In addition to continuous patrol with a sprint speed of 65 knots, three times that of a surface craft during World War II, airships safely escorted 89,000 merchant ships without losing one. Lesser known were the many types of assistance offered by blimps, from preventing collisions and groundings, to relaying orders, to even fish spotting. More than 1,000 people owe their lives to blimp rescue, a tertiary self-perfected mission of the World War II ASW airship. Numerous studies naming several other missions have shown the maritime patrol airship would be faster than a cutter and cheaper than a C-130 airplane, while performing functions of both. Fifty years ago an airship landed on and operated from the water's surface; an adapted advertising blimp launched and recovered a boat 20 years ago. Just as they detected telltale snorkel exhaust decades ago, airships have flown downwind while sampling the air mass to measure extremely diluted signature substances. With onboard sensors to analyze emissions emanating from suspicious contacts, airships could be detecting explosives, biological, or chemical threats from the sea. There is no environment too harsh to monitor fishing grounds or track polluters, no place airships cannot act as command posts for oil spill or maritime disaster management and recovery.

Airborne Early Warning (AEW)

The first Government use for airships was border patrol. Decades later during the concept-proving Project 'Lincoln,' Naval Historians recorded, " ...a continuous patrol was maintained for 10 days, 200 miles off the coast of New Jersey, by personnel from the Naval Air Development Unit, South Weymouth and Squadron [ZP]1. The weather proved to be the roughest part of the test. It was the worst the area had experienced in 35 years. The crews and their airships dealt with snow, freezing rain, icing, sleet, fog, rain,

zero temperatures and high [60 knot] surface winds. During the patrol, all military [including “all weather” fighters] and commercial aircraft were grounded due to severe weather, but the airships kept going and continued their patrols without mishap." The last airship delivered to the US Navy was a radar picket ship, the EZ-1A Vigilant. With its 40-foot radar antenna and typical 36-hour snowstorm mission, its 20-man crew manning its CIC easily replaced a malfunctioning air traffic control center. The need to detect small, stealthy missiles against sea clutter has only become more acute since the “Lincoln” experience was set aside and four airplanes in rotation were substituted per blimp. Today, impractical for airplanes, a stealth-detecting 1,000 sq ft antenna lofted to 10,000 feet would extend today's surface 25 Nautical Mile radar horizon out to more than 120 NM. Airplanes, gulping fuel constantly having to rush forward, are ill suited to 24/7 fence maintenance.

Mine Counter Measures (MCM)

A defensive vehicle removed from the opposing weapon's medium is as priceless an asset now as it was when ZP-14 worked mine hunting and killing in WWII. As one sailor wrote, "Minesweepers, used to waiting for explosions to announce the presence of mines, liked having the blimps tell them mines lay ahead. They liked it even better when blimps told them there were no mines ahead."

Minesweepers have become the most expensive-per-ton vessels in the fleet, hence the effort to substitute helicopter towed sleds for this unglamorous role. The airship N-1, which sustained a peaking 9,500-pound winch load and towed for 24 hours, demonstrated at-sea mine sweeping capability 50 years ago. The airship makes no noise in the water. The green laser that allows eyeballing suspicious undersea contacts is not at home inside a vibrating cacophony with downward frothing thrust that has to burn fuel like mad just to stop. A modern dirigible would be equally at home as mothership to remotely controlled underwater craft. In 2000, a small blimp carried UWB ground-penetrating radar that pinpointed buried Kosovo mines, saving man-years of dangerous searching on the ground.

Since mines are still the cheapest way of bottling up an enemy harbor, airships could place mines with GPS precision as well.

Anti-Submarine Warfare (ASW)

The submarine's only natural enemy is faster than a nuke boat, undetectable by its sonar and invulnerable to acoustic and new high-speed torpedoes that overtake the fastest destroyer. High mission availability of the WWII ASW airship is lost in journalistic assessments that deal only with the strongly discouraged surface combat -- for which they had no standoff weapon -- and even that official score is wrong. Overlooked but vital was the blimp's *raison d'être*, victories against underwater adversaries, never credited even when using homing torpedoes. Said one 1950s diesel submariner: "Planes, destroyers and helicopters are just the normal occupational hazards of our profession. But once a blimp pins you down, he can stay with you until the end of time." The last ASW exercise where airships were available, 'Whole Gale' of February/March 1960, just six ZPG-2s logged a respectable 1,644 flying hours in some of the worst Northeast gales and snow storms ever recorded. One 96-hour crew established today's record of 93 continuous hours on ASW station. Capable of scaleable, measured offensive responses, ASW airships are the sub-mariner's worst nightmare.

Aerostation - Command Post

Attaching odd sized instrument packages about the airship is less of a challenge than in other craft because of the large hull and car volume, wide center of gravity, and greatly reduced aerodynamic constraints. Vital for today's increasingly joint operations, buoyant switchboard platforms could transfer secure communications, translating incompatible formats relayed from spacecraft, ships, airplanes, UAVs and, replacing the E-8 *Mercury*, submarines. Differences from antennas placed bow and stern would enable more detailed interferometric processing, yielding detailed 3D data on a single pass. US Army troops are studying the twin aerostat JLENS missile warning system, and GPS augmentation systems also serve. These, as well as anti-missile systems that need to loiter aloft indefinitely, would find buoyant craft an ideal platform.

Unqualified successes as law enforcement command posts suggest the airship would be a secure position for a battle group's flag. In spite of thousands of hits no blimp has ever been lost to small arms fire. Even with World War One's highly flammable materials, exactly five Zeppelin bombers came down on English soil – one “beached” and scuttled by its crew. Airship response need not be limited to target illumination, chaff, flare decoys, or electronic deception; airships launched standoff weapons more than 80 years ago.

Aircraft Carriers

Sixty-seven years ago, thousands of miles from bases, airships deployed teams of scouting fighter planes as far as 200 miles from the mothership so reliably their landing wheels were removed. Their search capability cannot be equaled today. In 1943, two US Navy officers argued the updated flying carrier would compare favorably with the WWII escort flattop. Invulnerable to mines and torpedoes, deployable through land masses without canals, impossible to run aground or strike an iceberg, harder to find and hit, the flying aircraft carrier would put the same number of planes on target faster at reduced cost and risk to crewmen. Ever more important with today's uninhabited aircraft, a modern flying carrier would enhance radar by offering otherwise impossible visual search capability. Attack-capable UAVs hardly need a billion dollar national asset as a platform. Basing remote controlled or semi-autonomous sensor drones on board and airship is a natural, since both vehicles travel in the same medium.

Research & Development

Airplanes might still be made of wood if ALCOA had not been tasked to solve “the Zeppelin problem” and created duraluminum. Not a competition, airships were the vital platform as ascentive force overcame bulk, weight, and aerodynamic unsuitability for countless prototype systems. Possessing a flexible alternative to gravity leads to new solutions for old problems and widens research possibilities. Above all, the vibration-less, quiet, gently landing and stable airship offers a solid, capable platform in the air in contrast to the airplane's harsh, cramped, noisy and short-lived mission environment.

The US Navy's last airship missions were R&D; the “Flying Wind Tunnel” yielded invaluable data. The US Government’s 1990s return to buoyancy was also R&D. With its 22 foot by 8 foot cabin supporting two-ton payloads up to 5000 feet for a demonstrated 24 hours, the Sentinel 1000 tested sidestick fly-by-light control system and a bow thruster. The Sentinel 1000 demonstrated a portable sea anchor that held the airship steady with seas running five to six feet and winds of 20 to 25 knots. Reinstatement of the Sentinel 1000 program would deliver vibration-free, quiet real estate at altitude for about \$400/hr (in 1992 dollars).

Arctic and Sensitive Environments/Tourism

Before airplanes could cross oceans with passengers jammed into cramped seats, Zeppelins carried passengers in luxurious walk-around promenades with huge, opening windows. Wildlife sightings were common, and whale studies are performed to this day. Ecological observation from the Amazon to the Arctic was performed in comfort.

An Italian semi-rigid airship was first to cross the top of the world more than 70 years ago. More than forty years ago a US Navy non-rigid airship flew the Arctic, dropping mail to scientists a few hundred miles from the Pole. Airships love cold, dense air, and flexible envelopes were easily protected against snow and ice accumulation. A natural friend of the Earth, the quiet airship indeed “treads lightly,” emitting little pollution.

Is That All There Is?

Available histories document how these capabilities have been demonstrated, and need not be re-invented, only be re-instated. Modern materials add value; one achieved fourteen years’ service on one envelope with very few visits to a hangar, roughly equivalent to a surface vessel's need for a dry dock. Mechanized ground handling equipment has demonstrated greatly reduced personnel support; the Zeppelin NT is routinely ground handled with three people.

Crisis Response

Recent fatal firefighting airplane crashes underscore the challenges made on airframes used to dump fire-smothering chemicals. Although it presents extra challenges, firefighting by airship is certainly possible, and with new chemical agents, perhaps advantageous. Deploying oil dispersal chemicals or lifting entire containment structures are obvious applications. Onboard sonic transducers capable of coagulating dangerous smoke particles are but one proposal to use airships to perform, not merely direct, crisis response. Powerful LED-based searchlights and directed sound technology await deployment on airships.

Sea / Air Lift – Cargo

Airfreight is not only limited by what fits into the fuselage tube, but a cargo density of about 11 pounds per cubic foot for cost effectiveness. The great speed at which these relatively heavy rarities are moved from airport to airport is negated when measured manufacturer-to-consumer. Transatlantic vessels take 240 hours port to port, airships did city to city in 36 hours, jets only 7. That means airships realize 87 percent time saving over freighters, and there are few categories of high-density freight where the additional 13 percent is of real importance even without the advantages of point-to-point factored in.

"One of the greatest peacetime engineering efforts in history" has created the Airbus 380, an underwhelming 25.4 cm wider than a 747-400, and no faster. Greater capacity and significant speed is not coming by airplane because existing structural materials will not allow larger practical airplanes to be built in the next decade.

Some twenty percent of the US Gross National Product is generated by transportation; if airships shaved pennies off ton-mile costs, they would more than justify their required tool-up expense. Various types of cargo airships are needed. A very large airship would transport outsized indivisible loads point to point that are too heavy or bulky for any other method. A smaller version would relieve long waits by leaping loads over congested ports or retrieve loads from environmentally sensitive areas.

Also needed is an airship that has such a cavernous cargo hold that it could not be filled up, actually reaching maximum weight with the bulky but relatively light stuff of everyday life. The airship service, with twice the speed of trucks and about three times the average railroad speed, would not subject delicate materials to the rail's 20Gs, the truck's 8 Gs, but rather a gentle 0.5 G. Such ships, like the Sky Cat envisioned by Airship Technologies Group, would be equally at ease moving Fed Ex packages across country and combat supplies across oceans, so governments could have a reserve fleet ready for logistical response with a very small initial investment.

Quickly evaporating cryogenic liquids lose large percentages overland in trucks and costly pipelines. Hydrogen fuel and liquid helium are among the valuable cargos that lose some 30% getting to the customer. Methane tankers are already designed, and other light hydrocarbons would be practical for airship transport. Non-fuel hydrides (sulphur, phosphorus, even tin) can be blended with hydrogen to make semi-buoyant cargoes.

High Altitude Applications

Modern materials and solar/hydrogen fuel cell regenerative power systems will enable the unmanned communications relay and surveillance airships to station keep at altitudes above all traffic and weather. Unlike launch-and-forget satellites, long-endurance electronic platform airships can be refitted. With proper antenna design, a single airship could provide cell phone service to an area the size of Scotland, without the environmental impact of towers in sensitive areas. Ten airships could provide surveillance of North America for a fraction of the cost of irreparable satellites. Still, there is much room for improvement.

From the beginning, airships have labored with adapted boat or airplane engines, fuel and other systems not optimized for buoyant flight. These exacerbated teething problems also suffered in other fledgling air efforts that managed to escape media attention. History shows the most successful airship ever, the *Graf Zeppelin*, was by no accident the only dirigible ever built with a gaseous fuel system optimized for airships. About the

same weight as air, *Graf* required no apparatus to recover lost fuel tonnage, and could range with larger airships.

Other technologies have matured alone. Long needed all-axis thrust cycloidal propellers, for complete three-axis control, are ready for installation. We can finish the work on boundary layer control for faster top speeds, and build the already designed submarine-proved stern propulsion, possibly using efficient ring motors.

Yet even these new applications are not the ultimate. The hot-air balloon, the oldest flying vehicle, has complete control of its altitude as long as it has fuel, but has no control of its direction. The most advanced dirigible can choose a course, but cannot change its altitude with lift. We need a true airship, one vehicle that can do both. We can achieve this goal *and* triple the efficiency of buoyant vehicles (already holding all the records) just by taking advantage of what NASA has utilized these past 40 years – safe hydrogen fuel.

The showstopper problems facing cargo airships, consuming propulsion fuel weight and taking payload off the balloon, can be solved by a novel new employment of hydrogen fuel. Hydrogen fuel has three times the energy by weight, but only one third the energy by volume, of aviation gasoline. Evaporating from a liquid, it expands 857 times, lifting itself and payload weight. Since its only combustion product is water, it is possible to recover eight pounds of water per pound of fuel burned.

Allowed to expand from storage, hydrogen fuel could fill a center ballonnet to provide takeoff lift, and its bulky energy then consumed to gain altitude. Ballast could be used liberally since it could be “manufactured” on board. For the first time helium filled airships could be operated at efficient equilibrium, taking on or discharging payload all mission long as long as there is fuel. Available fuel cells will provide propulsion-independent electrical power for all systems including electrohydrostatic actuators, to eliminate hydraulics.

Alexander the Great lamented, “What a horse they are losing for want of skill and spirit to manage him.” We need to have greater endurance than our adversaries and responses equal to our challenges. Safe operations, foolproof defense and real profits await those who pursue the buoyant alternative.

Questions

Q: Does an airship exist that can carry such a load as a main battle tank?

A. (Richard Van Treuren) No. An airship does not exist at this time but they are certainly on the drawing board. There is no reason we cannot build them and the facilities to build them exist. The German operation Cargolifter sought to build a 150 tonne capable airship that was designed to carry this payload from say central Europe, to Africa or the tip of India. They had some technological issues that they needed to work out when the money ran out. But, there is no reason in the world that we could not build one today. The facilities exist, the technology is there and it just needs to be plugged in.

Q: In your presentation, the advantages of airships are very obvious. What has been the major constraint to the developer?

A: (Richard Van Treuren) Basically it is just prejudice and ignorance. But it is time we did start looking at airships because effectively we have built the largest airplane that we are ever going to build, the A380. It is just not practical to build anything larger. It is probably about the fastest we are going to get to. In our life times we are not going to see larger, faster airplanes because it is just not practical with today’s materials. Airships are not limited that way. We can make them as large or as capable as needed.

Q: How much weight should we expect to get an airship to carry from Winnipeg to a point in the Arctic?

A: (Richard Van Treuren) Well I wish I had a real quick answer for you. You would want to design an airship to carry a specific load, not necessarily the weight. Do we have

to put it inside a container or can we carry it outside in the windstream? Weight is only part of the problem. A lot of times it is the bulk and the density of the load. An airship has been designed to carry 150 tonnes, 4000 to 5000 miles (Cargolifter). It is just a question of somebody biting the bullet and starting to make it happen.

David Barlow
President
TCOM, LP

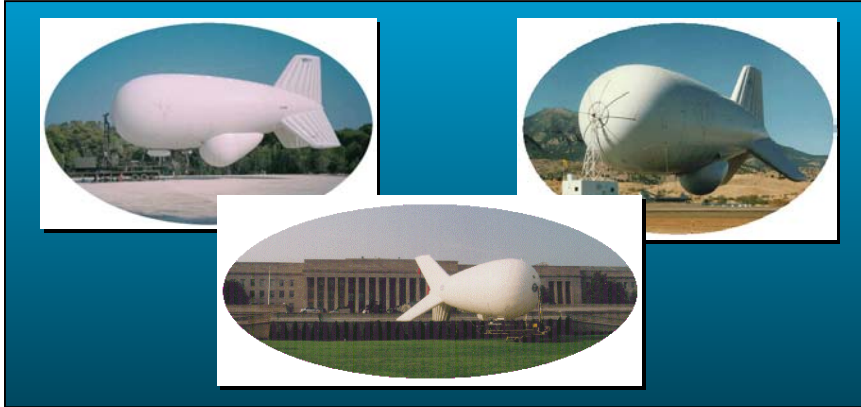
I really do want to thank Barry for the effort that he put into bringing this together. I think it is just a wonderful opportunity to bring together those that have real requirements, as well as those that have some capabilities. The question was asked earlier, why hasn't there been a really significant airship development in the past 20 or 30 years? In my opinion, it is that the airship community is too fragmented. There are a lot of people out there trying to do their own things. Whereas if people could actually come together, and the expression I like to use is, 'to aggregate and focus the available resources.' There is a lot that could be done to produce an airship that would meet the needs and requirements of many of those that have come here today. So, I just want to thank Barry for his efforts to create this forum in which to have this discussion.

I would like to also say that while I am here speaking on behalf of TCOM, I am the only person from TCOM here. Over the last four or five years TCOM has been collaborating with ILC. ILC and TCOM at one point and time competed for many of the same opportunities, but on the theory that we could do more together than we could do independently, we worked together on a number of projects over the last four or five years. We really found that our skills and capabilities were far more complimentary than they were overlapping. So to a degree, we have experienced the model that demonstrates what I believe needs to occur here, if in fact we are going to produce the airships that people would like to have produced.

We want to talk about the evolution of technology with respect to airships. TCOM has been around for 30 years. We have done over a billion dollars worth of business selling

lighter than air, so there is a market. The three aerostats in Figure 1 represent our family of products.

Figure 1: TCOM Family of Products



Westinghouse spent about 50 million dollars developing the technology related to aerostats. They spent a lot of time and effort at their research laboratories outside of Pittsburgh to develop a number of materials and capabilities for the envelope system. TCOM's background is really aerostats. The thing that we can bring to the party with respect to an airship is the envelope technology.

In Figure 2, the Fuji airship is a Skyship 600, for which we make the envelope. The middle airship in Figure 2 is a model of the Sky Cat that we built for ATG. The CL75 is sitting in the Cargolifter hangar on the right.

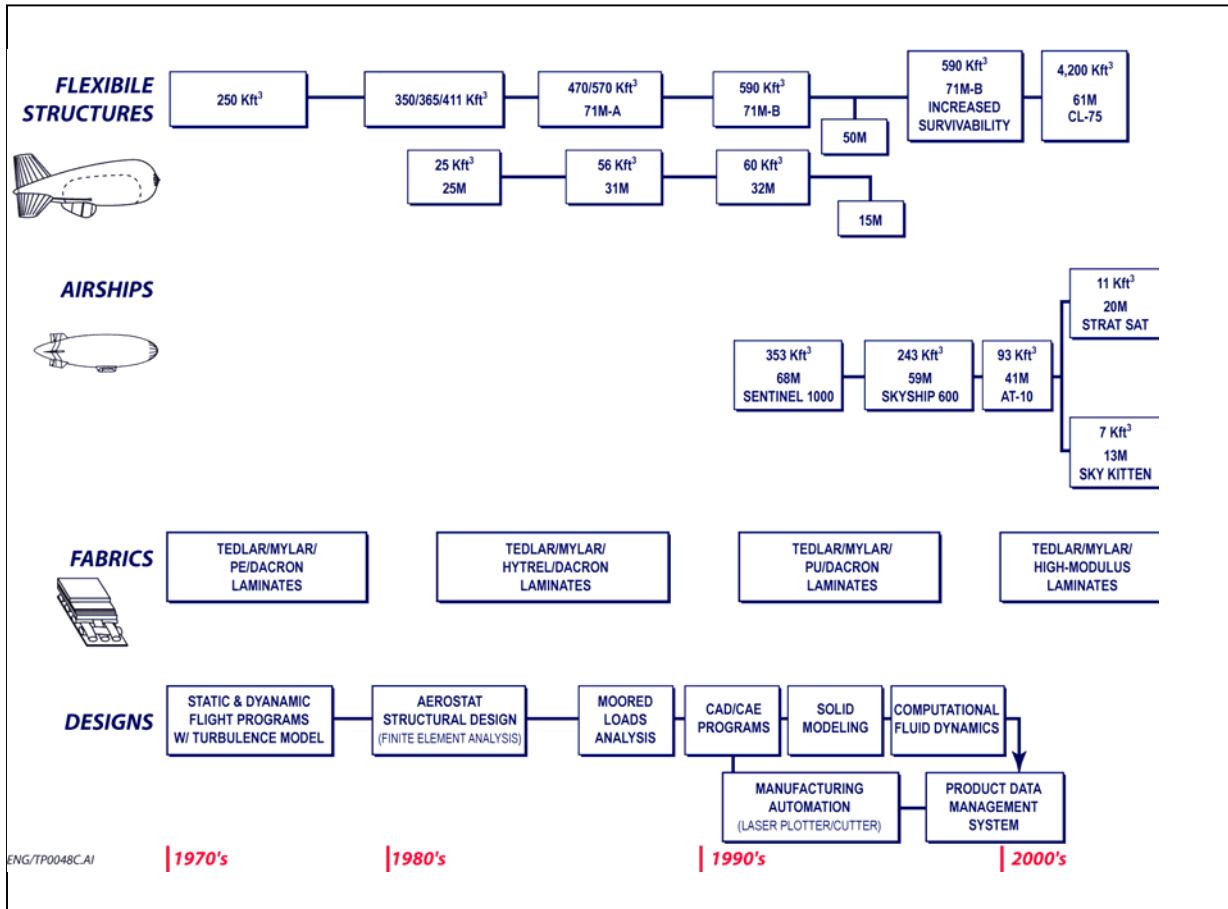
Figure 2: Skyship 600, Sky Cat Model, & CL75



With respect to operations, we have operated aerostats north of the Arctic for Dome Petroleum in the early 1980s. Also around the same time we went to northwestern Vermont, which is about as Arctic-like as we get in the lower 48, and tried to operate a 25-metre system through the winter. We got several thousand hours worth of operating experience through the winter to see how these things operate in the context of snow and ice. We have some experience that suggests that it is very viable. We started out with a 250,000 cubic foot system and finally for the air crane, the CL75, we produced a vehicle that was 4.2 million cubic feet. This is over half the size of the Hindenburg in terms of volume. TCOM did not foresee any problem building the envelope that Cargolifter wanted to build. In fact, we even gave them a fixed price offer.

Fabrics have been evolving over time. The fabrics on the left in Figure 3 had a useful life of maybe three to four years. They were subject to a great deal of hydrolysis, water seeping through the material and degrading its usefulness. Over time we have replaced the adhesives and now for the Cargolifter CL75, we even replaced the basic scrim member. We have developed materials that have a useful life of at least eight to ten years, perhaps even more. They have a strength to weight ratio that is several times what we started with back in the early 1970s. We have also developed the seaming technology to actually be able to make envelopes and vehicles out of these materials such that you carry the loads across the joints. This is no small feat.

Figure 3: TCOM LTA Technology Evolution



The other thing that has really helped in terms of these large envelopes is the design tools. As the capabilities with computers and models have evolved, so has our ability to model the requirements. The material that we built the 71M aerostat out of is only about nine ounces per square yard. It has a tensile strength of 300 pounds but yet we will put load patches in it that will carry stresses over 12,000 pounds. Being able to design a vehicle that is able to carry those loads and distribute it throughout the vehicle is very important with respect to producing envelopes that are going to meet specific requirements. Over the last 10 or 15 years, this technological advance has enabled us to develop the envelopes necessary for today's much needed modern airship.

The CL75 sphere, which is 61 meters in diameter, would not fit in our hangar that is 185 feet high. We built it with ILC. ILC built half and we built half, it was assembled it at

the TCOM facility, and shipped it to Germany. We inflated it in the Cargolifter hangar, and took it to eight inches of water pressure, which got a lot of people excited, but it performed very well. If you just build three of those and put them together, you basically have the CL160. The materials technology has made significant strides. We have the design capabilities with the finite element analysis and computation fluid dynamic analysis. All these combine to enable us to produce envelopes with a predictable capability.

TCOM produces aerostats and for many years we saw airships as competition. But once again, I think the two are very complimentary and what we can bring to the airship party is an ability to build envelopes of almost any size and shape. If an airship manufacturer gives TCOM the aerodynamic shape that it wants, tells us what it wants to hang where, and what weather conditions it wants to fly through, we can build that envelope. We not only design the envelope but we will design the material out of which we will build the envelope. We will then do the detailed design with computer-aided design tools. The design can then be fed directly down to our manufacturing facility in North Carolina where it will drive the cutting table that will cut and mark the material so that one can take the flat material, cut it, seam it together and create some very exotic curved vehicles.

Seaming technology has evolved somewhat over time. We bring two pieces of material together, put a structural bridge on the bottom and then put a UV barrier on the top. We weld that together. The key is to get the seams so that they are actually stronger than the base material. We create load patches with sewing and then weld that into the material. You can have specific loads on this material of over 12,000 pounds going into a particular low patch.

A lot of the people ask whether somebody with a 22 rifle or high-powered hunting gun could shoot holes in an airship and bring it down. Various governments performed a number of tests that involved shooting incendiary devices and 50 caliber machine guns. The material is not resistant to these projectiles. The projectiles do go through the material without much difficulty, but they are very resistant to tear damage. In a normal

airship we talk about two inches of water pressure. If you have a glass with about two inches of water, the pressure exerted by the water on the glass is about the amount of pressure that is inside of the airship envelope. We had a Skyship 600 envelope that they realized was losing some helium over time. So they did a complete vehicle inspection and found a six-inch tear up on the top. The tear had been there for a number of weeks, and there was no effect on the envelope other than the fact that it lost helium. They repaired the envelope and it continued to fly. Tear resistance is very important with respect to being able to absorb damage and continue to fly.

Ballonet material has to flex quite a bit and is altogether a different material than envelope. Gas permeability is important to retain the helium as best as possible, and on some of these larger airships that should be no problem whatsoever. It is important for the envelope to maintain its shape over time and so creep is something that we have a good understanding of.

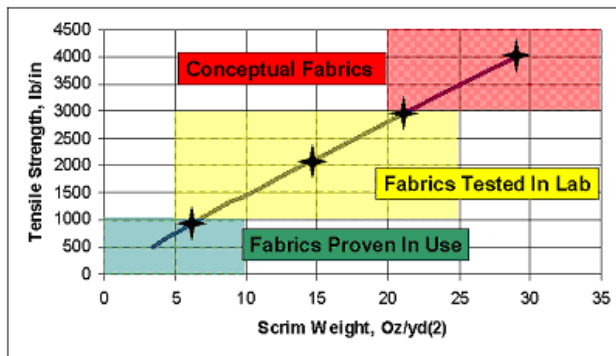
As you get into the larger envelopes, the seaming gets to be more challenging because the materials can have tensile strengths of up to a couple thousand pounds. The CL75 envelope had a gross lift capability of about 100 tonnes. The payload module on it weighed about 25 tonnes giving it had a net capacity of about 75 tonnes, hence the name CL75. The envelope contained 4.3 million cubic feet or about 110,000 cubic meters with a diameter of 61 meters. The tensile strength of that material was 700 pounds per linear inch. With a one-inch strip of this material, you could hang 700 pounds and not have it break. The weight of that was 11 ounces of yarn per square yard. Needless to say, it costs considerably more. But to build the high strength material is certainly within our capability.

Figure 4 shows the type of materials that we are working with right now. Again, we are doing this with ILC. We have actually produced the lower left hand fabrics, and the star there is about what we did with the Air Crane 75. The weight is just the scrim weight, which is about 6½ - 7 ounces for that material and that gives us about a 700-pound tensile strength. If we were to build a Sky Cat out of that material, that would have a capacity of

carrying about 20 tonnes. It has a much more exotic shape and therefore the materials have to be much stronger. But if you go up to the second star, that material would have a tensile strength of about 2000 pounds. It would weigh about 15 ounces so you would have about twice the weight for the scrim but about ten times the volume. With this material you could make an airship that would be able to carry about 200 tonnes of payload and that is about what we were looking at for the CL160. If you continue up the curve, it identifies the kind of materials you would need to be able to produce vehicles that could carry 500 tonnes and 1000 tonnes respectively.

The middle areas in Figure 4 are materials that we are actually testing in the laboratory. Materials, that if we got a contract to produce, we could build an envelope out of without much difficulty. We are working on even higher tenacity materials with greater strength. We are looking at improving the manufacturing technology, going to wider materials that would be less expensive with respect to manufacturing, new adhesives, and new seaming technology. All those things we are doing currently.

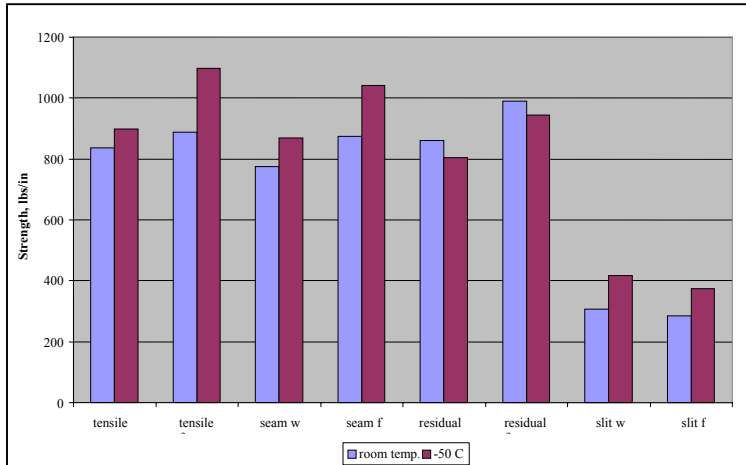
Figure 4: Tensile Strength vs. Scrim Weight



Finally, the good news for this conference is that these new materials like cold weather better than warm weather. Figure 5 takes the various qualities that we are looking for the material and compares how they perform with respect to normal room temperature and how they perform at 50°-C. The darker area is the performance in the cold temperature. The material performs very well in the cold temperature. We do not see providing envelopes that would operate in the Arctic as being a terribly large challenge. What we see as the bigger challenge is just getting the community to come together and bring its

respective resources and focusing them on the opportunity at hand. In conclusion, I would just like to say that the LTA system for cargo transportation is very much within our capability, at least in terms of designing the envelopes. The systems have been and can be operated in the Arctic environment. The LTA technology should be considered for transportation in the north.

Figure 5: Vectran Hull Fabric RT/-50 C Properties Comparison



Questions

Q: What percentage of the airship cost is represented by the envelope?

A: (David Barlow) Normally the envelope cost is somewhere between 25 and 35 percent. It depends on how exotic the airship is. If you go into different types of avionics, that can get to be very expensive, the envelope may come down as percentage of cost.

Q: It is a trivial question. How do you do you weld the last seam in the envelope?

A: (David Barlow) You have to talk to the manufacturing people. Normally there is access into the envelope, like in the ballonnet area, where you can actually go inside the envelope to do inspections and to do the last seam.

Q: What are the applications for the aerostats?

A: (David Barlow) The aerostat is optimal for certain sensor platforms. TCOM started out as standing for Tethered Communications. You could put an aerostat up 10,000 feet in the air and have a wonderful platform for a line of sight communications for television, for telephone, so forth and so on. Primarily they are used now for radar surveillance because if you fly at 15,000 feet, you have about 170 nautical mile line of sight to the horizon. If you have a cruise missile that is coming in at 600 miles an hour and you have a ground base radar, you can look 17 miles. The missile is coming at ten miles a minute, so you have 1.7 minutes to even find it, identify it and figure out what you are going to do with it. If you can look 170 nautical miles you have 17 minutes in which to do the same task. So it is used primarily for airborne sensors.

The small one (15-meter) has also been very involved with camera coverage. If any of you watched the British Open, one of our aerostats provided the elevated camera shots. We had one at the Australian Olympics that did the white-water rafting. Elevated platforms can stay on station for up to 30 days without having to come down. It is fairly easy to come down, make any repairs you want, put a little more helium in it and send it back up. It does not have the mobility of an airship though.

Session 2: RESUPPLY AND RESOURCE DEVELOPMENT IN THE ARCTIC

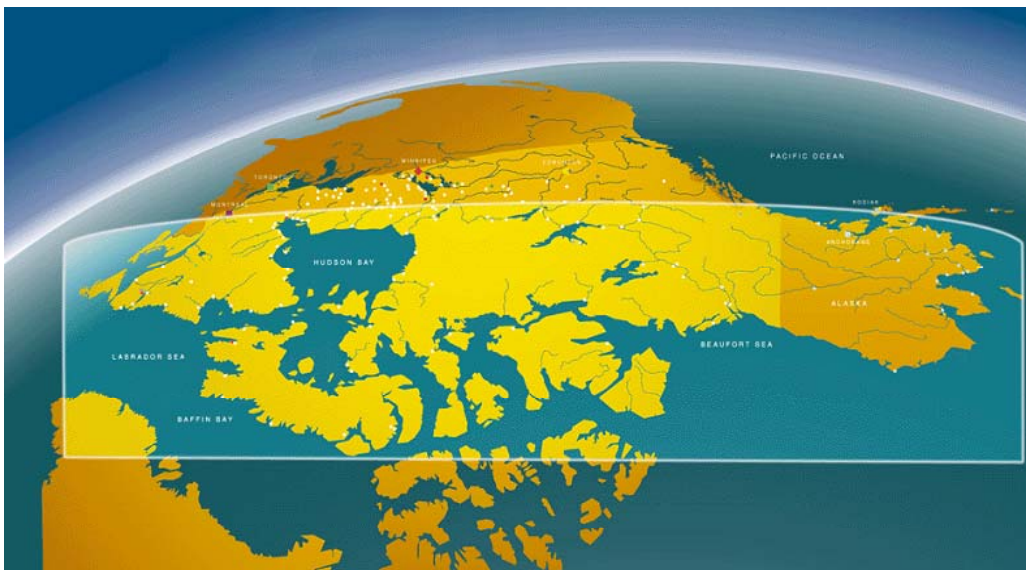
Andrew Horoski (Moderator)
Deputy Minister
Manitoba Transportation & Government Services

Paul Smith
Vice President, Information Services
(Former Vice President, Logistics & Supply Chain Services)
The North West Company

The North West Company is the dominant retailer of food and everyday products and services to remote communities in northern Canada and Alaska. We like to view the world from the Pole down because this is our world looking from the north down into the rest of North America.

The area that is hi-lighted in Figure 1 is our area of operations. We are a 750 million dollar company. We have mid-sized market cap, 176 stores across the north and that includes the Alaska Commercial Company where we have 28 stores and we 4700 employees company-wide all the way from Cartwright, Newfoundland to Dutch Harbour on the Aleutians. We are the largest private sector employer of aboriginals in the country, second only to the Government of Canada.

Figure 1: Map of the North



Our core business is in the north. We have many long-term people, both corporate and in the stores. We have no major competitor across the country. We have pockets of concentrated competition from Arctic Coop on Baffin Island and across the northern shore in the west, and FCQ, the Federation Coop, in Quebec. The bricks and mortar count for a lot. Our customers are very much necessity impulse type buyers. When they have cash, they want to be able to buy the resupply right then. We also have a fair amount of outshopping through catalog and Internet.

Part of the infrastructure is warehouses and housing that we provide to many of our employees. We have 136 Northern stores (a core group of stores) and six Northmart stores in places like Inuvik and Iqaluit that are more hub locations. The Quick Stops are convenience stores. We supply everything from snowmobiles to bridal dresses to soup to

nuts to everything. We are the store in town so we are very SKU intensive. It is a very broad selection but not very deep because our communities range dramatically in size.

We also have key services. We provide credit – we are the bank in town in most cases. We have 39 retail franchises with Canada Post. Our Selections catalog is an augment to the store where we provide an enriched assortment, and H & R Block Tax Services is a new offer that we brought to the table this year. When people walk into our stores in Barrow, Alaska or Inuvik or in Iqaluit it is just like walking into a supermarket down south.

Our goal like any other retailer and any other company is to be lean and agile. So, we want to carry as little inventory as possible in the stores. We need the agility and the flexibility to be able to resupply quickly and that is a key component of how we have repositioned our supply chain. If we stay too thin in the store, and there are blizzards or mechanical problems and aircraft cannot get in, we are into real problems. So I will explain how we get around that a little later.

We have 3PL (3rd party logistics) people in Montreal and Winnipeg who handle and move product for us that traditionally we had in house. We have around 80 transportation partners to manage the network across the country. Many have been with us for years like Gardewine North, which is our primary highway transportation carrier; Northwest Transport, who is our primary carrier, out of Edmonton to Yellowknife and to Inuvik; Calm Air, which is an airline based out of Thompson that serves the Kivalliq region; and many aboriginal partners. If you are looking for business opportunities in the north, I really recommend that you consider the people who own the land. Partnering with aboriginals and aboriginal communities and development corporations, I believe is a key part of our success in the north. So, for carriers we have partnered with Wasaya Airlines, First Air and Air Inuit and NTCL. The Arctic Bay store is pretty representative of the size of communities that we have. Arctic Bay is right at the top of Baffin Island, which is the island beside Greenland. To get product here, we have an alliance partner in Rouyn, Quebec who supplies dry groceries and produce. That product is consolidated

and then shipped over to Val-d'Or, which is about an hour away by truck. It goes on to a 55,000-pound freighter with other freight that is going to Iqaluit. Then it is trans-shipped onto another jet that belongs to mines in Nanisivik. It is trucked from Nanisivik airport about ten miles to the stores. So very long distances are involved and a lot of different people handle it.

Our key modes of transportation are truck and rail. They represent 32 percent of the dollars and 61 percent of the pounds. We have sealift and barge operations that are nine percent dollars and pounds. Canada Post represents ten percent dollars and pounds. Forty nine percent of our \$50 million transportation budget is for air to get 20 percent of the product there. What costs down south to our closest stores five to six cents a pound, just to fly the product from Val-d'Or, Montreal or Ottawa to a place like Pond Inlet which is right next door to Arctic Bay, is \$3.50 a pound.

We have an extensive winter road network in northern Manitoba and northern Ontario and through into the Mackenzie Delta. In Manitoba and Ontario we take in a year's supply of staple goods like flour, sugar, and carnation milk. In the Mackenzie Delta we take in a half-year supply because we are re-supplied by barge in the summer. It is also very capital-intensive business and presents real challenges as we work our capital down. Combined winter road, sealift barge freight is about 20 million pounds annually. We would love to find a way to get that product flowing differently, but as at \$3.50 down to \$2.00 a pound it does not make sense to fly carnation milk and flour.

An aboriginal group from Nunavik in northern Quebec owns First Air and Air Inuit. Out of Iqaluit we go from a 55,000-pound air freighter into a Twin Otter with about a 3500-pound payload to get into Blake Harbour. You cannot get into there with any larger plane so it is a real challenge. Air Creebec is owned by the James Bay Cree. We use their services out of Moosenee and Cochrane in Ontario to serve the west side of James Bay, which is at the bottom of Hudson's Bay. Another aboriginal partnership, Wasaya Air, is owned by eight communities in northern Ontario. They fly pure freight Hawkers, roll on, roll off with large doors. NTCL's barge operation is owned by the Inuvialuit

Development Corporation out of Inuvik and Nunasi Corporation. Wherever possible, we do whatever we can to partner with an aboriginal group.

The Hawker 748 is the primary workhorse in the north, especially for cargo, but it is getting to the end of its service life. It hauls 12,000 to 13,000 pounds when it is stripped for a freighter. Dedicated freighters make our operation much easier. Larger communities get jet service. Buffalo Airways is still flying DC3s out of Yellowknife into the communities in the Mackenzie region.

The Canada Post food mail program subsidizes freight into the north and that allows anyone in the north to order freight from the south. Our customers fortunately prefer that we do most of the legwork to get the product to the stores, which is more convenient for them. Without the Canada Post program, it would be almost impossible to sell product like milk up north. It is \$10.99 for four litres of milk in Iqaluit, but it would be a lot more if you started laying in the true cost. This is the type of product that is eligible to be mailed. Basically, without the food mail program, it would make it very difficult for retailers to support any kind of airship service.

Lastly, we have sealift operations that we run out of Montreal. We have two ships, the Ivik and the Inuvuk. Ivik means walrus in Iktatuk and Inuvuk means ship. We are in partnership with Qikiqtaaluk Corporation and Sakku Corporation and Makivik. We take this sealift up the east side and deliver product all the way to the stores. And again, we are taking in a year's supply of everything from couches to snowmobiles. On the ship are all the loaders, all the tugs, all the barges, everything they need to offload onto the beach. There are no port facilities in the north, so you offload to the high water line.

By year-end, we will have reduced our inventory, which was \$108 million last year, by \$10 million in this current year. We cannot really touch our foods because it is locked in for a year. We are constantly looking for more and better innovate ways to move product and I am really looking forward to learn more about the airship program. Frankly, right

now I am just a little skeptical about the timing and ability to deliver perishable product but I am very willing to learn more.

Brad Thiele
Vice President Meadowlake Project Development
Cumberland Resources Ltd.

Thanks for inviting me Barry. We had lots of interesting discussion over the telephone and this is what has come of it. I hope that we are able to get together with some providers of airship freight transport and see where we are going to go with this concept. I am here representing Cumberland Resources. Cumberland is an exploration company, a handful of geologists that go out and look for metals to exploit. We were fortunate enough to find a gold deposit that we think is going to be a mine very soon and I am working on developing it right now. Cumberland is a Vancouver based TSE listed company with 36 million shares trading at a little over \$2.00. We have \$13 million in the bank; it is other peoples' money. We are spending it quickly. We spent \$6 ½ million already this year drilling mostly and then dealing with the core. We are located in Nunavut, north of Baker Lake in Chesterfield Inlet. The Meadowbank Project is the primary asset of Cumberland. We also have interests in the Meliadine but we are not the operator.

Cumberland is going through a bit of an evolution where like I say a group of geologists found a good deposit and now they got bigger problems. I am one of the two people involved with the company that has done any mining as such. We are located at the 65th parallel, about the same as the Lupin Mine. We are in the eastern Arctic though. Ekati, Diavik, and Lupin mine projects are all in the western Arctic. We have many things in common with them. I am certainly looking closely at what the diamond mines have gone through, and what Lupin has gone through because we also have seasonal shipping and ice road access. Pretty much all the bulk freight to the site will come in over 90-kilometer ice road. To get it to Baker Lake, to the bottom of the ice road, we would ocean freight it in through Churchill or eastern points, Montreal, Halifax. We are looking at all options.

One of the first things we have to do is build some fuel farms. What really brought me to this conference is to find out if there was an outfit called Cargolifter that was going to lift 160 metric tonnes and carry it any distance you like and just set it wherever you wanted it. We heard that and that was our dream. We were going to build the tanks in Edmonton or Winnipeg and haul them up to the site and set them down, plumb them in and be in business. However, I have heard nothing but bad news since then about Cargolifter. In any case, we are still looking. By the way, if anyone has the answer take note of the color of my tie, find me and tell me what you can do.

We have a logistics problem with transport of all of our goods. Our annual resupply requirement is about 35,000 tonnes. I gather the demand of the Ekati mine is probably four times larger, Diavik is probably double our size, Lupin is about the same, Hopux is hoping to come on and they are probably close to us. If you multiply that all out, add it all up, it is about 300,000 metric tonnes of resupply annually all over ice road, and other means to get it to the ice road, such as barges, rail, and truck. All kinds of opportunities exist to lose it, break it, have it spoil, whatever. There is a lot of capacity for airships that can carry big loads. Right now all of that freight is purchased a year ahead, stored some place, shipped in, hauled up the road, and stored somewhere again until you use it. You have to put all the money up front, well ahead of time. It seems to me the airship opportunity is a really good one.

We are centrally located. The ocean freight access would be salt water to the mouth of Chesterfield Inlet. The Inlet has a restriction limiting the size of barge that can make it into the freshwater of Baker Lake. For a perspective on scale, Baker Lake to Hudson Bay is 300 plus kilometers. The freshwater lake is about 80 kilometers long. The narrows a third of the way from Baker Lake allow a maximum high tide draft of about 4.6 meters. There are transportation companies that feel they can get in there with 10,000 tonne barges. Our current plan is hauling everything in with 10,000 tonne barges. We would store it in Baker Lake, and then haul it in over a 92-kilometer ice road. The ice road will have 25 portages. There is about \$3 ½ million of prep work smoothing the portages and removing big boulders, so that later on it is easier to make a transport corridor that can

handle the kind of truck haulers that we have to employ. It is estimated that it would take about a million dollars a year to set up the road each year.

On the company itself, we are touting three million ounces (gold) resource. Actually that does not include this year's program so we think it is about 3½ million ounces. We will have those numbers out by the end of the year. The Meliadine property gives us another million and a little bit so that is roughly the size of Cumberland. For those who are familiar with mining, a study done in the year 2000 on information at that date gave us a million ounces of proven probable which means it has had a mine plan applied to it and has passed economic tests to show it being a viable mineable resource. We are 100 percent owned and operated so we control our own destiny at this point. The actual property is a very promising camp and we have barely tapped the surface on it.

We are mostly open pit, which the bankers like because it is relatively low risk compared to underground. To date our cost per ounce to develop this project is very low, which is a plus. It bodes well for developing it, too. Typically if it is that easy to find and put in a plan, it is probably relatively easy to mine.

Once our mine is built, we think it will be there a long time. There is a lot of unfound gold but many of signs that it is there. There are reserves in our current assessment with a model that is getting larger every day. The mine plan at the bottom production is forecast at 2.2 million ounces over a ten-year period. In summary there is a 20 percent return and payback in 3 ½ odd years.

The winter road has 25 portages, mostly water obviously, that is what you like to run on. It does leave a footprint. It is not as nice as the airship concept. We do have to modify the portages, so you can tell we have been there. We use a local expeditor in Baker Lake, a local Inuit entrepreneur who owns those trucks and has done a very nice job for us so far. This is how our freight goes in at the moment.

We did bring in some equipment in a Hercules aircraft through Yellowknife at great expense, but it got there. It cost us about \$2200 per tonne. We do not want to do that

again. We used a DC-3 for lumber for the building on an ice strip. Of course we have unlimited runway length on our ice strip. Three helicopters were used to haul mostly tents and drills. Our schedule shows production start-up in 2007. I have a number of tables that are in a report that is available at the back if there are any copies left. If not, you can get a hold of me, and I will give you one. It has all sorts of detail on the freight shapes, weights, and we are looking for someone to tell us how cheapest to haul that in there.

Clifford Abraham
President
Northern Transportation Company Ltd.

Good morning ladies and gentlemen. It's a pleasure to be here with you today, not least because, like you, I want to learn more about this intriguing concept of applying airship technology to the transportation needs of what is surely one of the most challenging and forbidding regions of our planet.

I have been asked to comment on resupply issues facing Northern communities and Northern industry. I am going to do so from a transportation company perspective. For the benefit of those who are not familiar with the Northern Transportation Company, I wouldd like to begin with a short overview of our major business activities.

NTCL's roots go back to 1931 when its forbearer began a common carrier tug and barge service between what is now Fort McMurray, Alberta and Aklavik, some 1300 miles to the north down the Mackenzie River. From early days, the Company found a major part of its business in serving the Northern mining industry. We became a subsidiary of Eldorado Gold Mines in 1936, serving the Port Radium mine on Great Bear Lake as well as various other mining developments and communities in the Canadian Western Arctic. As you can appreciate, the challenges of operating in the North were many (as they remain today), particularly as larger equipment was introduced into the system. We look back today with no little degree of admiration at the ingenuity and determination with which these pioneers gradually built up a transportation network in the North.

Because of the involvement of our then-parent company, Eldorado Mining, in mining the uranium that went into the Manhattan Project, Eldorado and NTCL were nationalized during World War II.

Things got interesting with construction of the Canol oil pipeline from Norman Wells to Whitehorse, probably the North's first megaproject. Over an incredible 12 month period, a road was built, 2650 kilometres of four and six inch pipe were laid, pumping stations were installed and oil began to flow by April of 1944, all at a cost of some \$300 million.

Equipment, supplies and personnel were sent to Edmonton beginning in May of 1942, and then onwards to the end of the rail line at Fort McMurray (or Waterways, as it was then known). From there, another 1,100 miles of rivers, lakes, rapids and portages had to be negotiated. Many of the US Army Corps of Engineers personnel that laboured on the project came from Louisiana and one can only imagine what a shock it must have been for these men to labour through a Northern winter.

During the remainder of the 1940s and into the 1950s, the highway and rail networks gradually extended northwards to Hay River and Yellowknife on Great Slave Lake, but the Company's business continued to grow with establishment of the DEW Line stations on the Arctic coast, increased mining activity and the advent of major oil and gas related activity. The heavy activity in the Western Arctic oil and Gas sector in the early 1970s led to a major expansion of our operations with new vessels and supporting facilities, including a ship docking and repair facility at Hay River.

Today, our fleet consists of 13 large tugs, 70 barges and two ice classed offshore support vessels operating from Alaska to the East Coast. In addition, we charter tonnage on international markets to supplement our owned fleet and service Northern resupply contracts with Governments, individuals, and large and small businesses. We operate freight terminals in Hay River, Inuvik, Churchill and Tuktoyaktuk totalling 336 acres, marshalling and packaging facilities in Montreal and a logistics division that serves

customers' needs for specialized transportation services throughout North America and around the world.

The final point I want to make about our Company – and perhaps the most significant one – is that since 1985 when the Federal Government privatized NTCL, we have been entirely owned by the people of the North. The Inuvialuit of the Western Arctic and the Inuit of Nunavut saw NTCL as a critical lifeline to their communities and a core investment in their future prosperity, and purchased the Company from the Federal Government (who had owned it since the War) in a leveraged buyout. The scope of our activities has broadened over the years. Our corporate group, Norterra, now includes an airline (Canadian North) so that our operations cover land, sea and air; however, a core commitment of NTCL remains that to serving the transport and resupply needs of its ownership.

Scope of Northern Resupply Challenge

I would like to move on, now, and talk to you a little bit about the scope of the Northern community and industrial resupply challenge.

In Nunavut and the NWT:

- we are looking at an area of over 1.3 million square miles or nearly 3.4 million square kilometres
- there are about 40 communities that we service regularly or from time to time, almost all of which lack 'conventional' land access
- they represent a population of about 70,000 people (or a little under 40,000 if you exclude Yellowknife and some smaller communities in the NWT that have year-round or near year-round road access)
- communities that do not have road access have water access, but mines and oil and gas sites are not always so conveniently located
- nonetheless, they all need fuel for heating and power generation, groceries, cars, construction equipment and materials, mining gear, drill rigs, television sets, furniture, etc., moved into and sometimes out of the region

- average winter temperatures are around -27° Celsius, but of course this statistic hides within it some unimaginably harsh extremes, as the personnel recruiters for the Canol pipeline project.

As in much of the rest of Canada, the principal economic links follow a North-South pattern – Edmonton through Hay River to the Mackenzie and Western Arctic, Winnipeg through Churchill to the Kivalliq region of Nunavut, and Ottawa/Montreal to the Baffin region of Nunavut. But no matter the point of origin, the seasonal transportation windows tend to be similar and this, together with the geography and related environmental considerations (of the non-climate type), constitute the principal challenges to accessing northern communities and resources.

Seasonal Considerations

Seasonal windows are perhaps the biggest factor to consider when we look at current transportation patterns in the North. From a marine point of view, we have a window of anywhere from four months, beginning about mid-June, for deliveries in the Mackenzie, to about six weeks in the Beaufort Sea, Coronation and Queen Maud Gulfs. Service in Hudson Bay typically begins in the first week of July with an operating window of 95-100 days, although this can vary by a couple of weeks at the beginning depending on ice conditions. The first summer resupply vessel calls in Iqaluit around the end of June or beginning of July, and the last is about mid-October. Some communities are only accessible by icebreaker or ice strengthened vessels.

Because the weather window is short, it is often the case that, in order to ensure all goods are delivered, vessels and barges have to winter in the north, and are therefore unable to trade and generate revenue for three quarters of the year. This is particularly the case in the Mackenzie River system.

In order to make optimum use of a limited time window, shippers must ensure that their cargo is delivered to staging areas well ahead of time, meaning that goods and equipment are tied up in transit for greater periods than might otherwise be the case. This is true

whether you are a mining interest, an exploration rig operator or a private citizen. Early planning and preparation is critical, but not always possible. So it is the case, for example, that we often see construction and infrastructure projects delayed for an entire year because the seasonal window has been lost.

Both shipper and carrier therefore see less turnover from their assets and inventories than might be the case where continuous, year round transportation is available. As a Company, we have a considerable investment in assets and facilities that are idle for much of the year, requiring us to recover our investment in a brief window with heavy consequences for our rate structure.

I should point out that this is not the case in all circumstances. Seagoing vessels do run in and out of some communities – particularly in Eastern Nunavut – and there is much speculation that global warming will eventually lead to the opening of a reliable route through the Northwest Passage that could be used for resupply purposes. But, seagoing vessels capable of efficient trading outside the North are not always well-suited for community resupply uses: their size can make it awkward to access some communities where approaches are draft restricted, and it can be uneconomic for them to provide service with any kind of frequency to smaller communities with smaller volumes to ship. Where a specialized vessel or marine equipment is necessary, (e.g. shallow draft, ice strengthened, combination dry and liquid bulk carrier) the additional cost of procuring and operating such equipment is a further burden on the system.

At the risk of stating the obvious, all of this results in a shipping pattern that sees non-perishables, consumer durables, heavy equipment, construction materials, drilling rigs and the like tending to move at certain times of year depending on the type of site access available – water, winter road, or in some cases a combination of the two. When combined with the marine mode, a winter road program requires that suitable interim storage space be available until a winter road can be built – probably in January – so the goods that were procured and shipped from the south as long ago as the late spring or early summer must wait up to six months before being put into use. (And you had better

hope that your supplier got the order right, because there is either a long wait or high cost to correct a mistake!)

Perishables, on the other hand, have to move by air where there is no year round or seasonal road access to the point of origin, resulting in some truly staggering grocery bills for those living in the more remote communities.

Geography/Environment

In recent years, as the people of the North have gained an increased say over the uses to which their land is put, we have seen a concurrent increase in the levels of caution exercised in planning any development or infrastructure project.

For instance, whether you are looking at building a bridge over a river to provide more direct, year round access to a community or region (the present proposal to build a bridge over the Mackenzie River at Fort Providence comes to mind) or to upgrade a wharf to permit safer or larger vessel access, the impact on the local fish population has to be considered.

The abundance of lakes and rivers combined with the spongy nature of the tundra make all season road access to more remote mining and exploration sites quite a costly proposition. Winter roads are an alternative – and here the lakes and roads can be your friend – but there have been concerns expressed recently that their season is being shortened by global warming trends. I am interested in how project planners are managing this long-term risk.

In either case, even if the straight engineering considerations can be overcome at acceptable cost, it is necessary, again, to analyze and minimize the potential impact on the indigenous wildlife, and what that might mean to locals whose way of life and livelihood depends on that wildlife. I have not spent as much time on these issues as the ones related to seasonal logistics because it is not really my field, but I do want to stress that they loom every bit as large in their influence on the northern transportation system.

Concluding Comments

What conclusions can we draw from this brief overview?

Transport and resupply in the North is a daunting challenge, but one that is, if not mastered, at least coped with year after year. As the population grows and the economy develops, we will see gradual upgrades in the infrastructure in the future, just as we have in the past. For the time being at least, and well into the foreseeable future, the pace of development is in part held back by the tremendous transportation challenges presented by the climate and by the need to protect the delicate environment.

I must admit that I never expected to even find myself at a symposium on the topic of airships, much less standing up in front of you being asked to offer some observations on how they might function in the North. Pretty much everything I know about them, I learned from the company websites and the presentations earlier this morning, but it is important to our company and our shareholders that we continue to seek better ways of overcoming the transportation challenges I have been speaking about. Can airships fill the gap between conventional air transport on the one hand, and the truck marine modes as they presently operate in the North, on the other? By expanding the seasonal transportation window, can they hasten economic development in the North? I do not think that there is any question that their environmental footprint would be considerably less than any other overland transport system, and that alone is a major point in their favour.

I look forward to hearing these and other points addressed as the Symposium continues, and thank you for your time this morning.

Questions

Q: For Mr. Smith, I wanted to know how much of your transportation is going from the south to the north, how much back haul do you have? How much call do you have for material coming the other way other than just the mail? And also, how much material goes from point to point, one community to another community?

A: (Paul Smith) This is definitely one of the challenges that we face. We did an ABC study with Gardewine North last year and even on the road coming back from approximately 35 points, the back haul was ten percent and that includes going to Thompson. There is a back haul coming out of Thompson to Sudbury for Inco. The planes are flying up full and pretty well coming back empty. Back haul is pretty non-existent given a fixed wing operation. Mines and the like store everything up and they bring it out in the summer on ships. I am sure they would love to free up that capital and get that product flowing back if the airships were a possibility.

Q: How about point-to-point from one community to another?

A: (Paul Smith) Point to point, we do utilize the network of the aircraft. Very little though because once it is in the community, we want it sold in the community. We do not want to add any more freight to it. If we have already spent \$500 getting a skidoo up somewhere, it stays there. We sell it in situ. There is some, but I would not call it any major impact.

Q: I have a question for Mr. Thiele on his 92 kilometers of winter road. Are there dimensional restraints on that road?

A: (Brad Thiele) It is pretty near flat. It is 70% on water. We envision a winter road similar to the Lupin road where we have probably got 40 tonne payloads on trucks, multi-wheel trucks, multi-axle. We do not haul a lot until you have got seven or eight feet of ice.

Q: I have a question for Mr. Smith. You said that for some of the communities that you serve, there is enormous difference in the cost per pound for the freight. Do you even your prices? Is it a sort of a cross subsidy process or do you let each community carry it's own load as far as price is concerned?

A: (Paul Smith) There are two different rates for food mail. In theory, a head of lettuce in one Nunavik community or one Nunavut community should be the same price in every store because the freight is the same and we are buying it from the same supply. So we do manage our pricing centrally for that perishable product and we would set the price at \$2.19 or whatever it was. However, for the balance of shelf stable product, like flour and sugar, to keep the concept of activity based costing true, we do offset the pricing in each community by the freight rate into that community. So we charge the freight as pure and the community would bear the prices. We are moving to a zone pricing concept where we will gather like communities together. So it is a bit of yes and no.

Q: I wonder if I could ask of Mr. Abraham the same sort of question about the back haul? Is it the same generally for you about ten percent? Do ordinary containers cover their return cost, or do you let containers stay there and get used for building purposes?

A: (Clifford Abraham) We like to keep close track of all our containers and if you keep them, you keep paying us for their use, so it is really up to the customer. But very much the same holds for us. There is very little in terms of back haul. Once goods and materials get up to the communities, they tend to stay there. The back haul that we do see tends to relate for the most part to either environmental clean up, or particularly in the western Arctic moving oil exploration rigs southbound that we previously took north. But there is very little back haul from a commercial point of view. I would say probably in the same order of about ten percent if that of our, of the head haul volumes would be the back haul amount.

Q: My question is for Mr. Thiele. In a mining project, do you have any guess what transportation would represent as a percentage of capital cost on the initial construction and then the same question for operating cost?

A: (Brad Thiele) The capital cost of the Meadowbank project is currently at 200 million dollars of which transportation is five percent.

Q: Mr. Thiele, you had talked about several hundred thousand tonne of freight using the examples of your developing Lupin, Diavik, and Ekati. Is this a long time frame to this freight? Is the potential there for that type of movements over a long number of years? And if airship technology were available, is the distribution over the years such that there would be a regular movement of that volume to the north?

A: (Brad Thiele) It is certainly project related. We are working on a ten-year mine life that I suspect will be at least 20. Ian can comment later on BHP, but these are major non-renewable resource products. Gold is where you find it, the diamond is where you find it, once you take them out, you have to go find some more. We see this as a growing business. Of course having found some, there are a lot of people looking for some more. I would not like to think it is some kind of a sunset thing over a 20-year window. It is the beginning of a viable, big push of mining business in the north. We have the means of getting up there. We have the technologies developing every day on how to mine in permafrost, etc. And I think mining in the arctic will increase, and better transportation merits a serious look.

Going back to the reference number that I made up this morning, 300,000 tonnes of resupply exists right now. The point was made if an airship was viable it has to fly steady. You need a fleet of them to fly steady to satisfy that particular demand and that does not include other than the four or five projects that I took into account. When you think of the benefits of no footprint, being able to haul year round, it is so much better than the barge or ice road limitations that I think airships are a shoe-in. It is a big business opportunity.

You are telling me technically the ships are viable. I guess it needs money. Somebody has got to bite the bullet, build them and offer them for service. What I am looking for is that particular guy. If he is not here, we will have to wait and do it the old way until he comes along. But it looks to me like it is a big opportunity and the business is there today. Ekati is running and hauling it on ice roads, as are Diavik and Lupin and we will

be there in a year or two. The business is there; it is not a dream or something. It is going on right now.

Q: So far we are talking in really vague terms. Suppose an airship was available right now that could carry 20 tonnes. How much would you be willing to pay for it? Or maybe, what cost per pound are you willing to pay for that shipping?

A: (Brad Thiele) As little as possible. (Laughs)

Q: There have to be some numbers put to this because the people who build airships need to be able to do it for a realistic amount of money. Maybe they can do it but they cannot do it for an amount of money you are willing to pay.

A: (Brad Thiele) Ice road freight for us is \$100 a tonne. Ocean freight you add on maybe \$200, so there is \$300. I have not stored it, and have not built the laydown yet. So if you were to use \$250 to \$300 a tonne, I think we would be talking to you right now, real serious.

Q: And Mr. Smith?

A: (Paul Smith) When we get into partnerships, we pretty well open the book. We get a full understanding of each other's business and we work to have our partners make a profit. Otherwise there is no point in getting into a long-term alliance with them. Understanding your capitalization, the business model, your cost of infrastructure such as it is in the north; that is what it comes down to. It has to be competitive with fixed wing, both in terms of cost and speed. So that relationship you can weigh one-way or the other. To get carnation milk up, it does not matter. It can take 24 hours. To get perishables up, we want it to go a heck of a lot faster than that. So those are the different constraints. I cannot give you a price, but it is somewhere less than \$3.50 a pound.

Q: Are there currently non-government, military, commercial operations?

A: (Paul Smith) No, and this is the chicken and the egg issue that Mr. Thiele has brought forward. He seems to be a very willing customer, but there does not seem to be a supplier. So certainly from a resource developer who is looking to move a tonnage, he is looking for that next step.

**The Honourable David Collenette (Luncheon Keynote Speaker)
Minister of Transport
Government of Canada**

I am very pleased to be back in Winnipeg — and especially as the guest of the University of Manitoba's Transport Institute. I want to congratulate the University for making transportation such a high priority in the curriculum.

One of the reasons I wanted to join you today was to express my personal thanks to Barry Prentice. In the five years that I have served as Transport Minister, my department has sought his advice, and he has given generously of his time and expertise on a wide range of transportation issues. He has brought his knowledge to bear on several of our policy panels, including the Millennium Conference and most recently as a member of the Selection Committee for Transport Canada's Urban Transportation Showcase Program. One of the major themes of my tenure as Minister has been that the transportation industry is a knowledge-based industry. And with experts like Dr. Prentice on hand, Canada is very well equipped to address 21st century transportation issues.

I want to talk to you about innovation and transportation. Usually, when I talk on this theme, the subject is innovation in existing modes — for example, applying computers, communications, and control technology, and management strategies, to improve the transportation system. Over the years, millions of dollars have been invested on research and development and in the initial deployment of Intelligent Transportation Systems.

But this symposium is about innovation of a different order entirely. You are here to explore the possibility of introducing a whole new mode to the transportation mix — especially for northern Canada.

Last February, the Government of Canada launched an Innovation Strategy. It set in motion a consultation process. As part of this process, Transport Canada convened a Roundtable last month to discuss innovation issues.

One of the themes that emerged at that Roundtable was the need for Transport Canada to play a stronger role to champion innovation in this sector. We need to explore new ideas that will improve the efficiency, cost effectiveness and sustainability of Canada's transportation sector.

I welcomed the advice received at the Roundtable. Clearly the participants felt there were areas where the department needed to be more effective, and we will certainly respond.

But on a broader scale, I was struck by how the issues that arose in the Innovation Strategy consultations dovetail with many of the issues we were already examining as a result of our efforts to create a transportation blueprint for the next decade and beyond.

We began that process in the spring of 2000 and, since then, we have made significant progress in identifying the challenges and in bringing together the ideas to form the blueprint. Our efforts were delayed by the events of September 11, 2001, but I will be releasing the completed blueprint document very soon.

The main goal of the blueprint process is to propose a vision for transportation in Canada and provide strategic directions. It will establish the framework for future initiatives and policy development.

Our overall objective remains nothing less than building the best transportation system for Canada and Canadians. A system that supports our economy and our trade. That stimulates competition and productivity. That puts Canada at the forefront of technological innovation.

We are building our blueprint around a number of important themes — themes that I would ask you to keep in mind in your deliberations today and tomorrow.

The transportation system must be safe and secure — in a way that protects life and property.

The transportation system must be efficient, meeting demands in delivering goods and people rapidly, affordably, and predictably.

The transportation system must be integrated, providing effective and efficient mobility of goods and services across all transportation modes and jurisdictions.

It should be affordable and transparent — where individuals and industry should be able to purchase transportation services and track progress easily.

It should be accessible — the transportation sector should provide access for all Canadians and to all parts of the country, including remote and hard-to-reach regions. That's certainly a relevant issue at this symposium.

And finally, the transportation system should address environmental concerns, including urban air pollution and greenhouse gas emissions.

Let me dwell a little longer on this last issue. The Government of Canada places a high priority on the quest for more sustainable ways to move both people and freight in Canada.

Greenhouse gas emissions are a special concern. Canada is one of the largest per capita producers of greenhouse gas emissions. This is not surprising. We have a cold climate. We have mining and manufacturing industries that are big users of energy. And we are also a land of long distances — we burn fossil fuels to move people and freight across the country and to international destinations.

So, although the transportation sector is not the only one contributing heavily to the production of greenhouse gases, it is the single largest producer in Canada — accounting for 25 per cent of all greenhouse gases. We need to find innovative transportation solutions to meet Canada's Kyoto targets. If current trends continue, these emissions will exceed 1990 levels by 32 per cent in 2010 and 53 per cent in 2020.

No doubt your discussions at this symposium will highlight some of the green benefits of airship technology as a mode that may pollute less than other modes. But pollution issues are not the only challenges we face in creating sustainable transportation.

I know that you will also look at such issues as infrastructure requirements, and impact on the landscape. Some of you might champion this mode of transportation because you see it as more environmentally benign in many respects.

But I hope you will continue to ask one another the tough questions that still persist. What are the environmental implications, for example, in obtaining ballast for the backhaul trip, once an airship has delivered its freight to a northern community? What are the options? Are they environmentally sustainable?

A symposium like this must combine progressive thinking with the penetrating questions that policy makers must ask in the public interest. So I am not here just to tell you that we want innovative ideas. I am also here to urge you to ask yourselves the tough questions.

And where better to ask tough questions than here at the Transport Institute.

In the course of the Innovation Strategy consultations — and indeed throughout the blueprint consultations — a recurring theme was the need for more academic study and university research into transport issues. There are not enough links between Canada's universities and the transport service industries.

We need to increase our research and development capacity. We need to strengthen the partnership among government, industry, and the university community. We need to attract the best and brightest to transportation. We need to inspire them to wrap their minds around the perplexing challenges that transportation offers.

The government has launched several initiatives to make Canada a country of choice in the field of research and development for the knowledge-based economy. Two years ago, the federal Budget announced the creation of the Canada Research Chairs Program, as one part of our nation's celebration of the new millennium. The goal was to establish 2,000 research chairs in Canadian universities by 2005.

But we need more research centred on transportation issues — especially in a nation that relies so heavily on transportation for its quality of life. In our transportation blueprint, we will take a close look at how universities can play a stronger role as engines of innovation in the transportation sector.

Ladies and gentlemen, Transport Canada has been very pleased to provide some financial support to make this symposium possible. This government has a history of promoting unique options for transportation to address the specific needs of remote and northern communities — which dovetails well with your objectives.

Two of the cornerstone transportation policies we have instituted — the National Marine Policy and National Airports Policy — both included special provisions for remote communities that rely on one year-round mode of transportation for travel. We are committed to promoting transportation options for remote communities and symposiums such as this are important for examining new alternatives. We have several departmental representatives here to report back on what will be said about the future of transportation to the Arctic, and the role that airships may play.

But right now, I believe we need more of the wide-ranging, broad-based discussion that this symposium is designed to provide. I am interested in innovative ideas. I am willing to entertain proposals for new solutions.

I wish you all an enjoyable and thought-provoking symposium.

Thank you.

Session 3: NORTHERN MEGA-PROJECT CONSTRUCTION

Jim Thomson (Moderator)
General Manager
Ironlink Transportation Management

I will try to be brief so we can focus on the speakers, who will have some very important things to say about how airships can be used to fulfill their transportation requirements for large industrial projects. However, I too wish to take a moment to compliment Barry for his vision and leadership. I know Barry has had lots of support but it really took Barry's passion and energy to make this conference happen.

Listening to the presentations this morning, what is becoming clear to me is that there are potential customers in attendance looking for a transportation solution. At the same time, there are manufacturers in attendance that are keen to provide this solution. Then listening to Minister Collenette speak, it is clear that we have a government that is interested in supporting the development of an airship industry. So the good news is that we have all the right ingredients coming together to make airships move from a concept stage into a commercial operation.

There is a clear need to solve the chicken and egg argument. We have heard the manufacturers say their airship technology works and that they would love to build an airship, but first they need a customer to agree to buy one so they will have the money to underwrite its construction. At the same time we have heard potential customers say that

they would be interested in using an airship for their transportation, but first they would need to see this technology proven.

What makes this panel particularly poignant to the conference is that these gentlemen will be speaking about mega-type projects where the dollars are fairly significant and the risks can be spread across a larger base. It is these kinds of undertakings that may actually provide the starting point for the industry to get its first commercial airship application.

John W. Markowsky, P.Eng
Manager of Major Projects Planning
Manitoba Hydro

Thank you very much for the invitation to speak to this very challenging and exciting topic. I would like to cover five topics here. First, I will give you a brief sales pitch on Manitoba Hydro, as some of you may not have a lot of awareness about Manitoba Hydro. Then, I would like to get into the types of construction transportation that Manitoba Hydro utilizes, and I have gone beyond just mega-construction into some of the other operational needs that we have in moving materials to our facilities in the north. I will give you some brief information about our planned hydroelectric stations, some of the transportation challenges that we will have on those projects and then I will finish with some thoughts to take away from this conference as Manitoba Hydro being an end user or customer for this type of technology.

Manitoba Hydro is a Crown Corporation operating under the Manitoba Hydro Act. Currently we take in revenues of over \$1 billion in sales of electricity and gas. We export electricity to 35 utilities and markets outside of Manitoba, primarily in the United States, and around 30 percent of our revenue comes from those sales. We are the owners and operators of 12 hydroelectric and two combustion gas turbine units. The vision of Manitoba Hydro is to be recognized as the best utility in North America with respect to safety, rates, reliability, customer satisfaction and environmental management and to be considerate of all people with whom we have contact. We have a very good website,

www.hydro.mb.ca, and I invite you all to visit it and view our Corporate goals as well as additional information about Manitoba Hydro.

We have hydraulic generating stations on the Winnipeg River, Grand Rapids in about the middle of Manitoba, and the Nelson River. The other facilities that Manitoba Hydro owns and operates are converter stations that are related to our DC transmission line. We have control structures to manage our water resource energy supply.

The types of construction and transportation requirements that we have in the north are very wide and varied. In the spring and in the fall during freeze up for a period of months it is not possible to build winter roads. It is very difficult to get materials or equipment into remote locations at that time period. Initially, the northern road transportation systems were served by cat trains. These cat trains would take all the fuel, materials and goods and services required in the north including the sleeping quarters and would go out on the winter road for weeks and months at a time before returning. In some places in northern Canada, these still operate.

Within the last five years Manitoba Hydro has reduced the haulage requirements to northern communities. We were supplying diesel, required as the fuel for diesel generating stations, to about 13 remote communities. The number of communities has decreased to four. We still take in about a million kilograms of material to the sites, most of that being fuel. One of the huge issues about having to take materials in to remote locations is that those materials are delivered quite a bit in advance of actual need for maintenance or construction. That being the case, one is forced to make capital expenditures much earlier in the project. Fuel is the main commodity that we have to haul to northern communities. We use all types of small transport to access our facilities in the north, jet rangers, small airplanes, but of course all of these types of transportation are subject to weather constraints and load restrictions.

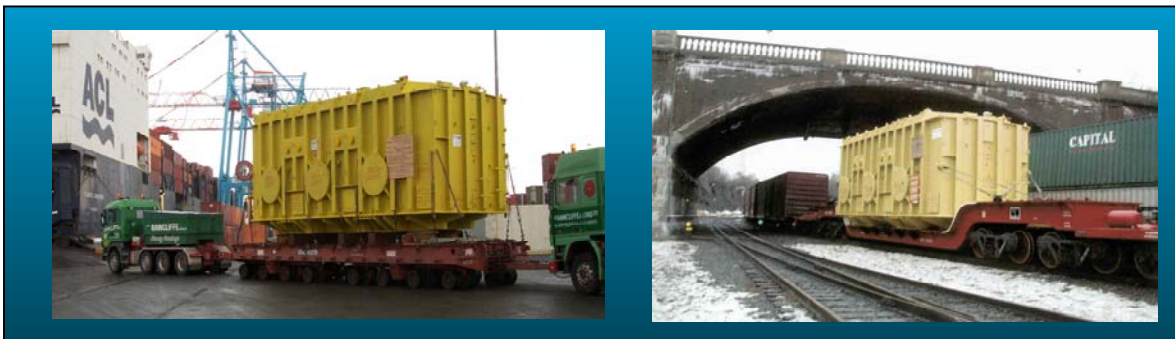
There are some communities where very high flows in the river prohibit an ice road and you have to maintain an open water ferry all year round. Bottom line here is that in most

of these communities we have six weeks to get in materials and supplies for a lot of our major operations. Typically, we plan to have fuel available in that community for about two years in case we miss a winter road season. There are many times when winter roads are not available and we have had to depend on air transport to get the materials and supplies in. We have hauled fuel into sites in planes utilizing flexible bladders. In the summer period, if the communities are so lucky as to have river or lake access, one is able to barge in materials.

Another part of Manitoba Hydro's responsibilities is the operation and maintenance of transmission lines. We have one of the longest DC lines in the world and we have to be prepared to maintain it and to repair it if there are any problems. We have had an event where we had a number of towers taken down. We utilize large cargo-type helicopters on contract that we may call on short notice to help us if these situations occur.

We have a lot of transformers that have come from all around the world. For example, the transformer in Figure 1 came from Alstom's plant in England. It had to be transported by a variety of modes of transportation with some very sophisticated modifications to equipment to get that particular transformer from the manufacturer to our end use. Typically, we have to deal with a lot of the constraints when we are moving on the ground.

Figure 1: Transformer



I want to give you a brief overview of the hydroelectric stations that we are currently planning. Wuskwatim is just to the west of Thompson on the Burntwood River and the

Gull is located upstream of Stevens Lake on the Nelson River. The access that we have to these plants is air and rail either to Thompson or Gillam, and then road into the sites. Wuskwatum is a 200-megawatt plant. It is approximately a \$1 billion project overall. Current target start is around the end of 2003/beginning of 2004 with an in-service date of 2009. The Gull generating station located on the Burntwood River is about a 600-megawatt plant, \$3 billion with a current target in-service date of around 2012. Typically the main heavy components come in about the middle of the project and the bulk of the weight of these particular items is really three categories: fuel, cement and reinforcing steel. The total combined of those construction materials is in excess of 50 percent of the total weight of materials that would have to go up to a generating station. The rest of the materials are general construction materials, food supplies for catering camp, transformers, turbines and generators and mechanical pieces, but the bulk of the weight is in these three products.

The transportation challenges that we face when we are developing hydroelectric plants are capacity, flexibility, reliability and the operating costs. At the end of the day, any generating station has to make good business sense. So anyway that we can reduce costs helps us. The same philosophy applies to any of the operating situations that Manitoba Hydro has. We have a lot of natural challenges in the development and work in the north. We certainly have to deal with, all of the normal wind, temperature and visibility issues, but we also have ice storms and we do not always have it cold and dry. We have wet snow as well. When you are involved in either a maintenance reliability issue or in a construction phase, you need to be assured that you are going to get the materials and equipment to site when you need them.

We have regulatory and environmental challenges that are a real part of any major, large engineering project in the world. We have to go through very extreme scrutiny to get licenses and permits, and we have to deal with all range of issues whether they be biophysical, aquatic, or pollution. Certainly emergency response plans are very critical to deal with when you are delivering goods and services to the north. So if you were to haul fuel or contaminants or something over, this would certainly be an issue that would have

to be considered. We would have to have assurance these incidents could be addressed if airships were to be utilized.

The other huge challenge is the socioeconomic portion of all of these plants. We are looking at partnerships with First Nations communities in the north. Critical issues to deal with include jobs and training, partnerships for long-term sustainability, and long-term benefit from these projects. So any type of transportation system or any type of impact on any of these aspects would certainly be issues that we would have to consider. At the end, we see ourselves as a potential customer to this type of service. The bottom line is that we need to be able to build hydro plants cost effectively, on time, on schedule, within budget. As developers and marketers of this type of technology, you should consider some of these issues when you are looking at us as an end user and a customer.

Ian M. Goodwin
Mine Manager, Ekati Diamond Mine
BHP Billiton Diamonds Inc.

Airships have been a fascination of mine for the past two or three years since moving to Canada and seeing the logistics issues that we had in trying to get our equipment up to the site. The presentation actually takes the form of explaining the operation, the winter road, air transportation, the challenges, the opportunities, and who knows, maybe the answer.

The Ekati Diamond Mine is owned 80 percent by BHP Billiton Diamonds that is a subsidiary of BHP Billiton Corp. headquartered in Australia. The other two partners are Chuck Fipke and Stewart Blusson. They were the two geologists that found the Kimberite Pipes in the Northwest Territories. They own ten percent each. Canada's first diamond mine opened four years ago in production and this year we also went underground with one of our pipes. We produce four percent of the world's diamonds by weight and six percent by value.

We are located in the Northwest Territories in an area known as the Barren Lands situated some 300 kilometers by air northeast of Yellowknife and about 200 kilometers

south of the Arctic Circle. The actual distance during winter when we drive is 475 kilometers to our operation and it is 1975 kilometers direct from Edmonton to the mine.

The winter road runs from Tibbitt Lake to Contwoyto where the Lupin mine is located. The first part from Yellowknife is 75 kilometers of constructed road. The total length of the winter road from Tibbett Lake to Contwoyto is 567 kilometers. Eighty-six percent of that road goes over lakes, the balance being on portages, the portages being made within the license restrictions of our operation. Normally it is open for 78 days of the year. This is the average over the past 15 years and that includes the white outs that we have taken out so it is 78 actual operating days. Normally it is open from the middle of February until early April, but again it is weather dependent for obvious reasons.

Last year we moved 8,100 trucks up the ice road. A total of 250,000 tonnes were moved with fuel being the biggest component of the tonnage and trucks on that road, probably somewhere in the region of 60 to 70 percent. The winter road is managed by three companies: BHP Billiton, Diavik Diamond Mines and Echo Bay. We each have an operating mine or soon will have an operating mine. Diavik is going into production very soon. On top of that we have two others. The Snap Lake mine is owned by DeBeers is in the early stages of being permitted.

The road is operated under what we call a license of occupation and land use permits. They are issued by the Department of Indian and Northern Development. The winter road services three mines, plus exploration. There is a lot of exploration activity taking place in the area. It also services some lodges for hunters and trappers on a smaller scale, and some tourists come up the road to have a look see.

We have a contractor who is employed by a joint venture management committee. The contractor opens the road and maintains it for the duration of the season. The road is 100 percent funded by the end users and we pay on a cents per ton kilometer rate. At the end of the year, the books are closed at zero.

There are three maintenance camps along the route. They serve the maintenance crews and also provide for the truck stops for the drivers. The truck drivers use the sleeper cabs, as there is no accommodation available for them.

Safety is a number one priority on the road and everything we do is related back to safety and care for the environment. Environment is second on our list but it is so close to safety that it is inseparable. We have driver orientations on how to behave on the road. We have set speed limits. We have a number of initiatives designed to look after our safety and care for the environment.

When the winter road is not open, we have to fly in supplies. This was also the case during our construction days when we were building the mine. It is also consistent with how we do our business today. The aircraft we use is the Hercules C-130, DC-3s and DC-4s. Most of these aircraft you have heard about this morning from various other speakers and we are no different. We use a 737 combo jet for our freight and passengers. We still have to get some people in there to work at the mine. The Hawker 748 aircraft has been a significant part of our operation in both passenger and combo form and we receive service from many other smaller aircraft like Twin Otters. Our exploration group mainly utilizes chartered helicopters. Ekati Diamond Mine is used as a base during our exploration programs.

So what are the challenges? There is an increase in mining activity in the north, not only in diamonds, as there are other mineral indicators such as gold. We have a 344,000-hectare lease and we are continuously scratching around to see if we can find more of these shiny stones that some people really like to buy.

The permitting challenges are significant. Just to give you an example, we have a small pit, which is located half a kilometer from our main pit as it stands today. For four years we have been trying to get permits for this venture that we will have mined out within three years. So the permitting takes a heck of a lot longer than the actual mining.

There is a limited capacity to the winter road. We have done a number of studies that suggest we could go to 12,000 truckloads on the road. This is probably the absolute perfect scenario in every way, shape and form. If truck drivers behave themselves, the weather behaves itself, and everybody else behaves themselves, then we could probably sneak 12,000 in there. We have had two very good years to gauge this by. The 2002 winter road had 250,000 tonnes, or just over 8,000 truckloads within the period from early February through the first of April. The year before was a terrible year for us and we still managed to move 8,000 loads but it took us a lot longer. We had a number of white outs, but we were lucky enough that the weather behaved itself towards the end and extended out till April 15th. So my best guess is our capacity on that road is 8,000 truckloads. Weather plays a big part and is always challenging. Horrendous incidents where trucks have gone through the ice have a number of causes with weather being one of them.

When things go through the ice, there is always the chance of injury and loss of life. We take safety and the environment very seriously. We move massive amounts of fuel. Ekati Diamond Mine last year moved 90 million liters of fuel over the winter road. When you are moving that quantity 86 percent of the time across lakes, there is every possibility that something can go wrong. We have good spill plans and some rules in place and we are doing our best to protect our environment. We have other users of the winter road as well, like the hunters and joy riders. Some of these people do not realize the dangers of the winter road and think it is the perfect drive on a Sunday.

So what opportunities are in store for us? Well first and foremost, we want to remain in business, so we want to keep our costs down and reduce our costs. We are very environmentally friendly and want to be more so. We are having a look at alternative transportation routes, one of them coming in through the Bathurst Inlet, using shipping, and then using winter road again from the north down south to the mine. This would give us probably another two or three months extra winter road hauls and a longer window to get our freight and fuel in.

We want to reduce our risks. We talked about trucks and the like going through the ice. There is also the risk of a freak year when we just cannot get the road open or not open long enough to get all our equipment in. We want to be less weather dependent. So we have been looking at how we can take the weather factor out, if possible.

Maybe the airship is the answer because you could use it all year round, 365, 7 and 24. What would that do for us? It means that we reduce our inventory. We do not have to pay for and cart 90 million liters up that road. We do not need a whole year's supply of tires. We do not need a whole year's supply of ammonium nitrate. We can get it in when we need it. We have an airstrip and will probably always will need an airstrip because we have people to move in and out. But if we have any delays of any kind on the airstrip whether it be animals or weather, then we feel that the airship is probably a good alternative.

The airship is environmentally friendly. We have heard that it uses less fuel, creates less noise, and animals and wildlife do not get knocked around by the airship. Is it cost effective? I do not know. I would like to think that it would be. If people are going to be competitive in this industry, then it is my view that they should not just be looking at it as an airship that is going to take you from A to B. It should be a complete supply chain. Why not take fuel, in our case from the Edmonton refinery, straight up to the mine using an airship? It is not just the cost of the airship itself – it is the whole infrastructure that you might not need to build. You might not need to build all your fuel tanks, you might not need to build all your warehouses, you might not need to build a winter road.

More viable mines? Well, who knows. There is a lot of activity going up in our area and one of the biggest cost factors is freight. Often the freight has to be taken down to a size where you can transport it in. Also there may not be a need to build extra roads to get from the main arterial winter road to wherever the operation is. So the opportunity is there to explore farther a field and perhaps there are better opportunities for more cost effective operations.

And safe? Well, all I know is we have often been told in the last 24 hours that they are a fairly safe operation and we hope that is the case. We will not compromise safety for any reason.

Somebody raised the issue of back loads. We do not have a problem getting our product out. We do not need a truck or an airship. Usually a handbag or some sort of briefcase can get the product out. You have probably heard about the five C's of diamonds, the cut, the color, the clarity, the carat and the cost. We are also very proud to announce there is a sixth – there is 'Canadian' as well. Thank you for being an attentive audience.

John Skalski
Manager, Gas Pipeline Technical Services
Enbridge Pipelines Inc.

When I mentioned to the group at work that I was coming to an airship conference in Winnipeg, the first question asked was, 'what's a pipeliner doing going to an airships conference?' And my response was, 'I'm going to learn and I'm going to share with many of the folks here what pipelining is all about, and to see if there's something that can be done to bring the two together.' I plan to take you down the Mackenzie Valley and look at the logistics and support structures. I will describe the type of project we would have and the activities that would be required to make the project happen. I will be talking to certain areas of the project such as the quantity of pipe, and some of the volumes of goods that are have to be moved. So we will basically build a pipeline project case.

Enbridge Pipelines formed initially as Interprovincial Pipelines. You may know them as that in the early 1950s. We are one of the largest crude oil or liquids pipeline companies in North America. The crude oil system runs primarily from Edmonton to Montreal via Chicago. Enbridge is listed on the Toronto Stock Exchange and I will let you refer to our website for further information (www.enbridge.com).

We are going to focus our attention on the Mackenzie Valley from Inuvik down past Fort Good Hope, Norman Wells, Wrigley, and into the Fort Simpson area. This distance is

approximately 1200 kilometers. We will attempt to build that pipeline in a two-year construction period. The two construction windows have to occur due to environmental and other matters. Each window is roughly 40 days in each winter season. So, we have a total of 80 days to build 1200 kilometers of pipeline. The existing infrastructure support is a railway into Hay River. Out of Hay River we have used the barging systems to move pipe. As a side note, since we have an existing pipeline from Norman Wells to Fort Simpson down to the border, I will relate a lot of my experiences on that project to the next project that is being considered. We utilized the barging system to a large degree to move our goods up onto that project. Since that time, the road system has been expanded. There is a road into Inuvik, and an all season road as far as Wrigley. During the Norman Wells project, which was built in the early 1980s, the all season road stopped at Fort Simpson. Beyond that there were some bridges and so on that were required. The winter road today does not go past Fort Good Hope. Its use is very limited to the period from January through to the end of March. With the weather patterns changing, there are no guarantees as to whether we can rely upon its use for all of our transportation. That will be determined at the time of construction. Our ability to use airport landings is very limited due to the volume that we have to move for a pipeline project. We are not necessarily limited by weight. Our pipeline is 36 inches in diameter, with a big hole in the middle of it, so we have a lot of volume but not necessarily a lot of weight.

So let's build a pipeline project down in the Mackenzie Valley. There is some discussion whether the line should be 30-inch or greater. I did my case on what construction could entail for a 36-inch pipeline with over a half-inch steel wall. I will talk to length of spread as 160 kilometers and that is based on the ability of a contractor, or a spread of equipment, being able to weld and install that much pipe in that 40 day window. It is all winter construction from mid January through to April.

Each spread requires 160 kilometers of pipe. With 80-foot joints of pipe, each spread then has 7,300 joints of pipe. Each joint of pipe with this particular wall thickness weighs roughly 16,000 pounds. This equates to 60,000 tonnes on a per spread basis just

for pipe. Those numbers can vary and will be dependent upon the type of coating that is applied to the pipe for its protection.

The pictures in Figure 1 are from the Norman Wells project. The supply chain involves a number of intermodal transfers and storage. It takes a lot of handling to get the pipe from its source, which could be Edmonton, Regina or even international, to the construction marshalling zones. The main pipe mills that were utilized during the Norman Wells project were out of those two locations.

Figure 1: Pipe Transport



The contractor has to work in a tight timeframe that is all camp supported. One camp with one contractor per spread, housing approximately 750 people. Each camp would have approximately 180 loads of materials, with an average unit weight somewhere around 40,000 pounds. This can vary depending on what the facilities are within the unit. Throughout the construction period, at least 45 loads per spread of consumables would also be delivered.

Figure 2 shows how the camp units are off-loaded, moved either directly on barges or off trucks onto barges. The camp is placed into an area adjacent to the pipeline right of way

for use by the working crew in the wintertime. The camp, the pipe and so on have to be purchased and moved months ahead of use. It is not unreasonable to expect the pipe to start to arrive six months ahead at, say, Hay River. Well in advance of construction also means a lot of pre-expenditure dollars.

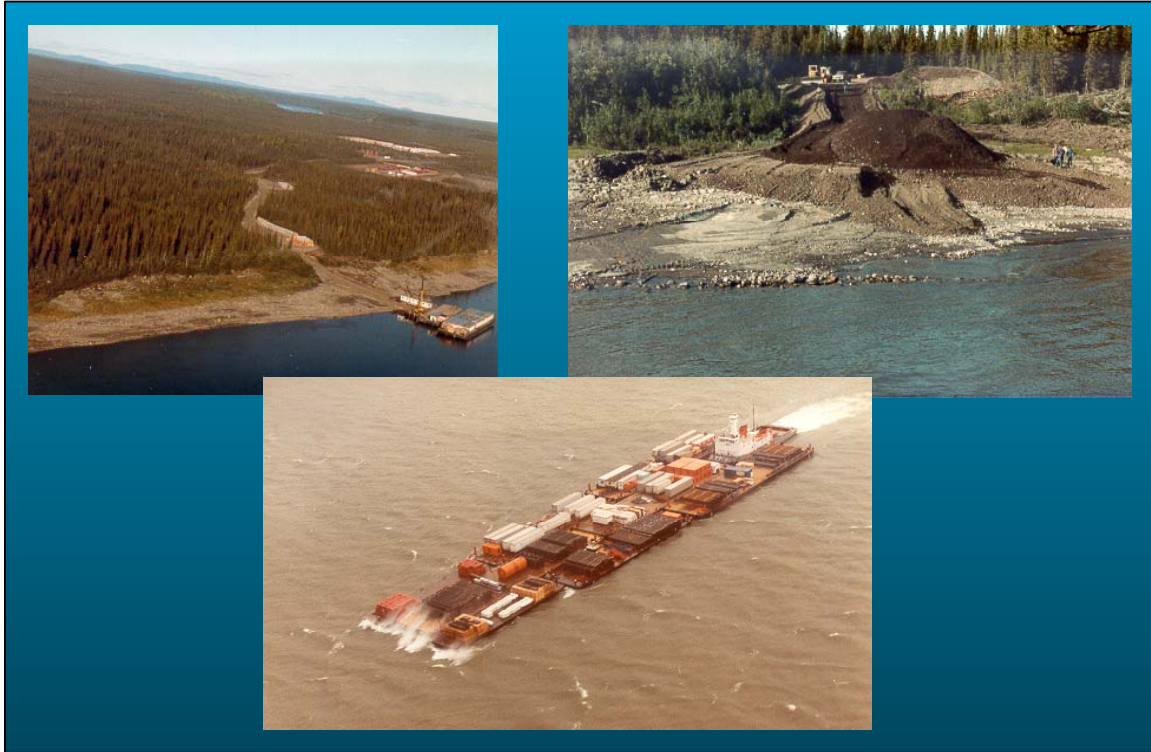
Figure 2: Off-loading Trailers and Camp Layout



The focus of this case is the first camp set-up, but consider that it has to be replicated several times for the rest of the pipeline. First, the camp has to be transported into the area (See barge pictured in Figure 3). Typically we would not be able to take the camp into an existing commercial barge landing location. It would be a remote shore landing, and subsequently a mini shore landing point would be built. This would be done in summer, with due concern for the environment in the use of the shoreline to land the barge. Once the ability to land the barge is established, the staging area is built. As a lot of the activities must occur between the shore and the site for the camp, a road is required, as pictured in Figure 3. From the barge landing, a good mile to mile and a half of access road is necessary to get the camp up to a suitable location near the pipeline right of way. The camp has to be moved and put into position prior to the construction operation. Once it is set up, the camp is utilized for that one short 40-day period, and

during construction prior to completion of that particular year of construction; the camp has to be relocated for the next year.

Figure 3: Barge Landing Spot, Road, and Loaded Barge



There are nine spreads of equipment and manpower working over a two year period: five camps the first year, four camps the second. Each camp then has to be dissembled, and moved into the next location. Weather permitting, the relocation will be done over land at the end of the first year of construction. If weather conditions prevent complete relocation, intermediate moves are required back to the barge landing, onto the barge and a move of 160 or 200 kilometers via the river to the next location.

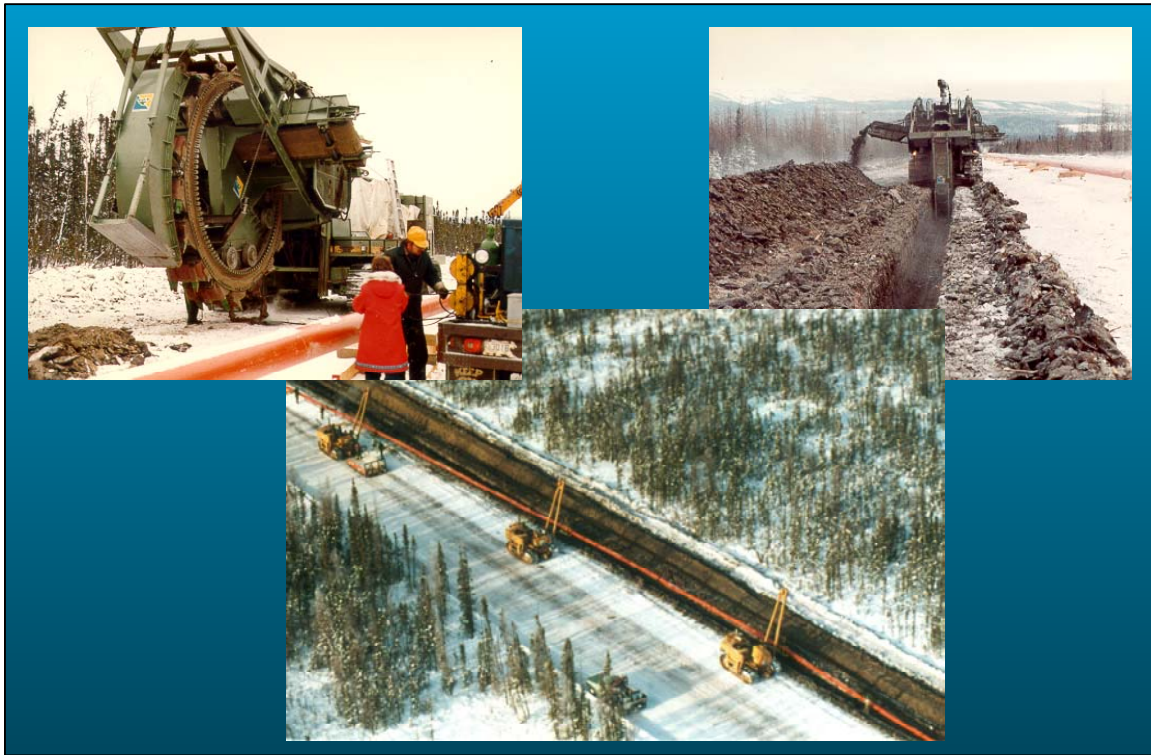
In the second year the cycle is repeated; 40 days of construction, and at the end of that, demobilization and removal from the north to a new location or stockpiling at some point. Figure 4 illustrates the camp movement, camp pad requirements, and the barge actually picking up the camp as it is relocated.

Figure 4: Camp Movement



Contractors' equipment numbers have also been generated for our discussion today. In terms of the size and quantity of equipment that would be moved, it is estimated that 250 loads would be handled. These loads include 400,000-pound ditchers that will dig a trench about six feet wide and up to ten feet deep. The movement of dirt, permafrost, rock, etc. is a major activity on the critical path. Side booms are required to handle the pipe once it is on the right of way. Side booms weigh about 125,000 pounds. The pipeline requires perhaps three or four ditchers, but side booms could be up to 20 to 30 in number. The movement of the 400,000-pound units would present considerable logistical challenges. But when the project has that many side booms, the picture changes. Daily fuel consumption of the entire operation on a per spread basis would be somewhere around 75,000 pounds per day. Figure 5 presents a trenching operation. Pipelining is like an assembly line. The pipe being prepared to be lowered into the trench has been welded and assembled upfront.

Figure 5: Trenching and Pipe Handling by Side Booms



The pipeline project could include up to three or four compressor stations. Each station would entail approximately 50 loads of cargo going into a site. A pipeline compressor station project is similar to mine construction. The heaviest unit would be in the range of 150,000 pounds and occur at a fixed location. This would be perhaps for a turbine compressor operation. The 50 loads of cargo would average somewhere around 60,000 pounds per load.

Figure 6 is a picture of a compressor station site. The control building is approximately two stories high, 150 feet long. The other building is for the compressors. It is similar in length but a little taller. Another facility on the right is the air coolers that would be required under gas transmission facilities for compression. When natural gas is compressed, heat is generated and the pipeline would be quite warm. The gas must be cooled before it goes back into the ground to eliminate damage to the permafrost.

Figure 6: Compressor Station Site



So that is a case study of the logistics and transportation requirements of northern pipeline construction. Can airships be utilized to minimize some of the handling activities that we just discussed?

Questions

Q: Ian, could you give us an idea of the cost to build and maintain your winter road, both on the ice and on the land?

A: (Ian Goodwin) The cost to build this road really is dependent on how much volume you are going to put through on the road. It has ranged from \$5 million up to, I think we have peaked at about \$11 million dollars. Cost would probably be a better gauge. Last year was about 10.8 cents per tonne kilometer. So each user that uses the road pays the distance to their property plus the tonnage they are hauling for. You have a portion of fixed cost and variable costs that increase with the number of truckloads. There are different methods of how you actually can manage the road. One would be what we call “twinning,” putting in a dual lane highway on some of the big lakes. So that increases your cost initially, but in the long-term it actually saves money because then you have the option of two roads to use.

Q: You mentioned shadow as being an environmental problem. I am unable to follow, a moving shadow being an environmental problem.

A: (John Markowsky) As mentioned, I was trying to get some feedback from our environmental people who help us on these projects and certainly it is not an issue that we have had to deal with. But, he stated that perhaps this could be an issue. I do not have any evidence or any statistics of it, but it was raised as possibly becoming an issue. When any new technology is brought in or utilized, potential impacts must be examined. If there was a large shadow going across during the nesting and nurturing period of birds or during the calving season of caribou herds, could this be an issue? I do not have the answer. It was raised as a challenge and as something that may have to be addressed.

A: (Ian Goodwin) Perhaps if you do not mind I have a couple of comments on back loading. It was raised this morning a couple of times. The inference, I presume, is about keeping a constant load in the airship up and down. During a construction phase and initially, you have one-way traffic getting in as much as possible. Then you go through a phase where you are getting rid of your construction materials like excess camp equipment to build a mine. Then when you get into an operation, you have the one-way traffic again for a little while, then you decide that you want to expand. So when you expand, you are increasing your fleet and your times, then you are going through your replacement, so then you have to haul out the replacement equipment, the stuff that you are selling or trading in, whatever you are, and the cycle goes on.

It is extremely difficult to try and say that every year there will be X amount of back loading. Of course that is only one mine. When you have other mines coming in at various stages, and the example of it being this upcoming 2003 winter road, we as BHP will have very little back loading coming out, but our friends across the lake, Diavik, they will have a significant amount of back loading. It just so happens that they will be using trucks that go up to haul back loads. So it is a win-win situation for both.

Q: My understanding is that in a lot of mining operations, there is growing concern about what is left afterwards. Are you required to completely remove all the materials that you brought in at some point when you wind down the mine? And if I could ask a second question, what size of airship do we need? Airships get more efficient as they get bigger,

but I crawled before I walked, and walked before I ran, and I think that is the nature of any industry. What is the minimum size of airship that would be useful to you, and then where do you see beyond that as to what is sort of scale and size of lift you would require for future planning?

A: (Ian Goodwin) As we leave the mine, we do not have to fill in the holes if you will, but we are required to pull out all of the infrastructure and all of the equipment. Now that is as it stands today. There are also clauses in there for negotiation. For example, with the situation that we are in with our Aboriginal peoples, we are on their land; if they want to use it as a camp or some business enterprise, then we can negotiate with them. So at this stage we are not sure whether we pull the stuff out or whether we leave it there; what we are working on just now is the assumption that we will have to remove everything. So if there is a piece of equipment there that we have used and we no longer use, then we get rid of it.

A: (John Markowsky) Every project has its own challenges, but I will relate to you the challenges that we had on one of the weir projects we worked on up in the Churchill area. One of the constraints was to move fuel across the Churchill River, approximately a kilometer across. We could only take two 45-gallon drums at a time to where the blasting operation was on the far side of the river. So, we used airboats. An application like that is in an extremely sensitive ecological and environmentally sensitive area. But as I mentioned, the other issues that pop up are dealing with spill response and these types of situations. I see those as challenges, and certainly I think there is a range of smaller applications rather than the large loads.

A: (John Skalski) If I could add to that comment regarding size, the biggest concern we would have, particularly on a pipeline project, would be the fact that we are trying to identify ways of reducing risk. Reducing risk would not necessarily take us down the path of saying we want the largest unit, and we want to be the first ones to try it out on the pipeline where we have to build it in 40 days. What I would like to have is a system that I could perhaps utilize to move one or two or three joints of pipe from the beach

landing to the stockpile point. Crawl before you run, that would be my thinking. I would like to hear more and see what happens for the rest of the conference in terms of convincing me there is reliability and security such that I would take the risk.

A: (Ian Goodwin) As far as we are concerned with size, I agree with these comments that you want to walk before you can run. We can have 40-tonne capacity that equates to a B train truck. Now on our highways, most of our trucks are super B, so they carry more. The studies that we have done on the ice show that we are not quite ready for that tonnage or that weight on the ice at one time given the loadings that we have and the spacings we have between our trucks. Now having said all that, when we were constructing the mine, the biggest piece of equipment was an excavator, a Demag excavator and the whole machine weighed 700 tonnes. We broke it down such that the largest piece of componentry was 65 tonnes. We carried that up on the road and we shut down the road for 12 hours afterwards to let the ice set and see what happened. That was successful. Since then we have moved up weights of similar size but we have always allowed the ice to settle.

So that gets back to what size of airship do you want to have. From my view, from my own operations, I would like to see a smaller one, somewhere around the 30, 40 maybe even 50-tonne; certainly not the 160-tonne vehicle that was getting bandied around by Cargolifter. I think that is a very specialized ship and needs very specialized loads. Where I see the smaller airship coming into play is doing the freight run. So it could leave Edmonton, head out for Diavik, shoot across the lake to BHP, hop up to Lupin, dive across to Meadowbank and come around and continuously do that and carry smaller loads. It could carry the fuel, etc. on a continuous cycle. My view would be similar to the airline industry that you make money when these things are flying. So if you keep an airship going all the time, then you are going to be making some money and we are going to be happy. We are not going to have all of the inventory that we need to hold.

Session 4: SECURITY AND EMERGENCY RESPONSE IN THE NORTH

Al J. Phillips (Moderator)
Professional Associate
Transport Institute

Walter Parker
Chairman
Arctic Council Circumpolar Infrastructure Task Force

The task force that I am chairing on infrastructure in the Arctic has three expert groups that we are pulling together and expanding. One on aviation, which met last spring, had strong input from Canada and the Russian Federation and somewhat less from Scandinavia because they do not need it as badly. A telecommunications group will meet in February in Washington, D.C. A group on marine transportation is still being pulled together. We have a mandate from the Arctic Council to proceed in developing these experts groups and if any of you have any interest, be sure to contact me.

The transportation system serving the circumpolar north in this century must meet a wide range of needs. It must support Arctic communities, especially the small communities that are not connected to the road and rail networks of their countries, and do not have instrument facilities at their airports. There are more than 1,500 of these communities. It must support resource development in the north. Oil and gas, after a two decade lull is coming back strongly in Alaska, in Canada, and especially in the Russian Federation. It must support scientific research, most especially those programs that input data into global models for climate change and local models monitoring habitat. The latter is critical to those northern residents who are reindeer herders, a majority of the indigenous peoples of the Arctic, and those relying on wild species for a large part of their diet. It must support transportation safety in all modes, most especially those trans-polar flights from Europe and North America to Asia that trans-sect largely uninhabited areas of the Russian Federation. The Arctic Council has working groups addressing environmental and economic concerns in all the above areas. This year at the Senior Arctic Officials Ministerial meetings in Oulu and in Inari, Finland the circumpolar infrastructure task force was authorized to develop the experts groups that I described previously.

Expanding on the transportation for community support, in North America air transport to small northern communities has been subsidized to guarantee a minimum level of service. It has been that way ever since World War II. In Alaska, this is accomplished through postal subsidies that provide a relatively cheap means of shipping small freight and providing an economic base to operators for their passenger operations. This makes it possible to transport passengers and other freight at rates that while high would be extremely high if forced to carry the entire economic burdens of frequent service to communities that have limited traffic. Most of the small communities have their needs for bulk freight met by barges arriving once or twice a year delivering fuel, oil, gasoline and freight items that cannot be handled by the size aircraft that can operate from small runways of 3,000 feet or less. To my knowledge, there has not been a study in Alaska to determine whether airships could fill part of these needs, especially the bulk cargo needs that are often not met due to weather or low water impeding heavy traffic.

As an aside, our experience in airships in Alaska is extremely limited. We did have a great hot air balloon fleet in Anchorage for a time in the 1980s, but the insurance companies drove it out of business. Sometimes we would have 20 or 30 balloons up over the city, but that is the limit of our experience in recent years.

I know that some freight operators have an interest in considering airships. Linden is one but no major studies have been done similar to what was done on the hovercraft. Thirty-two years ago Boeing did a major hovercraft study and we probably do not need to do one as big as that, but we do need to take a look at it. The State of Alaska's Department of Transportation and Public Facilities is just completing a major transportation study of northwestern and Arctic Alaska's transportation needs and this could serve as a base for examining the utility of airships to serve that area.

In the Russian Federation, helicopters are still a principle means of support for small communities. In many areas there is a good deal of interest in seeking other alternatives. Right now the Antonov 2 biplane is still used in large numbers and more modern versions are being developed. There are new aircraft being built but large areas are still unserved.

The Sakha Republic has major operations in diamond and gold mining and 400 small communities with no road network serving one million two hundred thousand people. This is a considerable market that is almost totally dependent on small aircraft and river transportation.

Major air support of resource development in the circumpolar north dates from when oil was discovered at Prudhoe Bay in 1968. The massive size of the discovery was soon confirmed and an oil rush was on. This generated an airlift from Anchorage and Fairbanks that at times exceeded 200 flights a day into two non-instrument airports. I was responsible for it and it was a hairy time. Everything available was used from new Hercules to some fairly ancient DC-6s and Constellations.

Seismic crews were spread across an area 120 by 50 miles in the winter of 1968-69, when a severe cold snap ensued. It was impossible to get enough fuel to the widely separated camps and a quick evacuation occurred by the majority of operators until more clement weather arrived. This shows the difficulty of serving many widely scattered crews as clearly as any operation I am aware of. Luckily the cold weather did not bring severely reduced visibility so locating the crews was not a problem.

We have many small mining operations that are not possible because the infrastructure to serve them is simply too expensive. There have been some investigations on utilizing airships to transport necessary supplies in and small amounts of processed ore out through the years, but none of these have been strongly pursued. Now utilizing the Capstone program under development by the US Federal Aviation Administration, many of the problems in supplying small, widely separated operations, whether communities, mines, exploration crews or scientific parties, have received a great advance. Utilizing Global Positioning Satellites (GPS), plus map, traffic and weather data from lower earth orbit satellite networks, Capstone presents a visual display in the cockpit showing exact location and a visual of existing map information. Traffic from cooperating flights and weather is also available. The program has been demonstrated on the flat terrain of the Yukon-Kuskokwim Delta of Alaska for the past two years is now beginning a

demonstration of the very different fjord, mountain, and island terrain in southeast Alaska.

As oil development in the north builds up again, the problem of oil spill recovery in ice will confront us. Canada, Norway, Germany and the United States have been working on this problem, but there is still a long way to go. The ability of airships to maintain station for long periods could be a real possibility in improving our spill response capabilities in remote areas where access by any surface transportation will often offer severe problems.

One of the most eagerly awaited presentations at the Arctic Council meeting is that of the Arctic climate impact assessment. The assessment has a great deal of sea ice data because we have been running US and British submarines on research programs under the ice. They collected a good deal of information since 1993 and we were also able to get the information obtained during the Cold War since 1957 declassified. We have the sea ice data but we are lacking terrestrial data. Getting permafrost information from many widely separated sites is going to be largely a helicopter or light plane operation. Because the difficulties of logistics support, most of the operations tend to gather around centers such as Barrow, Tuktoyaktuk, Resolute, Eureka or Nie Alesund in Norway. In the Russian Federation there are large gaps because of logistical problems. So any system that would provide a sure support system to field parties would be welcomed by scientists and those organizations that fund them.

Finally, there are several areas where airships may be able to contribute to greater safety. Fishing vessel safety in the Bering Sea, the North Pacific, the North Atlantic and parts of the Arctic Ocean is one example. Aviation safety is another. Marine and riverine storm and flood problems are increasing with climate change so support for rescue systems is increasingly important. Dealing with natural hazards such as floods and massive soil transport will probably be a part of the safety nexus. The Emergency Preparation, Prevention and Response (EPPR) working group of the Arctic Council, which is presently chaired by my old friend Laura Johnson in Yellowknife, has been charged with

recommendations on natural hazards in addition to its regular work on oil spill and radiation prevention and response.

We can create a system as an addition to Capstone that would hold the airship in place near enough to take care of small communities, small research parties, small exploration parties, and small mines. Certainly many of the computer operated ships and aircraft are already approaching this capability. Utilization of helicopters and other air supported vehicles to make the transition between airship and the surface would be another area of inquiry. So it seems that we are at a stage where we need to take a very hard look at many of these areas. A big problem is that there are not enough economic comparisons available to determine what airships can contribute to the wide range of possible uses defined above. It is probably time to get to work on making these determinations.

Charles J. Hunter
Director CORA
1 CAD/CANR HQ

I am here representing the Commander of the 1st Canadian Air Division. The Transport Institute invited him to speak on Air Force operations and how he thought they could utilize airships. He could not be here today because he is on an official visit to our Maritime air units in Greenwood and Shearwater, Nova Scotia. The reason you have me is that his staff quickly found out in our headquarters that I was doing some work on airships, not what has been talked about so far today, but one of the topics that you are going to hear about in tomorrow's speeches, which is high-altitude (HA) airships.

I am going to briefly describe the Air Force's capabilities. Our headquarters in Winnipeg plans and executes missions with what we have today, not with what we may have tomorrow. There is another individual here from the Chief of the Air Staff (Ottawa), who does deal with what we are looking at in terms of emerging technologies and what might be out there to help us with enhancing our capability tomorrow. So I will quickly put you through our routine day-to-day domestic operations. Talk a little bit about the NORAD mission because it is relevant to what we are going to talk about here and put it all in context with some issues and challenges. I will wrap up with the project that I am

presently working on, which is determining the utility of using high altitude airships for aerospace surveillance.

The one topic that I am not going to talk about and it is not that I would not like to, but I can only cover so many discussion points, is our world wide deployments in support of UN or NATO operations. What I am concentrating on is routine day-to-day and Canadian domestic operations.

Aerospace control is really done by a combination of our fighter forces that are located in Cold Lake, Alberta and Bagotville, Quebec. This is where we have CF18 fighters and just recently retired our T33s. Now they do not do this alone, but we basically control and manage Canadian airspace with our two command and control centers, one which is in North Bay that is an underground complex the equivalent of what Cheyenne Mountain is in Colorado. The region control center for NORAD is in Winnipeg, which is 1 CAD. It is aerospace control and the whole issue of communications and surveillance where I see potential utility of airships. I will come back to that, which is why I skipped over the fighter force pretty quickly.

One of our traditional roles is support for our other services, in this case the Maritime or the Navy on each coast. Of course they need to be near the water. We primarily do that with Sea Kings and Aurora aircraft. Now, I am not going to pretend to be an expert on airships. I have heard some things today that might change my opinion slightly, but I did not see much of what we do with our Sea King helicopters on board our ships that would be taken over or supplemented with airships. However, I do see a significant potential in complementing what we do with our CP140 Aurora. This includes surveillance patrols, fisheries patrols and sovereignty patrols off of our coasts and particularly in the north, if activity increases with the Northwest Passage. An airship could certainly take over the first phases of that role which is the surveillance and detection of targets of interest. This would leave our Aurora aircraft to investigate and prosecute those targets if need be. So there is one potential role for HA Airships.

The land force (or army) is set into regions spread across the whole country. The air force helps with our Griffin helicopters (CH146) and they are integrated right with our land force units. Even though they are air force, a lot of people think of them as actually being just an adjunct to the army units that they are part of. Within Canada two things we do on a regular basis are resupply with our transportation fleet and move our other services around, particularly the land forces. Our CC-130 is the main component of our fleet that we use to move equipment and people. There is an awful lot of equipment that we need to move in support of the army that does not fit inside a Hercules. So there is a lot of potential for some sort of other vehicle to help move these kits around. Now there are other options depending on where you are going. Of course, you can stick them on a rail or you could rent an air lifter from the US. We never do that of course, but we could. But those are some options where I see an airship. We have things like ten tonne trucks and our 105 mm Howitzers and Bison APCs that could benefit from something like an airship. They could also not just pick it up, but do a point-to-point rather than trans shipments.

Search and rescue (SAR) to the military is a very specific role and job where we respond to either an air or marine distress. This role has evolved substantially in the last 15 years with the advent of what is called the COSPAS/ SARSAT System, a constellation of polar-orbiting satellites for search and rescue. This system has turned our job around in search and rescue. As long as the aircraft or the boat has a transmitter that goes off, we will find that person within 24 hours. We have had literally thousands of cases where as long as that transmitter goes off, the satellite gives us a good enough fix so that our dedicated SAR resources can respond in time and perform a rescue very quickly. So in that context I do not see the airship helping us. I could see an airship help in a different role, which is more along what I might call a major air disaster, or a disaster in a more remote region. Luckily those are few and far between and hopefully we do not have to get into those cases too often. For routine search and rescue, we have assets in place to do that role now, and I see a rather limited utility for airships.

We conduct most of our pilot training at Portage la Prairie, Winnipeg and Moose Jaw. Of course if we owned airships, we would have to train some airship pilots. So there would be a posting or move for someone to go live in Moose Jaw.

Most people are very aware of when we deploy to places like Afghanistan and Kosovo. They forget that we are just as busy, if not busier, supporting things that happen in our own country. Most people, depending on where they live, would recall one of the floods or the ice storms, but may not recognize something like the Quebec Summit or Op Grizzly, which was the G8 Summit in Kananaskis, which was a big operation for us. A few people in Toronto were woken by some CF-18s flying over the community one morning in September. Canadians were out there responding to 9/11 as well as the US. Needless to say with such a multitude of different air resources, there has got to be some role in a lot of our domestic operations for an airship, whether it is sustainment, resupply, to offload some of the surveillance capabilities, or simply communications relays. One of the big problems in Canada with our sparse population is, of course communication gaps, so that is another potential role.

I am going to jump into the NORAD mission and you will see why when I get to the high altitude airship discussion. We have responsibility for our own sovereign air space. We are essentially the Canadian NORAD region and very quietly in 1997, Winnipeg became the Canadian NORAD region headquarters. There are two adjacent regions. Of course, there is the continental US, they call it the CONUS and Alaska has its own specific region.

Figure 1 represents the North Warning System, which goes across the northern part of Canada. You can see some additional circles, radars, on each coast but there are gaps and holes; it is not continuous coverage on each coast. This is notional coverage. If I showed you some real coverage, you would see there are actually a lot more holes in it than that. But everybody here should realize what is wrong with this slide if you think of 9/11. This protects us from threats from the outside, it basically protects the periphery of

Canada. There is a similar system of course protecting the US. What we find in 9/11 is that we do not have a lot of coverage internal to the country.

Figure 1: North Warning System Radar Coverage

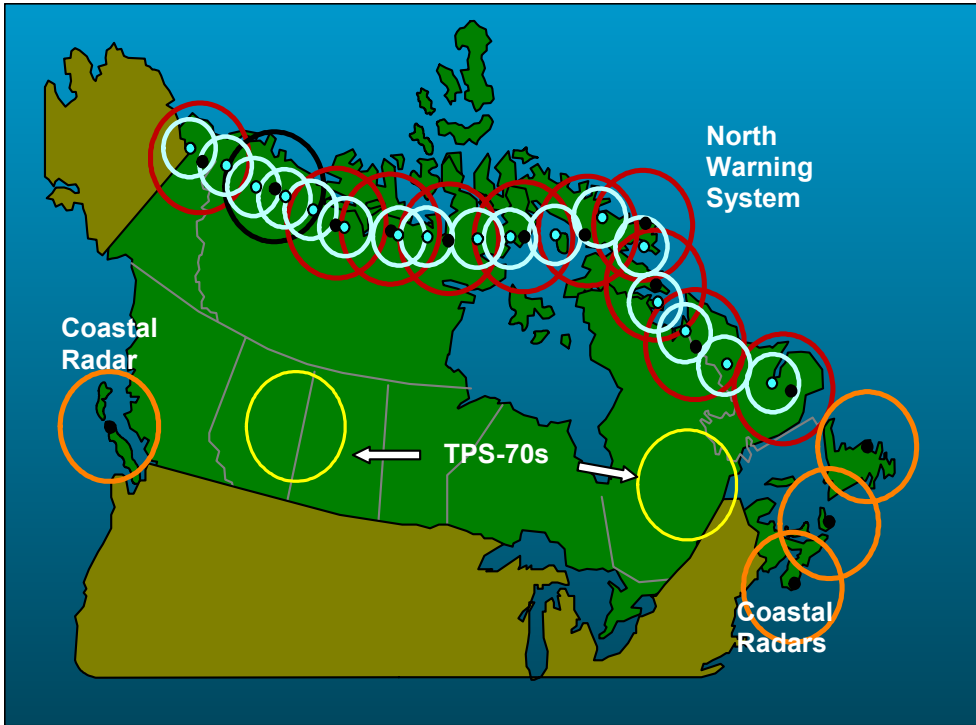


Figure 2 is a picture of our site at Cartwright in Labrador. It would not matter whether I was up at Cambridge Bay or Hull Beach – they almost all look the same. A couple of buildings, a couple of domes, and usually located at sites that you would not normally want to live. The old system, the DEW line, was all manned and there were a lot of people to keep these things going. We have recently put in upgrades to the radar, avionics and some cameras and stuff. They are all unmanned now and controlled remotely.

Figure 2: Cartwright, Labrador NWS LRR Site



Communication connectivity is part of the game. It is not just put out a bunch of radars and watch what is coming. You have to be able to deploy assets. We have some AWACs, an Aurora, which might be a communications relay, and of course fighters. If you are going to control things or intercept them, you need fighters that get you there fast. How would an airship come into play? An Aurora might be a pretty expensive communications relay aircraft. So where you have a known surveillance or communications gap an airship might be of some help.

I do not really think we have really wrestled to the ground what we are going to do about homeland security. But on the promising side, we are making some stabs at it, certainly inside the air force in the last 12 months. We have realized that we need some sort of new surveillance architecture plan that includes our needs for internal coverage, protection of critical infrastructure points in the country and those types of things. This is what led me on an investigation, and I found out my counterparts in Colorado Springs and NORAD had gotten very serious about doing a high altitude airship demonstration program. So, strangely enough, I decided to invite them to Winnipeg to talk about this. When they were up here visiting me in August, an article appeared in the Winnipeg Free Press that was describing this conference. I had not read that daily paper yet, and my US counterparts came to the meeting and they said, “you’re having an airship conference here in Winnipeg?” This article combined with the Commander’s busy schedule and his not being able to attend, is how I ended up participating in this conference.

I am not going to speak to the technical aspects of the high altitude airship. The people that are going to talk tomorrow can do that a lot better than I can. So I am just going to describe very briefly the NORAD demonstration program that they are going ahead with and why we are interested. The group I belong to is Defense, Research and Development Canada. We need some sort of long duration asset that can do wide area surveillance, and communications would be helpful too. So what is the purpose of the actual demonstration? To demonstrate the potential military benefit of high altitude airships. Basically, we are interested in a highly capable, multi-mission platform for surveillance and/or communication. What is it going to do? The nice thing for Canada as I talk to my NORAD counterparts is that we have already gone through the hoops; this is now an approved project for us. Approved in July, the US Army is the lead service and NORAD is going to be the lead operator of the trial. They came to us and said, 'we don't need money, but we really could use international interest,' which is too easy under the NORAD agreement, bi-national agreement and we already had a statement, a requirement in Canada saying we have a deficiency. So for us to participate in this program is almost a no-brainer because we are looking at a new surveillance architecture. Here is something that is almost no risk because they just want our interest and our participation. They do not even necessarily want our money at the beginning. But the best part for us in Canada is we are not even going to influence what they do in the first trial, but apparently they are going to leave the prototype asset behind for two years following, which I call additional trials. One thing you are definitely going to hear about high altitude airships is a problem operating north of 50 degrees Latitude. The way they are designing the conceptual is with solar panels in the skins. Everybody here that is from the north knows that six months of the year that is not going to work very well. It is going to be fairly dark and there is not going to be much sun. So we have to look at alternate fuel sources. We have some experts in Canada, like Ballard Fuel Cell, that might be alternate fuel sources for these high altitude airships.

Figure 3 presents the notional coverage of a high altitude airship. High altitude airships would operate with 70,000 feet range well above commercial aircraft and everything else, including tethered aerostats. They are supposed to be more or less stationary, and that is

why we find them potentially attractive as a surveillance platform. If they can do that and can stay airborne for something longer than a UAV, which means get beyond the 48- to 72-hour range, then we have to take a serious look at this.

Figure 3: Notional Stratospheric Airship Strategic Surveillance Architecture



Let us talk about a very specific special operation like the G8 Summit. The day-to-day radio and radar coverage in that area with the Rocky Mountains being on the west side is basically lousy. We had to supplement it substantially to be able to support the G8 Summit. So if we had had an airborne asset like a high altitude airship and parked it over the area, it could have functioned as a radio coms relay.

We are mostly interested in the demonstration payloads. What can we put on board these things? How long can it stay on board? Is there the potential for power generation? If we are going to use airships in Canada, we have to figure out the power propulsion problem.

Lieutenant Colonel Mike Woodgerd
Transportation Corps
Center for Army Analysis, United States Army

Good Afternoon, I am here to provide you a US military perspective on the range of possible military applications of lighter-than-air with a primary focus on the transportation role and particularly introduce to you a new term for a desired capability we call an Ultra Large Airlifter (ULA). But almost more significantly than that, I am here to learn from you what commercial applications exist and find what we call the “knees in the curve”—the critical points of a performance curve or a cost curve where an LTA platform would make a key difference for you commercially. I want to understand your critical requirements. I never use the term “requirements” to describe our military interests because it is very specific in my business. We must, however, mesh our military needs with your commercial needs to find where we should focus our mutual development efforts as we move forward.

As an aside, we are not the first folks talking airships in Winnipeg. If we had been here 54 years and one month ago, we would have seen the US Navy’s XM-1 non-rigid airship that was taking part in a search and rescue mission for some diplomats who had crashed while traveling from somewhere east to somewhere west far north of here. I blanked out on the names but I think it was from Churchill to some place west. They were later found, so it is a happy ending and just provided a good reason to gain some airship experience this far north.

The rescue vehicle became the first US Navy airship to ever penetrate the sub-arctic at 54° north. The airship co-pilot described the sub-arctic wilderness as absolutely serene. I do not know anything about the sub-arctic wilderness, so I will leave that up to you as to how much you believe it is absolutely serene. But many airshipmen have stated that, at least during the summer period, the polar regions are an excellent place to fly an airship.

There is a long history of progress in lighter-than-air technology, with certain periods of accelerated development. Much of that acceleration came from military needs, such as you see in WWI and WWII. That should be no surprise; military necessity often

accelerates technical progress. With regard to the 1920s-1930s era, I want to highlight two names: Paul Litchfield, on the American side, and Alfred Colsman, a name you never hear, on the German side, were the businessmen who enabled Goodyear and Zeppelin to exist. Litchfield's solid economic focus and solid financial status was what enabled the US to have airship fleets in WWII. Even the military money, which was actually written into the budget by Congress to build the Akron and Macon [two flying aircraft carriers built and operated in the 1930s], could not by itself justify fleets of airships. There has to be a commercial potential for any such capital investment. Litchfield was a visionary; he invested money up front for a long-term economic benefit. Because he ran a large corporation, he understood that you have to look at the whole system. For instance, the Goodyear blimps, while good advertising, also supplied a pool of trained pilots for government use in wartime. If he had gotten the transoceanic passenger system up, there would have had to be a feeder system. I am not the first person today to say you have to start out small then big. You train a pilot on something smaller before he flies something larger.

The bottom line of this thought is the importance of the commercial viability of any particular systems. A profit motive has to be the driving force. There must be a real commercial market to create a large enough fleet of LTA systems and the support infrastructure that the military could tap into. The military needs and uses will be a critical piece of the development of future capabilities, but they will not be the most critical piece. The remaining slide bullets show the US military and government uses and studies from 1940 until now.

[The next comments are spoken to a slide entitled Airships: Military Innovation showing views of the USS Akron and Macon with aircraft and moored at "expeditionary masts" (see Figure 1). The slide also shows the USS Shenendoah moored to the USS Patoka, a former oiler converted into an airship tender, or floating base (see Figure 2).] The US military has demonstrated various levels of interest in LTA over the decades. We have flown hundreds of non-rigids very successfully in all kinds of weather. As you have heard other people say, it is basically a very well proven technology, and actually led

aviation development in many ways during the early decades of the 20th Century. There is a unique symmetry between the time we now live in and the time period the photos on this slide capture. Today, the US Army, in particular, and the US Department of Defense as well are devoting a great deal of thought and effort towards transforming themselves for the future. But the 1930s were a time of incredible innovation as well, which led to carrier aviation and the use of lighter-than-air, for instance, all developed in fiscally constrained times. Even during the Depression, and with an incredibly small force structure, the military experimented with flying aircraft carriers, and with matching airships with surface shipping, in what we would now call sea-basing. There is always need, and room, for initiative.

Figure 1: USS Akron Moored at an Expeditionary Mast in Opa Laca, Florida

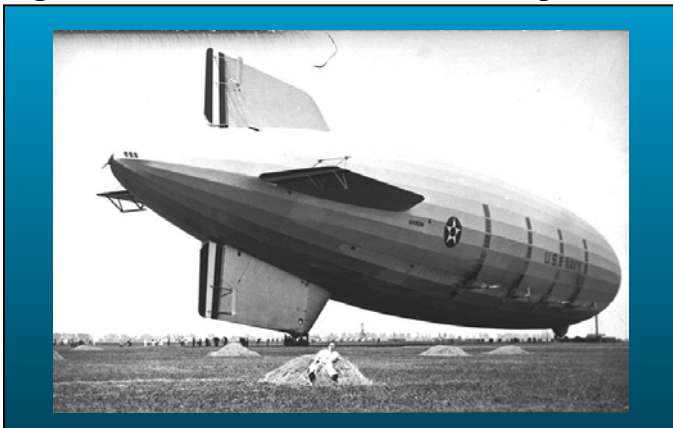
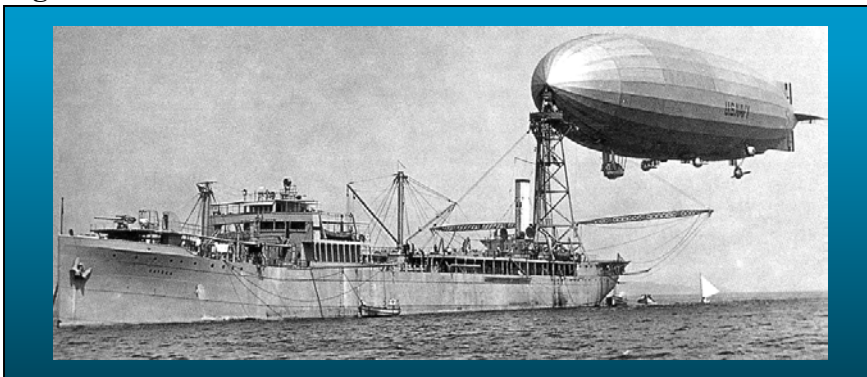


Figure 2: USS Shenendoah Moored to the USS Patoka



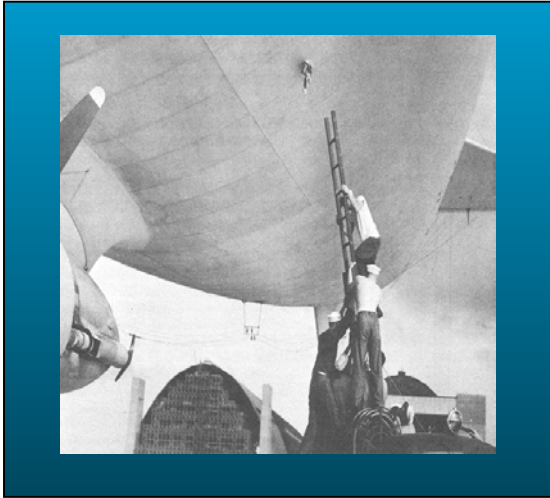
Now the draw of lighter-than-air technology to the US military, especially the US Army, is an almost insatiable demand for what we call strategic lift. There is never enough

“lift” to move everything that I have to move, and believe me, when you have to listen to generals ask you why you cannot move something you do not forget that. Lighter-than-air technology, such as airships and/or hybrid aircraft, offers tremendous potential as a transportation asset.

These pictures highlight one of the most critical points I try to get across, which is the relative infrastructure independence of an LTA system when compared to traditional lift assets [*a “lift asset” is a term for a plane, ship, or other transport vehicle*]. In general, for an airship, infrastructure is what is called “a stick in a field.” Very little infrastructure is needed compared to a port or an airfield. Basically, if I can put a mast in a field or utilize some other simple system of ground handling, I have a small footprint and no demand for additional complex infrastructure and can then put through a lot of payload or some key capability vice using airports and seaports. That is a very good thing for me.

One point on survivability; I just love showing this slide. If you look at Figure 3, you see a kid with no T-shirt. That is a ship that came in off patrol with a hole in it and so they stuffed a T-shirt in it and will fix it quickly and resume operations. The point to take away is that even with a hole that big in the envelope, the ship did not deflate. We have shot them full of holes; the British have shot them full of holes. They “degrade gracefully” is a nice euphemism. But simply put, they do not pop, the gas does not blow up, they do not plummet immediately and catastrophically to Earth. The airship deflates slowly and actually it is the bag’s loss of rigidity that causes an airship to lose its ability for controlled flight. The ship then comes down and not in a catastrophic manner. So, your payload survives, which is important to me, people are part of that payload. You do have a recovery problem, but you survive. You do not survive if your C-17 suddenly plummets out of the sky.

Figure 3: Ground Crews Plug a Helium Leak in the K-46 at NAS Richmond (U.S. Navy)



It is almost a requirement to talk about transformation nowadays, but it actually applies in this case. Lighter-than-air platforms of various types support almost every aspect of our intent to transform the Department of Defense. Projecting and sustaining U.S. forces in distant anti-access or area-denial environments – that is what I focus on. That is what they pay me to do – figure out how to move things better, faster, in different ways. Just to define some of our fancy terminology, “anti-access” means somebody is shooting at you or throwing chemicals on your airfield to keep you from coming somewhere. “Area denial” is more or less northern Canada; it is just really hard to get there, period. So, it is not an active enemy, it is just tough to get to some places. For example, maybe the airstrip is too short for my fixed wing aircraft, or the seaport is too shallow for my deep draft ships, or it is out of range and political overflight.

Communications is like transportation; demand always exceeds supply. So, the ability to surge in some airborne communications relays, or airborne radars, is very desirable.

With a flexible mobility platform that airship endurance offers, you start to see the value of getting a “first effector,” some critical capability, in and changing the initial dynamics. If we stack the deck early on in a situation, maybe an aggressor does not do something that he normally would have done. Mobility of smaller and faster forces is a key part of that.

Finding innovative concepts and technology is another one of my charters. The U.S. military is not going to buy airships and crew them like we did in the past. Primarily, then it has to be a civilian asset that we use. Down the road of course, there is some possibility – because the future is undiscovered country – that we might have some airships but it is certainly not going to start as a purely military acquisition project.

Next, I will discuss the general areas of interest of the US military. Of course, you have heard a lot about the stratospheric airship today. We are doing that technology demonstration now. The next area is what we call Ultra Large Airlifters (ULAs) and that is what I will spend the bulk of my time on today because that is where I focus my effort and it is also the most germane to your business applications here. The next area is what I call manned airships for surveillance, could be unmanned as well, but I want manned platforms along with the aerostats for pinpoint near shore security over a harbor, over the G8 Summit, etc. Maritime Domain Awareness is what my Navy and Coast Guard friends call out there about 200 miles off shore, knowing all the ocean around us, understanding it, knowing what is going on with relatively constant surveillance. A key thing to remember is augmentation. To quote the Durand Committee from 1936, “The airship replaces nothing. It augments everything.” It is additional airlift, it is additional security, it is additional platforms. No one, I believe, can rationally advocate totally replacing any asset we now have with an airship. It can do some things much better, but it is a part of an overall system, just as it must be an efficient part of the commercial transportation system. In the worldwide transportation network, any LTA system has to mesh and provide complimentary capabilities, and in a business aspect find the places where it, as part of a link, might be the most cost effective, time effective, etc. But airships are not a stand-alone thing.

Stratospheric airships will be dealt with tomorrow. Our Missile Defense Agency (MDA) is the lead on this particular Advanced Concepts Technology Demonstration. It is a method to take a mature technology, do a field test and stimulate the technological progress and compress it into two or four years.

I always talk about “desired capabilities”. The US military wants a capability like Ultra Large Airlifters (ULAs, see Table 1). CargoLifter and SkyCat, which are the proposed systems most well known to this audience, are two commercial proposals that have the kind of performance that we want as a stretch goal. We never have enough lift. We move more than most people in the world do, so we want something that is pretty massive. Range capability of thousands of miles allows me move from origin to destination without bouncing my fire power a couple of times, and it lets me go around people who do not want me to over fly them. Speed has to be greater than the surface ships, but everything that flies pretty much is. I do not need a significant infrastructure at the end where I am standing out there in the middle of Thailand or Afghanistan or whatever receiving cargo. In places like that I have to move in infrastructure, command and control elements, K-loaders, what have you, to service aircraft and other things. That eats up the very lift I am trying to do, which I do not want. I want it to be able to land, roll off cargo, deliver it and fly away.

Table 1: Desired Capabilities of Ultra Large Airlifters (ULAs)

<ul style="list-style-type: none">➤ Ultra Large Airlifter (ULA)<ul style="list-style-type: none">▪ New term for proposed systems either pure airship or hybrid aircraft (combination of LTA and HTA attributes)▪ Payload and Volume far greater than conventional aircraft (100s of tons)▪ Range capability measured in thousands of miles▪ Speed significantly greater than surface ships▪ Does NOT require significant infrastructure for operations➤ Additional Airlift: Origin to Destination<ul style="list-style-type: none">▪ Volume is perhaps most valuable asset▪ Must bypass ports and airfields➤ Seek Asymmetric Advantages➤ Not platform specific approach➤ Must evaluate overall system contribution and integration into Defense Transportation System.

That is the desired capability. Obviously the reality of ballast issues, ground handling and other aspects will shape the realistic limits. But when you compare it to being limited to an existing airport, if I can land in a field anywhere, even the small infrastructure I have to put in for ground handling still gives me a tremendous advantage. Volume is more important than weight. We cube out before we weigh out. I use up all

the space in my lift platform, be it an airplane or a ship, rather than weigh it out. It was somewhat surprising when I was doing my study of this capability and an AH-64 Apache helicopter pilot looked at me and said, “Sir, do you realize the value of this thing?” I will point out that while I am studying a generic ULA capability, I had to have some measurable baseline for my study so I used the Cargolifter airship as a baseline for my modeling and my analysis. It is not necessarily the only type nor are we tied to any commercial entities. Something with a payload bay on the scale of 26 ¼ feet high, 26 ¼ feet wide and 164 feet long (CL 160 airship payload bay dimensions) enables me to transport helicopters in an “operational” configuration. That is what caught the attention of that young helicopter pilot. I may not have to break the helicopter down into 20 pieces to stick it into the back of a plane. When helicopters are broken down, parts are broken, and it takes time to reassemble them, fix what was broken, and then they must be exhaustively flight-tested. It would be advantageous to fly a helicopter in an operational configuration, and I just have to take the rotor blades off, fold them back, depending upon the particular helicopter, roll it off, do a quick 30 minute ground check and I have an operational capability. For example, our modeling showed I could notionally move an Apache AH-64 Attack Battalion 10,000 nautical miles and have it up and flying in 12 days versus 33 days by sealift.

Now, to give you some feel for the significant benefit to the military that this would allow... We use helicopters to fight people, we use helicopters to feed people, rescue them, etc. So that high volume has tremendous military applications. Obviously if your commercial cargo is more space than weight, the same applies. So we just look at how we would militarily do it, double deck platforms for more rolling stock, because most of what I move is trucks and very boring things. I want to bypass the ports and airfields. Those are really big targets, and are very congested. I have to fly people to link up with their equipment. I have to unload the ship. I have to stage it; I have to move it out through a constrained road network. I do not want to do that if I do not have to. This kind of capability offers me a way around that. From the Joint Task Force deployment that I was responsible for in Thailand, and my time in Asia, I know that there are a lot of soccer field size open areas around the world. Airships utilizing crane delivery, as the

Cargolifter design sought to, require only small footprints. There are also drop zones and larger areas, so it is a trade off between the different capabilities of a more purely airship design with either crane delivery or a vertical landing or the different flight characteristics of a hybrid aircraft approach (most hybrid aircraft designs would use a larger open area due to flight characteristics). If I can put a modular capability right where I need it and I do not have to put in all the trucks to move it around, that can be a mission force multiplier. When I have to move a lot of stuff for humanitarian operations or to feed people over long periods and conduct sustained operations, I want a larger capacity that a hybrid aircraft might give me. I have multiple missions. I want multiple tools. I could use every bit of lift you ever gave me.

One critical aspect to understand is speed, as measured from origin to destination. Most folks immediately think of aircraft with very great speed, but that is only over certain legs. Look at travel time from your actual origin to your destination, in terms of speed and complexity. Average speed of military deployment, from the Motor Pool to drive down the highway to the Port of Beaumont, to stage, to get on the ship, steam at 24 knots or less, unload, etc. end to end is 19 km per hour. With an airship or hybrid aircraft, you are talking perhaps 90 to 190 kilometers an hour, a significant speed differential. So those are the potentials; that is what we are most interested in overall.

Like most people who have spoken here, surveillance missions are another significant asset, and another capability that we do not have enough of, be it radar or eyes on. As far as the Navy experience, I have been lucky in that I am located around the D.C. area, I am able to tap into a lot of the guys whom you hear talked about. I know former Navy airship pilots who have won the Harmon Trophy for significant LTA flying accomplishments, and engineers with lifetimes of experience. So I can talk to the guys who actually flew these and/or designed them and they can tell me what works. For example, the Navy found out through very well documented studies that maintaining a continuous barrier station over the Atlantic Ocean appears feasible under all weather conditions because in flight the snow and ice did not significantly hinder them. It did make some exciting times for the pilots of course. But it did not shut down their

operations. The ZPG type airship, as an example, can be economically operated up to 50 knots true airspeed. This was the technology in the late 1950s and early 1960s. Wind, in terms of force and direction is the most important consideration in these kinds of operations. Obviously, in the northern Arctic that might play a part in much of the year.

Ground handling is the biggest challenge to a lighter-than-air craft. What do you do when you put it on the ground? Do you have cabling, do you have rope pullers (a term for the ground crewmen who handle current commercial blimps)? Do you have a system such as the Air Cushioned Landing System that the SkyCat (the hybrid aircraft design being developed by one of the commercial firms present at the conference) folks are proposing? How do you get around that ground handling as you take cargo on and off? How do you equalize your ballast issue and maintain equilibrium? There are several technological and operational ways to get at that. There are relatively simple ways to do it now in commercial and military use and I already know two specific areas of technology research for means to solve the ballast issue by other means. I am like one of the earlier speakers in that a lot of times in military movements, most of my cargo is one way. I go in, stay until I do the big job and then I haul it out. I have very little backhaul over the course of an operation.

There are many diverse missions for airships and/or hybrid aircraft, but partnerships between civilian and military players are necessary to make it happen. This slide [*entitled "Airships - Part of International Transportation System"*] shows old pictures of the flying aircraft carrier, which in the future could be a flying platform for Unmanned Aerial Vehicles (UAVs). You see the ZPG-3W doing the traditional mission of radar surveillance, and LTA platforms can do that in the future as well as serve as communications relays. The image of the airship married to its floating base, the surface ship engineered as an airship tender, show that you could base these LTA systems of various types at sea for reasonable periods of time and maintain a presence where we do not have one now.

What we really need to most effectively utilize this kind of technology is a worldwide infrastructure driven by the commercial assets that need it. You want to have an airship-tweaked to its atmospheric conditions and have the pilots used to that area of the world. It is not as effective if I have to move them from different climatological regions. If I have to top off some helium or need some mechanics, it is obviously much more efficient if I have this worldwide network. We leverage existing commercial assets and we devote time and effort day to day to ensure we have that commercial capability and access to it. Through our craft system we provide subsidies to the airlines in return for them anteing up when I call to move my people around. It is a symbiotic relationship. It is a win-win where by combining the commercial demand and a military demand, we are helping to make sure that lift asset is continually used so it can turn a profit and keep relative cost down.

We are going to need literally hundreds of these ships *of various types*, because I have never had enough lift to move everything I need to move, and I will have diverse missions, so these future ULAs and other LTA assets can definitely be kept employed. The challenge of course is finding the right combination of people, putting them together and focusing the energies of either existing manufacturers or new players to produce these capabilities. The fact that no military is going to foot the bill on its own pushes us to find an innovative way to partner in some manner to develop this capability. It has been said that, “Airplanes are designed by aeronautical engineers, helicopters are designed by mechanical engineers, and so far airships are primarily designed by idealists.” But the example of Litchfield, Colman and the current opportunity suggests that now is the time to combine idealism with the pragmatic business and military sense. Part of why I am here is to get a feel for where those key break points are – the “knees” of the performance curves – to help identify the next logical leaps of developing a capability and see where commercial needs match some military payloads.

Questions

Q: (Glenn Beach) Mike, that was an excellent presentation. You made the point that the ultra heavy lift airships are probably not going to be a unique military asset. Secondly,

the US Government is looking to leverage commercially available assets or to lease them. The fact today is that there has been a near disintegration, certainly a fragmented commercial community worldwide that was nearly simultaneous, Sky Cat Inc., ATG, Cargolifter and others. There has been a dispersion of a lot of the talent as well as the focus of funds directed toward the heavy lift solution. I would like for you to comment on that regarding your perspective, your knowledge and perspective on the United States Government's real commitment and its ability and/or interest in making a very real strategic, targeted investment to realize, to truly realize a heavy lift airship is technically feasible. The C5A would not exist without focused interest from the government, commercial interest would not have driven that. The heavy lift airship right now, the community internationally in my view needs government focus. Can you comment on that?

A: (Mike Woodgerd) You are right. It is a real challenge, and I do not think that the existing "industry" alone can do it. These comments are all my own personal opinion, of course. I always have to be careful how I say this so someone does not go off and say, "the US military said." My challenge is trying to find a viable approach that I can sell higher, that will lay out how we can actually develop this capability. Since I first saw the utility of LTA for military deployment almost three years ago, I have been learning and evolving my thinking of how we get there from here. Part of that approach is being here to hear all this so that I can go back and say, "Alright, here is what we want, here is a way to get there." The interest is absolutely up there. Senior people in the US Department of Defense are familiar with this capability, with some of these proposed systems, with some of the analysis that I and other people have done. I am not a one-man show in this of course. So, the fact that the potential exists is well known and the basic position that most of them have is "okay, show me and if you cannot show me one flying then how do we get there from here?"

So, I have that "How do we get there from here?" mission and I am supposed to go back with some plans and at that point we will see how convincing I am. It also just becomes like any major business. You have a lot of needs, you have a lot of wants, you have a

limited amount of resources, so where is the priority? We have the Global War On Terror, we have the transportation demands, the Army is modernizing its combat vehicles, and every senior officer gets bombarded every day with requests for money and requests for reprioritization of resources. So finding new combinations of players, maybe new people into the industry, people we do not even know yet, people we do know and a clearly demonstrated commercial interest, and a lot of people would be willing to come to the table and offer up assets and/or money as one potential way that we might get some development going. That is an answer and if not, I hope that was a good enough tap dance that I do not appear in the Winnipeg Press as saying the US military is committed to something or else I might stay here longer than I thought.

Q: (Glenn Beach) Just one follow-up. It was a good tap dance. [*Said in jest, as Mr. Beach and LTC Woodgerd know each other*]. I think that this forum really is a good place to have that type of discussion because in my view the ministries and the military and the commercial entities have to come together or it will be ten years from and now we will be having the same discussion. The three really need to come together if there is a real need.

A: (Mike Woodgerd) You are right, it will take a combination of all three. One other factor, as you and I and anyone else who knows the old timers knows, we have a fairly short window in which to take advantage of those national assets, those LTA veterans with that critical real world experience. It is not so much, in my opinion again, the technical challenges, daunting and difficult as they are. They are achievable. Any major large construction problem can be solved. Every bit of this is technologically feasible and it becomes more of a management of allocation and engineering discipline and systems management problem. We have men with invaluable experience in design, engineering, and operations. They know what worked and what were dead ends. They could save us years and millions of dollars if we take advantage of their capability to share knowledge with a new generation of engineers to help this effort. I asked Gordon Vaeth, who was a very famous historian and has worked on these things for decades, is it a technical issue? Is it a money issue? What do I take forward? What is the hardest part

to crack? He said, "It is training, training, training." It is the training of the flight crews, the training of the ground crews, the training of the support staffs, the training of human beings and development of operational procedures that is going to take the longest time and is going to be the real long pole on the tent as to whether we have success or failure. We will know when we actually have something operating as to whether it can really do the job fighting the winds up here and trying to get into a mining camp.

Q: Yes, I could not agree with that gentleman more and your comments as well. At the show me level, what are you talking about? The prototype level? Are you talking about an actually physically working aircraft that actually can haul several tonnes and do what is needed and performed in your wish list?

A: (Mike Woodgerd) What is needed is a good demonstrator. I will echo the comments of industry starting off with something in the smaller payload range that you could actually test and use. That clearly would be the best demonstrator to industry and the military. Now can you get there on a new system without flying an instrumented scale model to do wind tunnel tests, and computational fluid dynamics and water tests and everything else? Probably not, and especially in the new system, so it is still building something that is going to fly. You have got to go through your engineering to sell that to people. So, again we are sort of in the point of research and trying to find what folks might be able to produce that could demonstrate that concept. It is the same chicken and egg discussion that we have been having all day. That is the way it is right now.

A: (Walter Parker) I think there is a congruence building here. While Exxon and BP only have \$207 billion, in the case of Exxon net value \$167 billion, in the case of BP they do have the resources to at least think about some of these things and they are moving into ice-impacted areas with major investments. In Sakhalin, in the eastern Barents and the Kara Sea, where the idea of waiting for an ice breaker proceeding at six knots to pull them out of whatever hole they might be in as opposed to an airship coming along at 90 knots might prove attractive to them. I think that if someone wants to keep working that beat, there is some hope at the end of the road.

Q: Charles, you made reference to “operational need.” Nothing goes forward with the Forces unless you have an operational need. If you had to sort of latch on to a key one that you see as the greatest immediate opportunity, not necessarily the high altitude one, something relatively short-term that would really light a fire under this, what would you describe it as for your operations?

A: (Charles Hunter) Probably a lot of people would like me to say heavy lift asset but with my experience with Canadian Air Forces, we already have a very large project called Strategic Airlift on the books and it has already been on the books for I do not know how many years and we still do not have one so I would not see us turning around and buying a heavy lift capacity airship. When I talk about a surveillance platform, it does not have to be necessarily a high altitude one that is going to stay up there even if they think months or years. Just some sort of asset that is in the range of what I will call strategic UAV, like the Global Hawk or the Predator, which are kind of in the 48-hour range. Just give me an asset that I can use to do surveillance, that I can offload a duty that is chewing up a lot of our time right now with things like potentially illegal migrant ships off our west coast, counter drug, you name it. We do not have enough manned assets to do that. We cannot sit off our coast and watch for these ships to come in. Give me an asset that can sit out there and at least do that surveillance role for some sort of duration. This is what I would be looking for.

Q: Charles on that subject, is there a budget that identifies how much funding is available for those types of assets and some description of what duration is required and what the targets are that need to be detected?

A: (Charles Hunter) I am going to answer that in reverse order. Yes, we have revamped our surveillance needs. We are currently putting through our senior levels at the Air Force, essentially a statement of requirement that does spell out what we want, or what we think we need for a new national surveillance architecture.

There is not a paper on the street right now. Are there moneys available? No. We get major capital projects approved as an entire project when it reaches that stage and then we get the entire budget for it approved at that time. We do not go year by year, more like the US way. I can tell you what is in that document. There are three time horizons. What is out there that we could use now, so it is already mature, what is available in the next five to seven years, and then what is out there in the long-term. If you talk about surveillance, etc., long-term to me is space-based radar and stuff like that. I put airships in the middle category.

Letter to the Conference Banquet:

Message from the Hon. David Anderson, Minister of the Environment
to the International Airship Symposium,
“Airships to the Arctic”

Winnipeg, Manitoba
October 22, 2002

On behalf of the Government of Canada, it is my pleasure to offer greeting to all participants in the “Airships to the Arctic” symposium. I applaud your efforts to search for new, innovative and clean solutions to meet the transportation needs of our northern communities.

As you know, the transportation sector is a major contributor to greenhouse gas emissions, and developing sustainable transportation solutions is a key element of our efforts to combat climate change. The effects of global warming are expected to be particularly severe in the North, where we are already seeing the impacts.

The Arctic ice cap is thinning. Sea levels are rising. The permafrost is melting. Some winter roads are closing as much as two weeks earlier than usual, leading to increased costs for transportation. In some areas, there is more open water in spring, making transportation and hunting more dangerous, if not impossible.

Symposia such as this remind us that fighting the effects of climate change is not just about costs, but also about opportunities. There is no doubt in my mind that, as we seek and develop new technologies to slow the pace of climate change, we are at the same time opening countless opportunities in the fields of energy efficiency, renewable energy and sustainable transportation.

Please accept my congratulations for the effort you will put forth during the symposium, and my best wishes for an interesting and profitable discussion.

David Anderson
Minister of the Environment

**AIRSHIPS TO THE ARCTIC SYMPOSIUM
“APPLICATIONS FOR NORTHERN TRANSPORTATION”
PROCEEDINGS (DAY 2)**

Session 5: PASSENGER, SURVEILLANCE AND ADVERTISING BLIMPS

Dennis G. Wright (moderator)
Coordinator, Environmental Affairs,
Environmental Science Division
Department of Oceans and Fisheries
Central and Arctic Region

I have worked in the Arctic on and off for about the past 30 years and we have a lot of trouble with logistics. We do quite a bit of work with marine mammals and observing marine mammals and trying to formulate management plans for them. One of our big problems is how do you get an accurate count of something that spends about 70 percent, 80 percent of its time under water? If you are observing things by aircraft, you have two choices, the eyeball and/or the camera system. The eyeball does not function all that well for observing something at about 110 to 120 knots, so we have been using a lot of camera systems. But how do we correlate numbers that we see on the surface to total populations when the animals are spending about 80 percent of the time below the surface? It would be excellent if we could find a platform that would allow us to do long-term observation over a spot. Barry brought this concept to us, and our people have jumped at it. If the platform is available, we are ready to go and utilize it.

Similarly, the next big recreational opportunity is eco-tourism. It is gaining more and more in prominence every year. For example, just this past week an Air France jetliner was forced to land at Churchill because of a malfunction in the cockpit. The people could not find a place to stay because too many tourists were in town observing the polar bears. They had to get a special flight in to bring them to Winnipeg. In the spring there are waves of tourists congregating in the Churchill area to do whale watching, bird watching, and bear watching. In order to go out and enjoy the things that they are trying to observe, you have to be intrusive. I think airships will provide an excellent platform to observe our natural wonders in the north in a very unobtrusive way.

Rudy Bartel
Engineering Manager
American Blimp Corporation

It has been a real pleasure being here. I have learned a lot about what the industries are seeking when they are looking for different modes of transporting goods. As an engineer though, I have always found marketing fascinating. For example, looking at airship Internet sites and brochures. The American Blimp Corporation is one of ten companies that claim to be the leading airship company in the world.

I will discuss our vehicles and how we utilize them. I will explain some evolutionary changes that can be implemented over the next few years and I will talk about some revolutionary designs.

American Blimp Corporation or ABC got started in 1987 by Jim Thiele. We have manufactured over 25 airships. In marketing terms, to make it sound a little better, that is probably about 85 percent of the world's airship fleet. Eighty-five percent sounds a lot better than 25 airships. The first flight of the A-50 prototype was in April 1988. It was designed very specifically for advertising. The envelope was translucent. We put two 1000-watt light bulbs inside and it looked like a flying saucer at night.

What else does it mean though? Well, what it does mean is when you court Fortune 100 companies, you tell them you are going to be over the super bowl, you better be over the super bowl. So you talk about reliability, you are flying all around the country. You talk about being very rugged and you talk about repairability. It all boils down to simplicity. This airship is a little bit smaller than most of the airships you have seen. But as I always tell people, they are all this big on TV. The production version of the airship had to be FAA certified, which added a lot more safety features as opposed to just proving a concept. This forced the airship to grow in size and so we produced what is called the A-60. The 60 stands for 60,000 cubic feet of volume in the airship.

Within the first year, it started to be used as a surveillance platform. It is amazing when you give someone something and pretty soon they use it for things that you really never

intended. As a result of being used for a surveillance platform, now suddenly you have a gyro-stabilized camera. It needs more electrical power. You now have a camera operator on board, etc. This drove us to design the A-60+. Essentially it was an A-60 with a larger envelope to carry a little more weight so that it could, in some of the hotter, higher climates carry the camera and a camera operator for six hours. The first flight of the A-60+ was in October 1991.

In 1996, we decided to expand the fleet a little bit and came out with another model called the A-150 (150,000 cubic feet). This airship tended to address the sightseeing market and also the military surveillance market. No sooner did we announce that we were going to build a larger airship than companies that were advertising with us said well we want the bigger one. Now some of the larger airships are being used for advertising as well.

Under an FAA approved production certificate, ABC currently produces two models, the A-60+ and the A-150. The A-60+ is 128 feet long, seats five people including the pilot, and has two engines for reliability. We felt that two-engine reliability was key for marketing it to the Fortune 100 companies. Some unique features about the A-150 airship that differentiate it from the A-60+: We essentially took the gondola and stretched it and then we put larger engines on. We went from two German Limbaugh engines each rated at about 80 horsepower, on the A-60, to Lycoming IO-360 engines each rated at 180 horsepower. Both of these airships are designed to be put in standard shipping containers. You can break up the A-150, and put it into three standard shipping containers, ship it anywhere in the world and inflate it within a few weeks.

American Blimp also designs balloons. Several of our 600,000 cubic foot balloons were used successfully on Vancouver Island for logging in environmentally sensitive areas.

Our airship fleet has over 150,000 hours of flight time and several of our airships have over 10,000 hours each. To put that in perspective, if you fly an average of 60 kilometers per hour, that is 600,000 kilometers for one airship. This is about the equivalent of flying

18 times around the world. As a comparison, over the same time period that the airships have flown, we would go through two to three sets of ground support vehicles to support that operation. Think of your own car and what it looks like after driving 60,000 or 100,000 miles. Yet we have airships that have flown the equivalent of over 600,000 kilometers.

Aviation authorities from over seven countries have approved our airships for operation in their country. We have worldwide flight operations through our wholly owned subsidiary, The Lightship Group, with offices in North America, South America, Europe and Asia. We have operated in a wide variety of conditions. We have operated in 1994 in Lillhammer. It was -40° and it actually snowed a lot, a lot more than they ever thought it would. Figure 1 is an A-60 in Goodyear colors taking off in the morning to dust the snow off its back. We have flown in very hot climates, as shown in Figure 2. Figure 2 is a picture taken during flight-testing in Phoenix, Arizona. Throughout the day it does get quite hot and we have flown there regularly. We have also flown in high altitude situations; we have taken the first airship ever to Mexico City and operated it there, and we have also taken an airship around some of the Caribbean Islands in the tropics.

Figure 1: A-60 in Goodyear Colors taking off in snow



Figure 2: Airship Doing Flight Testing in Phoenix, Arizona



Platform utilization can be broken down into three areas for our class of airship: the obvious one is advertising, the second one is tourism, and the third is surveillance. Advertising is the primary mission. Tourism is an untapped potential. We have always wanted to get into that market hence we developed the A-150. But so far advertising clients have come along and we have been very busy growing to meet their needs. We have tried to give rides in two areas, in Las Vegas and in Orlando, Florida. Both of those ended when we found the airship could be used more profitably for advertising.

I could probably characterize the surveillance market into three different categories: police with infrared/optical packages, the military, usually with more comprehensive sensors, and the natural sciences. We use infrared/optical packages for border patrol, sporting events, for example covering the Olympics or soccer games. You can monitor people and take their pictures and download them to the police. They can see whether that person is a terrorist, or in the case of soccer games, a hooligan. The Rio police have one of our blimps as a very visible proactive measure against crime. As an experiment they decided to use it and it ended up in all of the papers. Translating some of these clippings from a newspaper in Brazil, “blimp fights crime.” The airship shows that you are being very proactive against crime because it is a very visible entity in the sky.

In Kosovo we have flown what is called ‘Mine-Seeker.’ They had been using the antenna in labs, but decided to take it out into the real world and found out that the airship was a very successful platform. We now want to go to the next step and take that to a production version. The United Nations is very interested in sponsoring that

program to support flying airships around the world to detect some of these millions of land mines that have been left in farmers' fields.

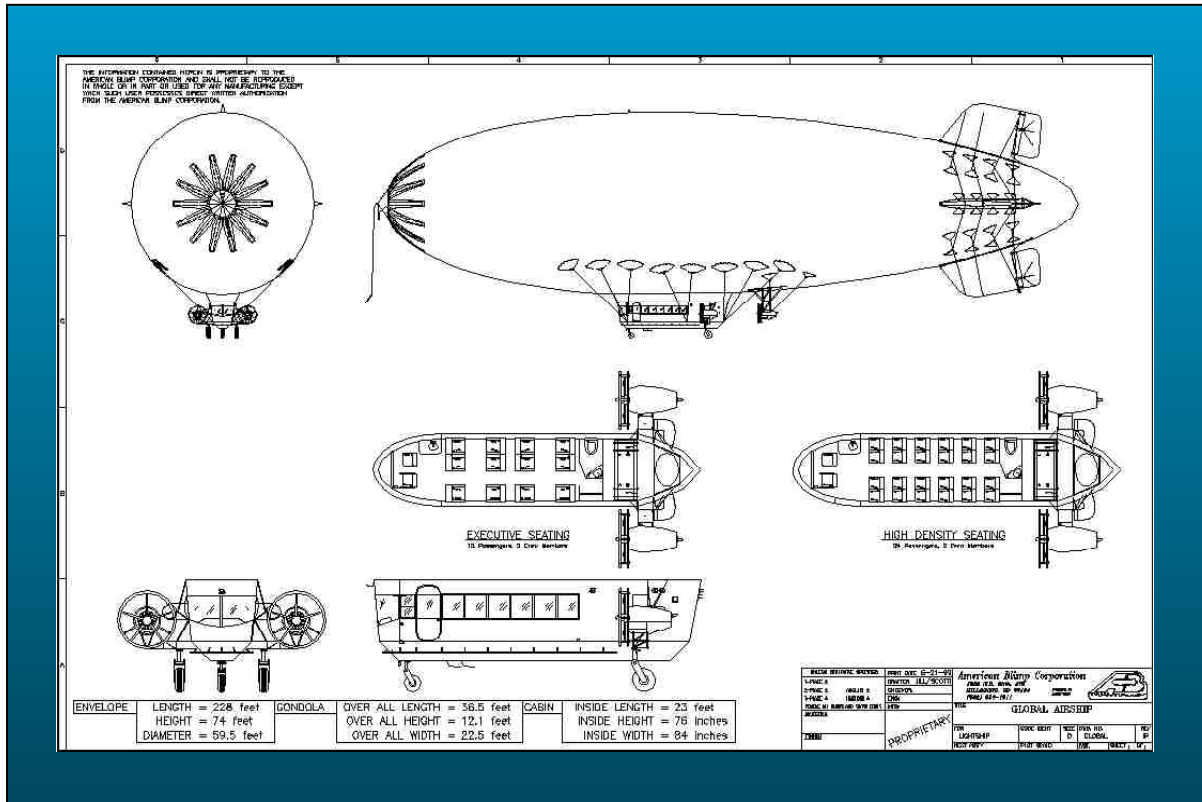
I cannot talk about some of the other programs that we have been involved in, but one of the things that I find consistent throughout is that the people who develop the sensors, specifically the radar people, really like the airship because they can now put a bigger antenna on their current system and increase their effectiveness. The radar specialists have always been driven to smaller and smaller radar and now, to take that same system and put a big radar on, their gains and resolutions just went way up. What the airship does promise that other vehicles do not do as efficiently is the persistent airborne presence.

One of the things that I have really enjoyed is taking a ride in an airship cross-country and seeing the wildlife down below. This is one of the things that amaze me. Obviously if you fly low enough and fast enough, you can scatter them, but if you fly high enough and you go nice and slow, the wild life is not at all disturbed by this airship flying slowly overhead. It can be an environmentally friendly vehicle.

I have shown you platforms we have and where can we take those platforms in the next year or two. It really depends on the mission, but some of the obvious factors are just changing from normal internal combustion engines that use gasoline to diesel engines. You immediately increase the fuel specific consumption. Bigger fuel tanks are something you can easily add to airships. Another one is the propeller muffler optimization. When we designed the A-150, we specifically designed it to be a quieter airship and we actually took performance penalties as a result. We had a company design specifically for us a five-bladed propeller so that the propeller signature was a lot quieter. We specifically had a company design a muffler for us. Essentially we drew this engine in the nacelle and sent the drawing off to the aircraft muffler manufacturer with our orders to put the biggest muffler they could fit in there. It is a pretty big muffler. What amazes me is that it is a very quiet engine. So if you want to increase the performance and sacrifice noise, that would be one of the areas that you could immediately address.

Some of those evolutionary changes for example can end up like the illustration in Figure 3. This airship does not exist, but it does take some of those key things that we talked about and incorporates them into a 25-passenger airship, with huge windows, beautiful for sightseeing. The airship in this conceptual drawing is about 228 feet long.

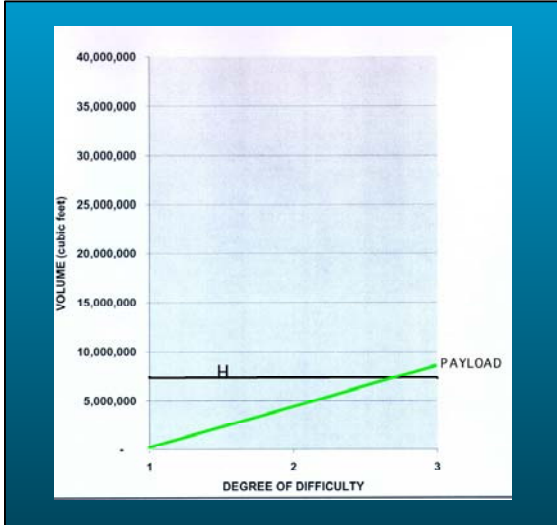
Figure 3: Evolutionary Changes



Well, where do we go from here? One of the things that drive costs is airship volume. It is one of the primary indicators of cost. I thought an interesting analysis would be a parametric study changing one variable at a time, payload, airspeed, altitude, and duration. Let us say, as a starting point, you have a 1,000-pound payload, 40 mph cruise airspeed, and you fly 10,000 feet for ten hours. You end up with an airship, coincidentally at 150,000 cubic feet. Volume of the airship is a good indicator of cost. I have gradually increased the payload of that airship to see what happens to volume. As you increase payload, the airship has to get bigger and needs more horsepower to fly that 40 mph at 10,000 feet. Figure 4 suggests that the payload actually increases linearly, but

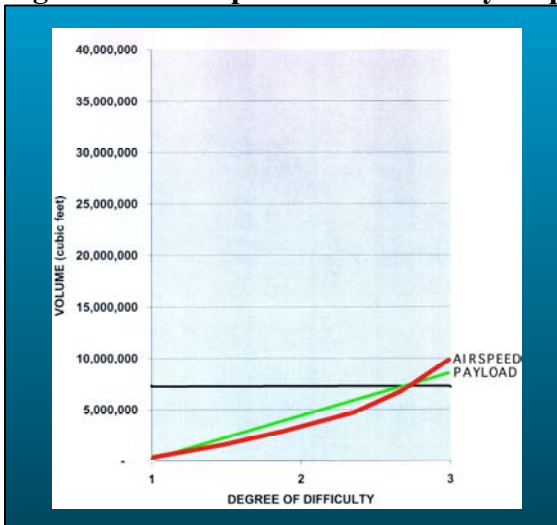
not very much. I call this axis the degree of difficulty. When you get to 300,000 pounds, you start talking about a very complex airship.

Figure 4: Airship Parametric Study – 300,000 lb Payload



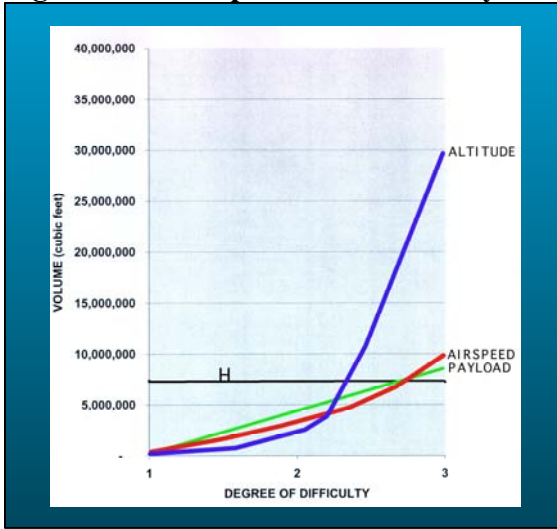
In Figure 5, I have increased the cruise airspeed of the airship to 150 mph. As a data point, the Hindenburg cruised at about 70 mph. With higher airspeed cost increases somewhat linearly but it does get slightly steeper toward the end.

Figure 5: Airship Parametric Study – Speed of 150 mph



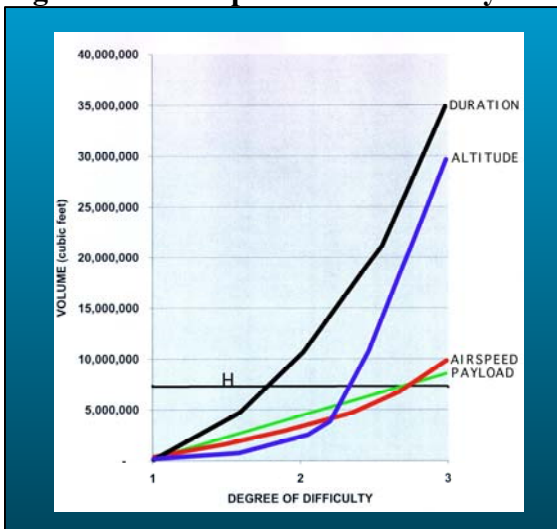
In Figure 6, I have increased the altitude to 60,000 feet. Suddenly the airship volume increases rather dramatically. This is one of the challenges of flying at a higher altitude.

Figure 6: Airship Parametric Study – Altitude of 60,000 Feet; 1,000 lb Payload



In Figure 7, I have increased the duration to one month. This curve is not really valid; if an internal combustion engine operates for one month, a lot of the parameters are not applicable anymore. Realistically, it is possible to fly for one week, but beyond that issues such as reliability, weight changes because of fuel burnt, etc. effect the parameters of the study. Beyond one week, it is necessary to use certain other energy balancing techniques such as solar cells. However, as a data point, it is rather interesting.

Figure 7: Airship Parametric Study – One Month Duration



In conclusion ... I will put my marketing hat on now ... there are a lot of challenges depending on the mission, and American Blimp Corporation can solve them. Actually it requires some rather novel solutions. If you just use the standard parameters, you end up with some difficult and unusual airships. As you will see from some of the other members today, by applying some novel technological solutions, airships can do a lot of the jobs that you are talking about. Airship technology however may not necessarily be the driver anymore; a lot of other things do like cost and environmental impact. On the one hand the airship has a very low environmental impact but on the other hand what is the environmental impact of an airship flying in northern Canada with, say, 10,000 pounds of fuel on board and the airship crashes. Now of course airships are not supposed to crash, but that is the question somebody is going to answer. So it starts becoming more a political solution than a financial solution versus a technical solution.

Questions

Q: Just out of pure ignorance and flight characteristics of an airship, what happens when you fly into icy conditions? And number two, what happens when you let go of a one tonne, five tonne or ten tonne payload?

A: (Rudy Bartel) No, those are good questions. Our airships are certified for IFR conditions which means flying into conditions where you need instruments. You are not supposed to fly into icing conditions, but nevertheless occasionally aircraft and airships do end up flying in icing conditions and heavy snow conditions. One of the interesting features of our airship is that the envelope coating is like Teflon in a pan. The snow and ice tend to shed off. With the Goodyear airship, at Lillihammer it snowed through the night and the snow would pile up. Before they put the fuel and people on board, the airship would take off and go once around the field. There would be a big cloud of snow behind the airship. Then they would come in and land and the camera operator would go on board and some of the other people and they would put a full load of fuel on for the day's mission. So snow is not really a problem. Dropping a payload is. Obviously the airship flies very close to equilibrium with or without a payload. If you do have a payload and then you drop it, the balloon goes up. You cannot do that. You can possibly

come up with some novel solutions, depending on the job and depending on how much you wanted to pay. There are some novel solutions for very unique cases where you can do something like that. But as a normal mode of operation, you really do need to account for your dropping or taking payload off. You have to put an equal amount of weight back on.

Scott Danneker
Airship Pilot
Zeppelin Airships

It is an honour to be addressing this symposium. I have learned a lot about the Arctic in the last month. I actually had no idea I was going to be here until about four weeks ago, and I must confess to somewhat less than a limited knowledge of the challenges that are presented here prior to my notification that I would be coming. Hopefully also within the last couple of days you have learned something about the airship industry and our capabilities. I have heard a lot of talk about the potential uses of airships for carriage of heavy cargos up into the Arctic regions. It has also been illustrated that at best it is still some years in the future. So rather than focusing on potentials and speculating on what those potentials might be, what I would rather do during the course of this brief presentation, is to tell you exactly where we stand today. I will be talking about the company, the characteristics of the Zeppelin NT and what makes those unique in the airship industry. The main focus of this presentation is the passenger carrying capabilities of airships. Finally, I will wrap things up with a brief description of some alternate applications.

Airships are not an alternate solution to aircraft or helicopters for quick or scheduled passenger or cargo transport, but they are ideal solutions for special missions. I am not saying that these other applications are not possible or feasible, they are. But right now, this is basically where we stand in the industry. The Zeppelin airship currently in operation is a derivative of the old Zeppelin Luftschiffbau GmbH. that was founded in 1908 by Count Ferdinand Von Zeppelin. He made his first flight 102 years ago on Lake Constance and for the next 40 years the core business of the Zeppelin Corporation was airships for both military and passenger applications. During World War II, the airship

construction facilities were pretty much destroyed so they had to go into other business ventures, among them being the construction of radar antennas and heavy equipment. They are manufacturing caterpillar products under license in Germany right now. The core business at the old Zeppelin Works in Friedrichshafen is currently the manufacture and construction of chemical silos.

In 1992, the decision was made to re-enter the airship business with the new design of the Zeppelin NT airship. The Zeppelin airship company basically consists of two main entities, the first one being Zeppelin Luftschifftechnik. The purpose of this company is the design, construction, development and production of airships. Once the airships have been designed, manufactured and certified, they are operated by the Deutsche Zeppelin Reederei, DZR for short, whose specific purpose is to operate the airships.

Zeppelin NT is currently the largest airship flying in the world, so this gives you an idea where we stand in terms of capability. The volume is just over 8,000 cubic meters. It is about 75 meters in length and has a payload of 1.7 metric tones, which translates to 12 fare paying passengers plus the pilots. Three engines rated at about 200 horsepower apiece provide propulsion power. All of the flight test activities, developmental flight testing, and certification flight testing activities were conducted with the first prototype, the airship Friedrichshafen. To date, it has made over 1,200 flight hours, over 300 flights and LBA certification was awarded to this airship in the spring of 2001.

Once certification was awarded, the Deutsche Zeppelin Reederei was established to operate the airships and the passenger operations. DZR was originally founded in 1927 to supervise the operations of the Graff Zeppelin and the Hindenburg. Once the passenger services ceased there, it was kind of shelved. DZR was re-registered on January 24, 2001 for the specific purpose of operating commercial airships and the commercial service began in August of 2001. The Bodensee was the second airship built and the first production series airship. It has conducted over 1,400 flight hours, approximately 1,400 flights and it has carried over 11,000 paying passengers to date.

NT equals new technology based on a semi-rigid design. The advantage of using a semi-rigid design is that we can remotely locate the engines from the gondola. This provides a much quieter and more comfortable flight for the passengers. But more importantly, because of the engines being located out on the hull of the airship, it allows a much higher degree of maneuverability. The propellers are vectorable and are used to control the airship at all air speeds.

The design of the new Zeppelin differs from the old Zeppelin. The Hindenburg was a rather complicated, rigid framework within which were contained the gas cells for the lifting agent. This was a rather complicated and very expensive process. The Zeppelin NT has a triangular structure with three longitudinal girders running fore and aft constructed out of aluminum that are held together by a series of transverse frames. The structures that look like a Mercedes Benz logo are the attachments for the fins. ILC Dover manufactures the envelope. Once the pressure testing is completed, it is placed over the structure. It is pretty much like putting a sock on a shoe. Figure 1 presents the internal structure with the fabric envelope attached. The little horizontal bar to the right is called the “dog bone.” The forward engines are attached to the dog bone and that also contains the fuel cells for the forward engines.

Figure 1: Triangle Structure with Envelope Attached

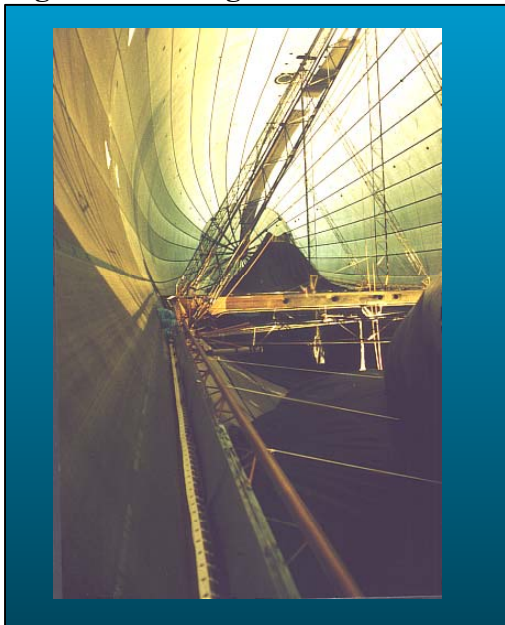
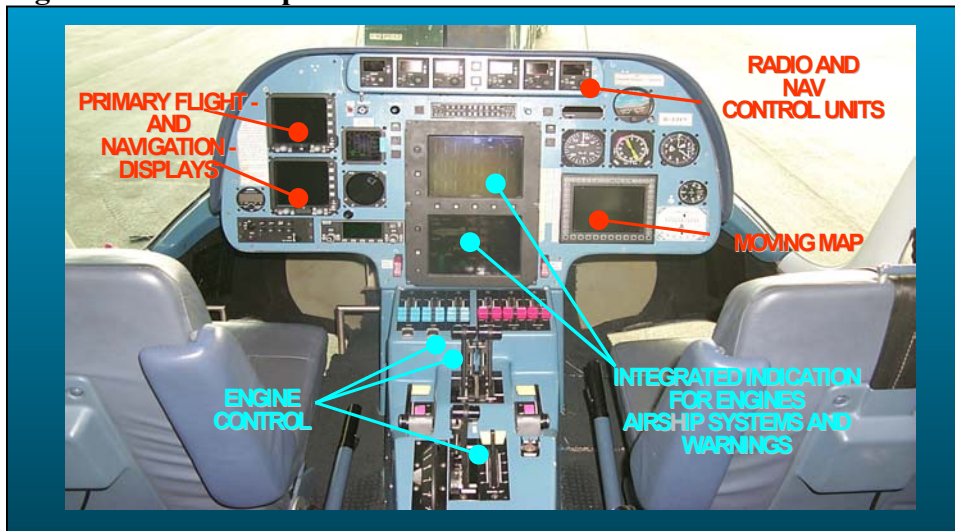


Figure 2 shows the cockpit of the N07 that employs the latest, up-to-date avionics. The radio and navigation control units are pretty much common to all aircraft. The engine controls control the thrust of the engines as well as the angle of the vectors. Integrated instrument display system is basically the pilot's eyeball into the airship system. It tells him just about everything there is to know about what is going on inside the airship. Moving map display is hooked up to the GPS, allowing for precise navigation. During normal cruise flight, the aerodynamic controls are controlled by pilot side stick, which makes the workload for the pilot much easier. It does not have a complicated series of wheels or very heavy control loads on a control yoke to deal with; it is all done with a side stick. During the take-off and landing phases, the side stick also controls the aft propellers for pitching and yaw control.

Figure 2: N07 Cockpit



The forward engines of the airship swivel in the take-off configuration and they are also in a similar position for landing. The real star of the airship is the aft propulsion unit. It is a single engine connected to two propellers. We have a lateral fan on the side that looks much like a helicopter tail rotor. During the landing phases it provides the pilot with the yaw control. The vertical propeller will also provide the pilot with pitch control during the landing phase. The important thing to remember about an airship, a conventional airship especially, is that in order for the pilot to steer it, he has to have aerodynamic control. This is fine and great when you are flying, but when you are trying

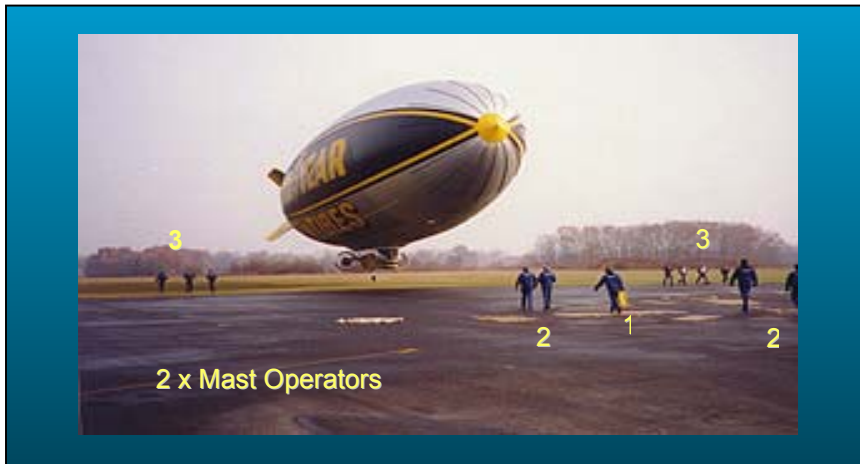
to land, and especially when you are maneuvering on the ground and trying to get the airship onto the mast in very calm winds, the pilot simply cannot steer. There is no means at his disposal to do it. But with the thrust vector system, it does allow the pilot full control authority both in height, and in pitch and in yaw, basically giving him everything that he needs to maneuver the airship up to the mast and secure it without excessive aid.

The airship forward engines in cruise provide forward thrust as does the aft propeller. The lateral propeller during the cruise phase just spins idly and all the directional control with the airspeed is accomplished very easily with the aerodynamic surfaces. During landing, it is a little bit different; the forward engines are vectored upwards. With the forward engines, the pilot will control his height and his airspeed, the aft propeller will act as an elevator for pitch control, and the lateral fan will act as a rudder. This is independent of airspeed or wind speed and it gives the pilot full control.

So how does that translate into some sort of advantage for a potential customer or an operator? The best way to illustrate is to compare it against a conventional airship landing. Figure 3 presents a conventional airship without augmented thrust vector control making a typical landing. The crew chief's job is to direct or conduct the operations or the activities of the other ground crew member. A big misconception about airship ground crews is that they are there to hold the airship down on the ground. This is simply not the case. As I said before, when an airship lands in light winds the pilot cannot steer. There is maybe some little bit of thrust that he can get off the engines used asymmetrically but basically the pilot is helpless, so the ground crew is there not to hold the airship down but rather to steer it. They are conducted by the crew chief. To assist the crew chief in this operation, you have two people who are going to be working on the left side of the car. Another two persons are going to be working on the right side of the car, working the handling rails, plus a linesman. This makes three ground crew on each side. There are actually four people on the right hand side of the picture, but normally the idea is to keep the crew balanced, so I assume that that fourth person was just a spectator. On top of that you need two mast operators, one working on top of the mast to

lock the airship on, and another person on the line to pull the airship physically onto the mast. This leads to a total ground crew of thirteen. These people have to be paid and, as a result, of course the operational costs are going to go up dramatically.

Figure 3: Conventional Airship Landing (Ground Crew of 13)



Zeppelin, on the other hand, is a different story. We have one ground-handling officer. We have eliminated the term crew chief because it is superfluous with no crew to coordinate. We have one ground-handling officer, and two mast truck operators, one to position the mast in front of the airship and the other one to operate the mechanical wench, for a total of three. This is a dramatic cost reduction as far as ground crew numbers are concerned.

Figure 4 presents the inside of the airship. Twelve passengers currently fit into the production ship that is doing passenger flights. It is also possible to enhance that to more of an executive suite. So what is a Zeppelin passenger flight really like? What is the modern Zeppelin experience? The passenger handling facility in Friedenshafen is a rather elaborate affair. We have a place where the people can come in. They receive their tickets and their souvenir booklet. In a little room in the back, they get a safety briefing prior to being taken out in the airship. Once they are checked in, true to southern German tradition, there is a bar where they can buy beer and schnapps, and sit back and enjoy that while waiting for the next flight to arrive. There is also a souvenir shop. How

elaborate the passenger service or passenger reception area is, of course, up to the requirements of the individual customer.

Figure 4: Standard Cabin Arrangement



Passenger unloading is a rather straightforward affair. All the passenger transfers are done off the mast. In Figure 5, the crew chief is in front of the airship and the two people at the door helping the passengers on the airship are the mast truck operators. So, we are still down to three ground crew. Once the passengers are loaded on board, the stairs are removed and normal take-off is made.

Figure 5: Passenger Loading and Unloading



Normally we conduct anywhere between seven and nine one-hour long flights per day over Lake Constance. The pilot stands up and gives the passengers a quick brief immediately before landing and just after take-off. During the flight, the passengers are not normally sitting down. They are free to move around the cabin at their will and take photographs from either side. One of the advantages of the engines being located out on the hull is a better view of the scenery. Given the wonderful view, the comfort of the ride, and the quietness of the ride, the airship really lends itself to eco-tourism.

I did some surveys on what an eco-tourism flight would be like in Churchill, Manitoba, although I am sure there are many other places that could use this type of transport as well. One of the first questions is weather, so I did a quick analysis of the weather at Churchill from the Internet. The temperatures, albeit a little bit colder than what we experience in Friedrichshafen at the same time of year, are certainly well within the range of the airship and do not afford any problem whatsoever. Additionally, the airship is provided with a very efficient heating system and it makes for a very comfortable ride even in temperatures below freezing. Average daylight hours are a little bit better but still somewhat comparable to the average daylight hours that we have during June, July, August and September in Friedrichshafen. These months are our biggest passenger carrying part of the year. For average rainfall, Churchill compares very favorably to Friedrichshafen. We have flown in rain and we will continue to fly in rain. The reason I bring it up is that generally in rain showers, the visibility is somewhat reduced and is not so good for the passengers who want to see something. But we have flown in rain, and in fact we have flown in light snow showers with the airship.

Another main consideration that we have of course is wind speed. The highest average wind speed in Churchill for these months is roughly about 23 kilometers per hour, which again is well within the operating limitations of the airship. Strong winds in and of themselves are not a problem for airships. I would much rather land an airship in 25 knot steady wind than wind at 10 knots gusting between 5 and 15 because with those gusts there is a change in direction and that is what makes it really sporting. When the winds are steady, there really is no real problem for the airship. In fact the Zeppelin has

operated up to 28 knots with three crewmembers. Churchill is on Hudson's Bay and to the west the terrain slopes up gradually over many miles. There is not much orographic uplifting or mechanical turbulence created in this type of environment, so we could pretty much expect steady winds when those winds actually do come.

We learned yesterday that search and rescue is taken care of by satellite and there is no real role for airships as of right now in specific search and rescue. But perhaps there is a role in case of a disaster of larger proportions; the airship can provide a very good and stable communications base. The Zeppelin NT has pure hover capabilities like a helicopter so it can loiter over and perhaps even pick people out of the water. This is certainly within the realm of possibility. Mail transfers from ships have already taken place, so that could be adapted easily to recovery of people from the water. Airships have been involved in urban patrol over large assemblies of people employing infrared cameras and high-resolution color televisions. I believe that technology could be adapted very easily to anti-poaching. The suitability of an airship for Maritime patrol, harbor defense and force protection has already been discussed. The airship also can be modified very quickly from a passenger fit to put in any type of surveillance equipment that would serve these applications. Environmental monitoring can be done during the course of normal passenger operations, as it was when I was involved in passenger operations in San Francisco. We would fly up and down the bay with a load of paying passengers and on several occasions, we saw ships that were putting out or discharging oil in an unauthorized fashion. We would notify the coast guard who would take the appropriate action. There are several tasks that can be done during the course of normal passenger operations.

Questions

Q: What do you charge for a one-hour flight?

A: (Scott Danneker) Depends on what day of the week it is. On weekdays, it is 300 euros per hour and during the weekends they up it to 330 for a one-hour flight. I also

have to add that in Friedrichshafen every flight this year, and the year prior to that, has been fully booked. They are already starting to take reservations for 2003.

Q: What led the Zeppelin Company to elect stern vector thrust versus at the bow, and what are advantages?

A: (Scott Danneker) Oh gosh, do not get me on the subject of bow thrusters and tail thrusters. I have flown both of them and I have some very definite opinions that would carry us into the wee hours of the morning. The main advantage of the tail thruster is that it can be used as a normal propulsion engine during a normal cruise. You can use it as a forward driving engine whereas a bow thruster can only be utilized during the actual landing process when the airship is going on and off the mast. The bow thruster is a rather complicated bit of kit that has to be dragged along, with the resulting weight penalty, throughout the entire course of the flight just so that it can be used for perhaps the last five minutes of the flight. The tail thruster can be used throughout the course of the flight and it does not rely on a separate fuel system.

Q: But that is the question with regard to the size of the airship. Obviously it works at the size you have now. As you start getting bigger, if you, say, expanded to a 20 passenger Zeppelin, do you need more crewmembers for the ground?

A: (Scott Danneker) No, I am convinced that it would not. Obviously it is something that would have to be assessed but I am convinced that it would not. The thrust vector system that is currently in place on the Zeppelin gives the pilot everything that he needs, and the larger the airship becomes, the more stable it becomes. The higher the inertia, the less susceptible it is to wind changes. So I can only assume quite confidently, that the larger the airship, the easier it will be. It is just a matter of scaling it up because of the technique and the system works very effectively.

Q: With regards to the NT design, I am aware that there are in fact larger designs that have been on the drawing board. I am not sure of the dimensions of the new hangar in

Friedrichshafen. Has there been any talk of Zeppelin possibly receiving contracts for larger scale airships? Have they looked at acquiring the Cargolifter facility? I know it is probably far beyond the size of what Zeppelin is looking at. But, has it been considered?

A: (Scott Danneker) Zeppelin, I am proud to say, is very provincially minded. There have been a lot of companies who have gotten up and tried to run before they can walk. Zeppelin is definitely not one of those types of company. Right now the focus is being placed on the LZN-07 and assessing its commercial viability. All signs right now are looking very positive. Any plans towards expanding the size of the airship and expanding the facilities, perhaps up to Cargolifter as you suggested, are still in the future. This will only come when the commercial viability of this ship has been fully assessed, the profits have been brought in and there is actually room to expand. Basically we keep ourselves small, work with the small and as the opportunities arrive, we will expand. Everything is looking positive right now, but a larger ship is still somewhat down the road.

Lei Harris
Species at Risk Biologist
St. Andrews Biological Station
Department of Oceans and Fisheries

Good Morning. I am going to present an overview of some work I did this summer in collaboration with Jim Hain from the Associated Scientists at Woods Hole. We work on the North Atlantic right whale, which is a highly endangered species. It is one of the most endangered cetacean species in the world. Current population estimates vary between 300 and 350 individuals. The Bay of Fundy is an important area for this species of whale. Up to two thirds of the entire population spends its summer there. It is an important nursery and also an important feeding area. The Bay of Fundy is also an area of much vessel activity. There are groups such as whale watching companies and right whale researchers that focus on right whales. There is also other vessel traffic that is not focused on right whales, such as recreational boaters and commercial fishing activity. Currently, there are no regulations on the minimum distance that vessels must keep from right whales, although they are highly endangered.

We decided to undertake a behavioral study to describe and quantify disturbance to the North Atlantic right whale due to vessel activity. Through this project we hope to provide a definition of disturbance. This can be used to establish precautionary terms for management of right whale research. It could also be used as a defensible basis for regulations for vessel approaches and for whale watching. We could use this to refine ongoing programs to educate mariners on how changes in vessel operating procedures can minimize the disturbance to right whales.

One problem was trying to figure out how we were going to observe the right whales without causing a disturbance. Obviously if we approach them in a vessel, we are part of the problem. Some people have done similar research from land, but the right whales are too far off shore to be able to do that. So we decided to use a remotely operated video camera suspended from an aerostat.

In August 2002, we conducted a pilot study to test our equipment and also our study design. I have prepared a ten-minute video to show some details on the video system, the aerostat that we used, and examples of some footage we were able to collect this summer. This pilot study was for 14 days, so hopefully we will get funding for next year as well. We plan on having an extended field season next year to collect more data. This summer it was mostly focused on testing of equipment and the study design.

(Video voice track)

In preparation for a field investigation of vessel induced disturbance to right whales, a 14 day pilot study was conducted in August 2002 to test the study design and equipment. We used a remotely operated camera mounted to an aerostat to non-invasively record right whale behavior in the Bay of Fundy. The advantages of this overhead video system include: a unique perspective, increased accuracy of behavioral data, real time information and the ability to locate a whale below the water surface.

We used 43-cubic meter helium filled aerostat from Aerostar International. The envelope was made of ripstop nylon and had four removable rigid fins for stability. A payload

rack constructed of 12 mm PVC pipe was affixed to two longitudinal lacing strips on the bottom of the balloon. These are positioned laterally to the centerline and below the center of lift. The total payload including the rack, camera, pan and tilt mechanism, weather station, and camera control cable weighed 12 kilograms.

The aerostat was deployed and retrieved using a winch bolted to the deck of the boat. The tether was made of six-millimeter double braided nylon. The camera system used was a Sony Digital 8 handycam in a waterproof enclosure. A polarizing filter was affixed to the inside of the enclosure in order to reduce glare. The pan and tilt system was controlled remotely by a cable attached to the main tether. The zoom and focus were fixed.

Wind speed, barometric pressure and other environmental measurements were monitored at the balloon using a Rainwise MK3 wireless weather station. The images were transmitted to a Sony Digital 8 Walkman. This enabled us to keep the camera on the whales using the pan and tilt system. We also used the walkman to record the images so that we could change tapes without lowering the aerostat. Information on environmental conditions was transmitted to the monitor.

This footage of a surface-active group was recorded from the deck of the boat. It was difficult to discern individual whales or their behavior. As seen in this footage of the same group of whales, the overhead video system provided a unique perspective. Individual whales and their behavior could be observed clearly. It was immediately obvious that there were four whales present in this group. Also the feces at the surface was much harder to see from sea level and was not visible in the previous footage.

We also found that from the overhead perspective we could see whales under water to a depth of five meters. This enabled us to follow individuals with the camera except during deeper dives. In this footage of a surface-active group, the white belly of a third individual can be seen under water. Only two whales were visible from the boat. Distinct behaviors such as blows or dives were easily observed and quantified.

The time-coded tapes were analyzed after returning from the field. By recording the whales' behavior we were able to collect more accurate and more numerous data. Another advantage to using the aerostat is that we were able to maintain some distance from the whales without compromising the data. During this recording, we were approximately 100 meters from the whales. In addition to behavioral studies, this technology has other applications. Recordings can also be used for photo identification. Still images can be grabbed from a digital video allowing the researcher to select the best shot of a callosity pattern. Distinguishing marks and scars can also be documented. A white patch on this whale's left side is clearly visible even under water. We can see a large white mark across the back of this individual. We can also see small white patches toward the trailing edge of the flukes. Deep wounds on this whale's left side are easily seen in this footage. By transmitting these images to a monitor, one knows immediately if the required images for photo identification have been recorded. This minimizes the amount of time one needs to spend with each whale.

This methodology also proved useful in the assessment of a whale prior to a disentanglement effort. Behavioral information on the entangled whale was provided. The overhead perspective allowed us to see the entire whale, even those parts submerged, for a more thorough assessment of its condition. Two white floats can be seen on the whale's tail stock underwater. And unlike other aerial photography methods, this provides real time information to the disentanglement team.

The video system also allowed us to visually follow the whale when making shallow dives and keep track of its location. This could not be done from the boat. Based on this pilot study, we feel that this aerostat and camera system work well for behavioral research such as our study of vessel induced disturbance of whales. We were pleased to find it had additional applications such as documentation of features for photo identification and assisting in the assessment of entangled whales.

(End of Video)

Questions

Q: What was the cost of this operation for the two-week surveillance operation?

A: (Lei Harris) Including field staff, vessel charter, subcontractor it was about \$50,000.

Q: \$50,000?

A: (Lei Harris) Yes, but a lot of that was things unrelated like the vessel charter. The cost to use the aerostat was minimal. Our associate already owned the aerostat and he just filled it up at the beginning of the two-week period and we had to top it off. The camera system was not expensive either. Well, it depends on what you consider expensive. It was about \$10,000.

Q: What is the status of the regulatory development for airships?

A: (Rudy Bartel) The smaller airships that you see flying today have well-established regulatory requirements. Because of the development program you have heard about, they essentially forced the issue that regulations needed to be written for much larger airships and the German LBA created some of these regulations. I think that started first with Zeppelin forcing regulations for larger airships to be written. The basis of those regulations has now been used, or will be used as the foundations for regulations in the UK. The FAA is using the German LBA regulations as a basis for their proposed regulations on larger airships.

A: (Scott Danneker) The Transport Airship Regulations (TARs) were developed in conjunction with the LBA. Norman Mayor is the contractor from the United States and a Zeppelin company and it was based on the large airship requirements.

Q: How long does it take from design to certification of an airship?

A: (Rudy Bartel) For what size project?

Q: A 40 to 50 tonne capacity airship?

A: (Rudy Bartel) It depends on how fast you want to burn the money. It would be really hard to put a number to it, but probably from project go ahead to when you had a certified production vehicle for the customer would be four to five years. You start talking about larger airships and the problem gets bigger. You start needing a very large hangar.

Q: My question is regarding training the pilots. How long does it take? Where is it done currently? And what is the cost?

A: (Scott Danneker) As far as pilot training is concerned, it depends on which regulations you are certifying to. In the FAA, the course from taking an already trained fixed winger pilot through the full lighter-than-air course has a minimum requirement of 50 hours. However, this is the minimum requirement. Very seldom during that 50 hour period do you get to expose the pilot who is under training to all the conditions he may encounter in the real world. So generally what happens is a pilot will receive his official credentials, if you will, from the regulatory authority and then he will operate under supervision of the company who he is employed by as a pilot under supervision. Generally it is about 150 to 200 hours before the company will allow him to go out and operate as senior authority on board that airship because it is a major investment. You want to make sure that the guy is going to be equal to the task of any conditions that he might encounter during the course of the flight.

How do the companies factor training into the operation? Obviously you already have the staff. All the training, I should stress, is done by the companies. There is no airship pilot school that you can go to and say, 'hey, I want to get my blimp pilot's license.' There was a company in Fort Lauderdale that operated for just a couple of months with the GA-42, the smallest airship obtainable, single engine, micro light type of airship. He did offer private instruction to anybody who was coming off the street and that was running at about \$500 an hour. But for that he had to pay for depreciation on the airship,

his time, the ground crew, etc. But with a company that is already in existence, like Zeppelin, ABC, or Airship Management Services who have the crew in place, it is just a matter of the fuel and the depreciation on the airship for that particular flight hour.

Q: Are there any training aids that are in place like simulator-type equipment?

A: (Scott Danneker) Simulators can only be used as procedural trainers on an airship. An airship pilot has to rely to a very large extent on the seat of the pants feel. The airship responds slowly but when it responds it responds positively and over years of experience and many flight hours, he develops what we refer to in the industry as ‘the feel.’ The visual cue is always going to be the most important one, but the way he actually responds to a certain environmental influence, the wind switch, what have you, depends to a large extent how successfully he corrects, depends upon that sense of feel. This is not something you can get from a simulator. Simulators are good as far as a procedural trainer, but developing that skill is something that really has to be done on the airship itself and real world conditions.

Session 6: HEAVY-LIFT AIRSHIPS AND HYBRIDS

Glenn Beach (moderator)

President

Paradigm Technologies LLC

Barry, I think you have done a wonderful job putting this symposium together. It is bringing together members of industry, the government and manufacturers in a wonderful forum. The session on heavy-lift airships and hybrids is one that is of great interest to me. I have been involved in a number of the heavy-lift programs using lighter-than-air over the last several years. The Holy Grail seems to be in the high altitude airships for communications and surveillance and secondly, for the cargo airships. What is interesting is that the technology is available to achieve heavy-lift airship capabilities. I truly believe it is a matter of getting the right teams together.

Gordon Taylor
Director of Sales & Marketing
Advanced Technologies Group

I am proud to be here because I know we have a fantastic product that is ideally suited for Canadian infrastructure development in the north and areas where we have problems with global warming. I will provide a quick overview of the company and then we will get onto the main reason why I am here, which is a product called SkyCat. Advanced Technologies Group (ATG) is the product of one man's vision in Lighter-Than-Air, Roger Munk, who is well known in the LTA business. He is quite often known as the father of the modern day airship. He has been doing it for 30 years. He has quite a team around him. ATG has two main products, StratSat, a geo-stationary platform, used as a communication and surveillance platform and SkyCat a heavy-lift transport aircraft. The AT-10 is a high tech airship, like the ABC airship, used for surveillance, advertising, pilot training, and tourism. This is a five-passenger machine. It is also a risk reduction machine for us because encompassed in the AT-10 are all the benefits we have developed over the years in fabric technology, fiber optic flight control systems and a light weight diesel engine. I will talk more about that when I go into Sky Cat. But it is a very unique engine. It is a derivation of a German design in the 1930s.

ATG has always gone for the higher end scale of the market: bigger airships. Airships become more efficient as you get bigger. We call it the square-cube law. ATG has produced 20+ high tech airships over the years. The Sky Ship 500 and 600 are Roger Munk's old designs. The US Navy Sentinel 1000 program ended up being a \$200 million program. We are basically the repository of LTA experience. We have had more money go through this company for research and development than anyone else in the industry as a team.

The traditional airship problem was ground handling, and that continues or has continued to haunt airships since the very beginning. The whole purpose of SkyCat is to take away the ground handling problems. Overall configuration is that of a lifting body. This means that instead of being a traditional cigar shape, the actual movement through the air creates lift. It gets 40 percent of its lift aerodynamically. This means when it is not

floating in the air, it will come down. So the helium provides 60 percent of the lift, 40 percent is aerodynamic. As a result, you remove the ballast transfer problems. The landing hover skirts enable you to land and take off anywhere. There are four engines. The two engines in the front are generally used for take off and landing only. There is also a bow thruster. Notwithstanding the rationale provided by Zeppelin, we have simplified the bow thruster to a point where it is not a huge expense sticking on the front of a \$20 million aircraft. In the middle of the bottom is the payload module. This is where everybody sits and the cargo is carried.

We are getting away from the word airship. We call the SkyCat a hybrid air vehicle (HAV) because of the combination of helium and air dynamic. It is amphibious, which means that it can land and take off on water, tundra, snow, ice, desert, whatever. The smallest version we are making is envisioned to be a 20 tonne payload. SkyCat can vertically take off and land at 60 percent of their max gross payload weight. Normally we envision it as a STOL (Short Take-Off and Landing) craft. With the maximum payload on board, in the case of the SkyCat 20, a 20 tonne payload, it will take off in two and a half to three hull lengths. A Boeing 747 that is 230 feet long cannot do that; SkyCat can. There is no magic; it is pure physics. The only difference is Sky Cat will not fly as fast as a Boeing 747.

The key feature in making SkyCat viable is that it requires no ground crew. Like taxiing an airplane, someone will give the pilot signals so he does not run over anything on the ground, but basically Sky Cat needs zero infrastructure.

In the cargo configuration SkyCat has a pilot, co-pilot and a loadmaster. SkyCat 20 is 270 feet long and carries 20 tonnes. The SkyCat 200 is 600 feet long but carries ten times the payload and flies faster. The SkyCat 20 carries one and a half times the payload volume of the C-130 and its operating cost is about one-fifth the cost of a C-130. It can generally land and take off from any level terrain. Go to SkyCat 200 and you have a full roll out capacity. The flight deck in the front actually sits out over the trap door. You can load on and load off at the same time (loading from the rear and discharging

from the front or visa versa). SkyCat 1000 is the big one. Here are the rules of thumb that are easy to remember. SkyCat 20 operates on a cost per tonne mile basis similar to airfreight on a Boeing 747. SkyCat 200 operates within 20 percent of standard road transport cost. Sky Cat 1000 is closer to sea cost per tonne mile. So you can see it just gets better as you get bigger. It is the same as comparing a small coastal ship to a super tanker.

SkyCat with 20 tonnes goes 1,200 miles with 20 tonne payload, but it depends on speed. With maximum payload at 70 knots the SkyCat can travel 1,200 nautical miles on a standard day at 4,000 feet. What is significant with the north, having worked there, I can tell you that this makes a big difference. I can see SkyCat being used on a regular basis, just the way a bus would go between villages, land on the water, taxi right up the beach or land on tundra as long as you do not have obstacles over a meter high. You could have a scheduled service using this very cost effectively.

SkyKitten is a one-seventh scale working model of the SkyCat 20 that we have flown that many times. It has been a great vehicle to test with; it just was not quite big enough to do the final testing. We could not put a retractable gear on it. So SkyKitten II, 50 feet long (one-sixth scale), can do that and can do vertical take-offs. It should be flying later this year.

Envelope fabric has come a long way in the last 30 years. It is similar to what Zeppelin is using. It is high tech with welded seams. We operate this at a slightly higher hull pressure because we have to maintain a somewhat unconventional shape as opposed to normal airships. The standard SkyCat 20 will have ballonets of 27 percent. You need a larger ballonet to go higher, particularly for military uses.

The shape has no hard structure. It is under tension. Catenary lines come down to suspend the payload module and are also used to maintain the hull shape. We have to maintain the hull shape because it is aerodynamic lift, which is one of the tricks that we have had to learn.

You can do what you want with the SkyCat 20. There are not the same design constraints that you would have with a fixed wing, or wings to worry about. It has a much bigger center of gravity because it is suspended all the way along. The box has a module on top that is up in the back. It can be used for a number of things, such as extra fuel, storage of materials, and even crew accommodations on long duration flights. Coming back to the payload modules, we have had a lot of experience with the Sky Ship 600s and 500s.

People generally are aware of Hover Craft. The big advantage we have over Hover Craft is that our “Hover Craft” does not stay on the ground all the time. This means we can make the skirts a lot lighter, which is very useful in aerospace. To meet air regulations, you have to have redundancy systems, but this is, in effect, a totally new hover system. If you can imagine Hover Craft lifting off, you would lose the shape because it has to have the plenum chamber in order to buy the cushion. We have had to redesign a totally new skirt with British Hover Craft. This skirt design also has to be retractable to make it more aerodynamic.

We have commonality in all of our products. We use the same propulsion units in different sizes. We have the same fiber optic flight control system. We have the same tail fin, just larger, that is how we can do these things cost effectively. The SkyCat 20 to 200 and the 1000 all have engines mounted in the same position, just different sizes.

The engines are quite unique. The little one is a 100hp, two stroke, liquid cooled, two cylinder, four piston engine. The engine pistons are coming together to create a combustion chamber. The larger one is a 600hp, two stroke, four cylinder, eight piston engine. We are getting a lot of interest in the engines on a worldwide basis and not just for aerospace.

Flight controls are very similar to the NT-07. We have developed fiber optic flight control systems. The NT-07's are software driven; ours are solid state analog. SkyKitten 1 has flown a lot, and Sky Kitten II should be flying at the end of this year and this is the last iteration that we need before building a full SkyCat 20.

Where are we now? Basically, we walk before we run. We know SkyCat works, and we already have a customer. ATG would go to contract to deliver a SkyCat 20 within the next 20 months, certified within another six months. Now the reason why we say that with a level of confidence is we have been working with the CAA, LBA and FAA on certifying SkyCat 20 to the new airworthiness rates for heavyweight lighter-than-air vehicles. We are looking at a 24-month time frame from the time we are fully funded to do get the big ones.

Questions

Q: How vulnerable are the bigger airships when they are on the ground with respect to wind and snow and other environmental factors?

A: (Gordon Taylor) I am the newest member of ATG; I have only been in lighter-than-air since the late 1990s. Ground handling is the Holy Grail, that is what Roger Munk and the team were looking to. They have operated airships all over the world. As Scott mentioned earlier, larger vehicles obviously have more mass, more inertia, and they tend to be more stable. But then there is the opposite – they are big wind catchers. On the question of actually handling the vehicle on the ground without a ground crew, we are totally confident in the tests that we have done in scale winds of 35 to 40 knots. We actually had a Sky Kitten moored on water in a 75-knot wind scale effect, and with the hover system in the suck down mode, it is very stable. If we are going to park one of these things and not fly it for a long period of time, we will probably put it on water.

Gennady Verba President RosAerosystems

Our little team here represents the Russian lighter-than-air. There are a lot of similarities between Russia and Canada: same ethnic, climate, transportation, economic and environmental problems that can be solved using the recent airship technologies we are discussing at this symposium. In European Russia the density of the roads is 100 to 150 times more than in regions like Siberia and Yakutia Tyumen. I think the same problem is in Canada. It is hard to imagine that hundreds of tonnes of high tech equipment for oil

and diamond exploration can be delivered using temporary roads. Wheeled and tracked transportation methods destroy the vegetation in Russian tundra. The vegetation is very sensitive and needs about ten years to recover after one machine has traveled over it. Also the airships could be the only solution for preserving the natural lifestyle of peoples that live in northern Russian, as well as the Canadian north.

The Russian north is a very rich area containing oil, natural gas, diamond, and gold deposits. There are many Russian oil companies and gas exploration companies that are interested in airships, but their position is that they are willing to buy airships after we show them their capability to carry cargos. Generally, no one is willing to invest in developing these machines. But there are some exceptions to that rule. Responding to that demand about two years ago, we started to develop a cargo airship. We call it DZ-N1 for Ziolkovsky, dirigible number one.

Constantin Ziolkovsky was a great Russian scientist living at the end of the 19th century. He predicted the great success of rocket technology for space exploration. He is considered the father of Russian space technology but a large part of his life was devoted to designing airships. His greatest invention is the thermal airship with a whole metal breathing envelope. He proposed to use engine exhaust for heating of the lifting gas. His ideas were used in the Soviet era by several designers and several groups of airship enthusiasts designing the cargo airships for Siberia and the Far East. Most of them were hybrids. The most famous one is the thermal plane. It was designed at the end of 1980s and the first prototype was built in the early 1990s. Unfortunately the collapse of Soviet Union financing ended this project. It is very arguable that it was the first real attempt to build a cargo airship in the world, because it was to carry about 400 tonnes at the end of the 25-year program.

Most of cargo airships designed during the last 30 years are hybrids. They combine the aerostatic method of creating lift with a dynamic method, as was just presented by ATG. What we propose for the DZ-N1 cargo airship is plasma generators as a method of heating lifting gas. Figure 1 presents the actual size of this unit (you see a conventional

ball pen in the bottom of this picture for scale). It is a very small, compact unit, capable of transmitting heat (about 25 kilowatts per unit). A little blower pushes the cold helium through the little plasma stain created by very high voltage between cathode and anode. The generator is from our point of view the only way to heat helium in a sectional airship.

Figure 1: Arc Plasma Generator (Plasmatron)



The idea of heating helium is very old. The problem is how to transmit energy to heat, let us say, 16 gas bags of a big airship. To transport engine heat to every bag is impossible because the airship is so large. What benefits we can get from just heating the helium by 50°C? If we have an airship with a 500,000 cubic meter volume, 400,000 cubic meters are helium. If we heat it by 50°C, we gain 71 tonnes of additional lift. Of course, we heat the helium on the ground using available sources of electricity. During the flight we use a smaller generator of 340 kilowatts power, just to compensate for losses of heat. What is very important in Arctic is that we use this heating for anti-icing. Shapes that were just shown by ATG, and we have quite a similar shape, are very sensitive to the icing. In the Arctic areas it could add hundreds of tonnes of ice and water to the top of the airship. We have to fight with this problem somehow.

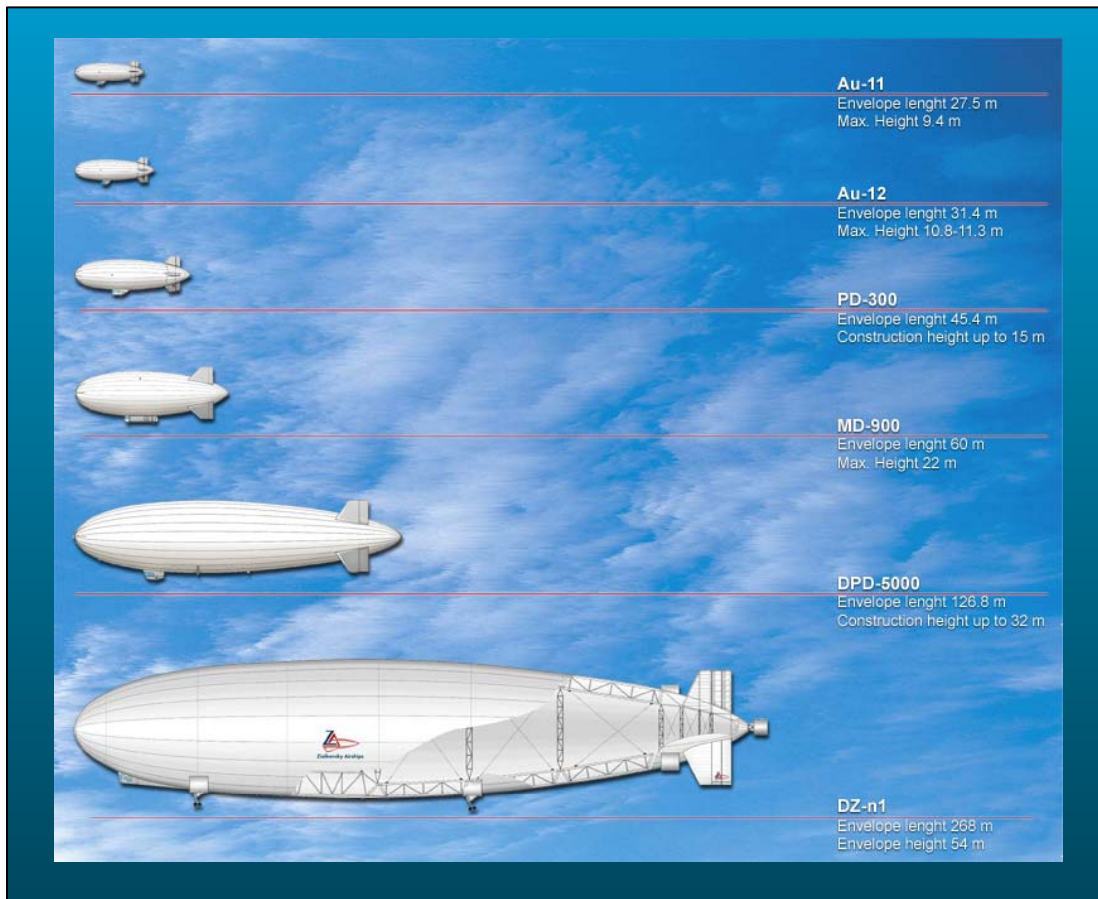
How about the efficiency of this system? We have two tonnes of generators and 3.35 tonnes of additional fuel needed for this generator to work. This is a total of 5.35 tonnes and we gain 71 tonnes of lift. The thermal dynamic method and the aerodynamic method are combined during the take-off. We have mostly thermal dynamic method initially and during the flight we slowly transfer to the aerodynamic method.

This is the general structure of this airship. I cannot discuss all the technical details of this project right now because it is at the very beginning. In general, the airship is semi monocoque design having a vertical frame. The vertical frame and composite panels form the envelope and the 16 gas bags are inside. Part of this frame supports the cargo compartment in the lower part of the beam. The compartment is forty meters long and 12 meters high; it can contain low-density cargos or carry cargo on tethers.

The general specifications of the airship are 268 meters long, 54 meters high. It can fly at 170 kilometers per hour, with a cruising speed of 120 kilometers, and carry 180 tonnes for distances of 15,000 kilometers. This long range is available only because of plasmatron technology.

If you look at the attempts of the last 20 or 30 years to create a cargo airship, the natural question may arise, why it has never been done. I think the major mistake is that people attempt to jump over the natural steps of development of such a complicated machine. We need many years of research and development based on experience of operating a real airship. The real projects we are involved in at this moment (see Figure 2) start very small with the Au-11 one-seat airship that was built almost two years ago by our company and presented at the Moscow air show last year. The next one is a two-seater small airship, the Au-12. Both of them are below 1,000 cubic meters in volume allowing some countries to consider these airships as ultra light aircraft, which makes the certification process easier. Next the PD-300 is a 3,000 cubic meter airship taking the same niche on the market as the AT-10 or A60+ made by our colleagues. All three airships I just mentioned are conventional blimps.

Figure 2: RosAeroSystems Airships

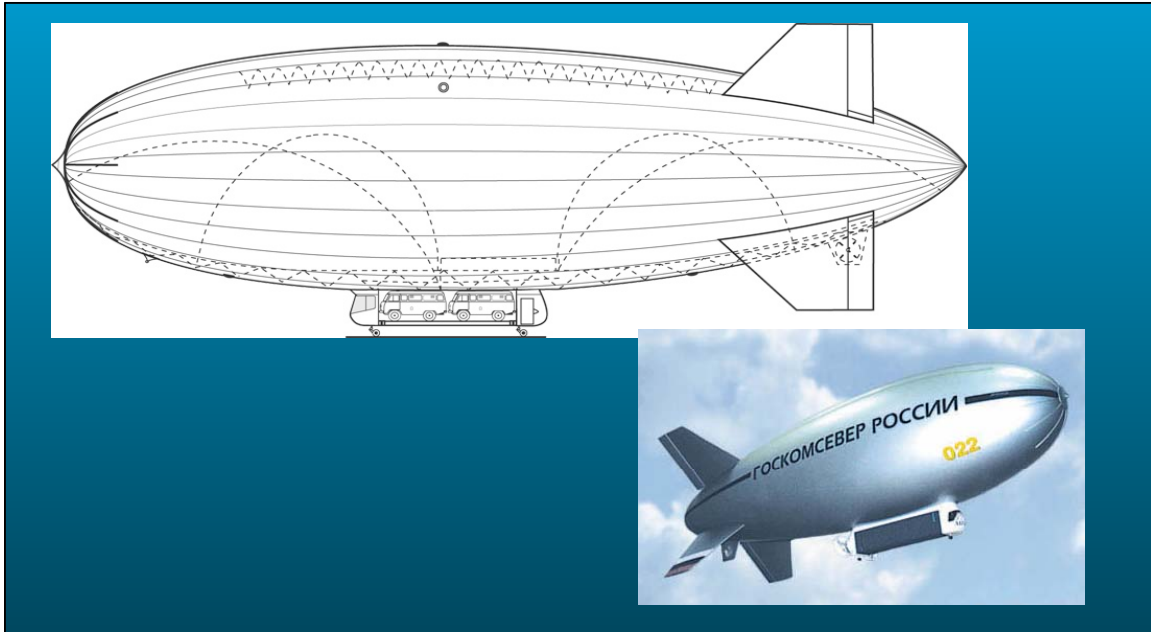


Next, the MD-900 is a semi-rigid airship. This is the smallest possible cargo airship. It can carry just three tonnes of cargo. The next one is the DPD-5000 that was designed for long-range surveillance. We also have a cargo version of this airship called the DZ-10 capable of carrying 25 tonnes of cargo. The final goal is the DZ-N1 airship.

We produce and supply not only envelopes but also fly-by-wire systems, empennage and some other electronic parts including pressure control systems. Using thrust vectoring we can operate this airship from very small fields. We also have a very interesting project to put barometric equipment on board this airship and use that equipment for exploring the gas, oil and metal deposits. This is the most contemporary geological technology in the world.

Figure 3 is the MD-900 modular airship. In the central part of the gondola are two little cars. These modules can be exchanged. We can use a tourist module, cargo module, portable power plant module and some others depending on the need. The module has the exact size of the 25th container, and can be easily changed of course with lower weight.

Figure 3: MD-900 Airship



We analyzed the usage of MD-900 versus the ME-8 helicopter. The ME-8 helicopter that was produced in a great quantity, about 12,000 units, is very popular in Siberia and the Far East. This is a very successful machine, but unfortunately it was created about 35 years ago and there is nothing to replace this machine at this time. We created a proposal together with the Russian committee with the north territory to replace the ME-8 with MD-900 airships, which have lower operational costs and much higher range. The ME-8 has a maximum 300-mile range with additional fuel. MD-900 has a maximum range of 3000 miles. I think it would be very interesting for the Canadian north too. We think that this machine can be the first proof of airship transportation technology suitability for the north, either Russian or Canadian.

We have great potential to use a former Russian aerospace facility to produce airships and tethered aerostats. The total area is about 10,000 square meters (about 90,000 square feet). The Wawichken Design Bureau performed Russian moon, Venus and Mars programs in the past. Today all of these programs are cancelled. We are lucky to be able to use these great facilities to produce not only envelopes, but also gondola frames, electronics and some other parts.

In the same premises we created a line of tethered aerostats. The most recent work is a passenger balloon for tourist purposes. We just received a type certification for that balloon and we are trying to promote this product in different countries. It is 3000 cubic meters. The smallest tethered aerostat is 17 ½ meters long and 450 cubic meters in volume with sail type empennage, which is very effective on the small aerostats. We use this aerostat for surveillance purposes, sometimes for advertising, for TV broadcasting, etc.

We are lucky to have a testing facility at the Moscow Aviation Institute. This is the largest aviation university in the world and also our shareholder. We are testing our recent aerostats in their wind tunnel. Generally we use the experience of Russian lighter-than-air producers of the past, producing mostly semi-rigid airships, envelopes of great volume and surveillance tethered aerostats. We have access to the Russian aerospace industry facilities, which are not in very good shape now, but maybe it is a unique situation to use it for the renaissance of airship technologies, especially for the north. It is our deep belief that there are two major applications for transport airships. The one application is in the northern territories, Russia and Canada, and the other one is tropical countries like Brazil and Africa, but this is a different story. I hope in a few months we will have another symposium, airships to the tropics, but in that case we need an enthusiast like Dr. Barry Prentice who organized this wonderful symposium. Thank you.

Questions

Q: How vulnerable are the bigger airships when they are on the ground with respect to wind, snow and other environmental factors?

A: (Gordon Taylor) Ground handling is the Holy Grail, that is what Roger Munk and the ATG team were looking at solving. They have operated airships all over the world. As Scott mentioned earlier, larger vehicles obviously have more mass, more inertia, they tend to be more stable. But there is the opposite problem, they are big wind catchers. On the question of actually handling the vehicle on the ground without a ground crew, we are totally confident in the tests that we have done in scale winds of 35 to 40 knots. We actually had a Sky Kitten moored on water in a 75-knot wind scale effect, and with the hover system in the suck down mode, it is very stable. If we are going to park one of these things and not fly it for a long period of time, we will probably put it on water.

Fred Edworthy
VP Programs & Business Development
Worldwide Aeros Corp.

The Worldwide Aeros Corporation is located in southern California. The operation of the company includes manufacturing, marketing, operation, research and development of traditional non-rigid airships, the rigid transport category Aeroscraft, advanced unmanned stratospheric airships, as well as tethered aerostat systems. Figure 1 presents some products. Our traditional non-rigid Aeros 40-B received the FAA type certificate in June 2000; as well we build some small portable aerostat systems. Our entry to the transport category airship world is the rigid body Aeroscraft and is shown at the top right hand. The bottom right hand is a test article for our stratospheric airship program. Bottom left is the aeros 40-B, and a couple of small, mobile tethered aerostats systems are pictured at top left and center.

Figure 1: Worldwide Aeros Corp. Products



As we look ahead and plan for the future of the transport category aircraft, we have to look back at some of the limitations of the air transport today. Some of the limitations are the fuel cost, noise emissions, safety, high cost of operation, multi mode transport delivery, very expensive maintenance systems and cargo size constraints. Proposed future operations must be weighed with consideration of the special problems and advantages of the northern environment. Chief among those problems are the high winds in the Arctic coastal areas, the remoteness of the sites, and inversion layers. On the positive side, thunderstorms are infrequent and low temperatures prevail much of the year.

Airships are sometimes promoted as the ideal vehicle for transporting heavy loads into remote areas without prepared sites. Often overlooked is the fact that the airship must hover as a free balloon to offload cargo. There are two ways around the inherent problems with the traditional airship concept: either vent gas or take on ballast. Valving helium would be prohibitively costly, so the remote sites must be prepared to supply ballast water, fuel or the like equal to the weight of the cargo off-loaded. From what we have heard about the remote sites throughout the north, those particular aspects are going to be limited by the engineering and economics.

Airships are much more sensitive to wind than airplanes. On a round trip to an upwind destination, the high speed on the return does not compensate for the reduced speed on the upwind leg. The other aspects of airship economics are not so easily evaluated. Vehicles of classical design with non-rigid envelope construction will require at least one heated hangar in the north to look after maintenance, repair and shelter from severe storms. A large number of ground crew and the complex ground handling operation are other limitations.

Lighter-than-air developers must produce a credible design concept. The complexities and economic uncertainties associated with establishing a transport system around the new mode of flight must be realistically assessed. Building one or two cargo airships is not going to change the world; it is not going to change the north. It has to be integrated into the existing structure. Aeros believes that there is a definite market for a more efficient mode of cargo transport to the north. Based upon this premise, Aeros has gone into the development of Aeroscraft partially buoyant aircraft. The Aeroscraft ML-200 is capable of carrying up to 40 tonnes and eventually scalable to 200 and up. It is quiet, fuel efficient, and can operate without standard runways.

The concept of the craft is to build a rigid hull structure with gas cells that will hold sufficient helium to buoy at least 70 percent of the total weight. The remaining weight will be lifted and held aloft by the lifting body shape and structure, much akin to the conventional airplane lift derived from the wing. The size of the first generation of the Aeroscraft code-named Aeros ML will be designed with a maximum useful payload of 40 tonnes. The cabin configuration can be customized to suit the customers' needs.

The design philosophy for the Aeroscraft is a pilot errorless concept with a management system on board rather than an actual pilot that flies the craft. It is designed for transcontinental operation, ground crewless operation, all weather vertical take-off and landing performance, 150 knot cruise speed, hangarless maintenance and ultra low noise emissions. The Aeroscraft has a rigged panel truss structure, lifting body shape, electrically vectored thrust secondary propulsion, turbo-prop main propulsion, thruster

control systems, an air cushion take-off landing system, fly-by-wire, fiber optic C2 systems, digital flight management systems, and a pneumatic and hydraulic network.

Airships of this type are going to be able to reach all parts of the globe. They can carry cargo whose size and weight is unsuitable to other modes of transport. It can also avoid the rehandling of cargo along the way. The design concept of the Aeroscraft makes it a perfect air transport for logistic applications in the North. The Aeros ML is the first aircraft of its type, designed to be truly autonomous for takeoff and landing. The key element is the reduction of handling labor, one of the biggest hurdles towards lower operational cost of airships today.

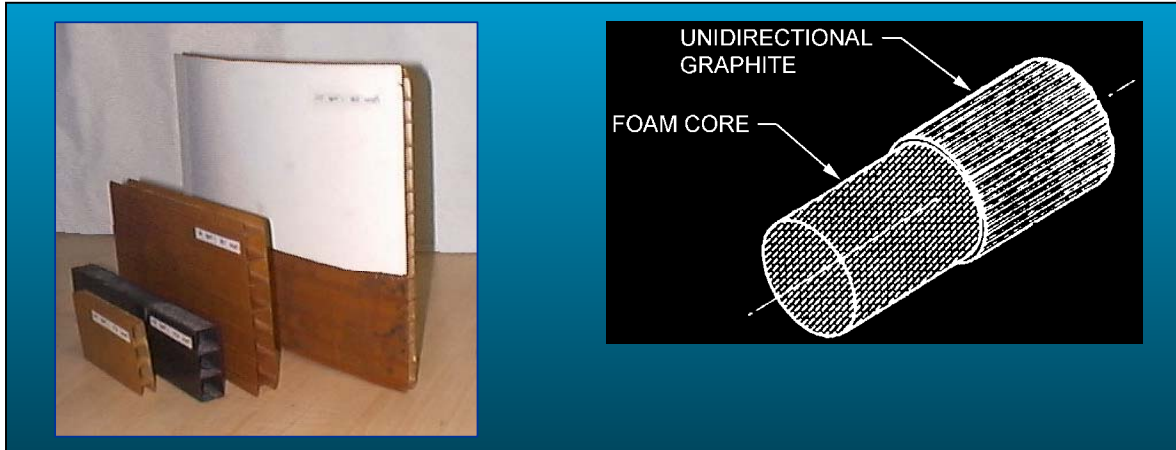
The Air Cushion Take off/Landing System (ACTLS) utilizes surface effect technology. Located on the Aeroscraft's belly and replacing conventional landing gear, the ACTLS adheres to the ground by creating a vacuum for positive anchorage upon landing, and reverses to launch the aircraft into the sky to alleviate the effect of static heaviness upon taking off.

Non-rigid and semi-rigid airships (all the other airships that are either in operation or under construction today), we feel lack adequate safety, as trans oceanic crossings rely on fabric as the sole gas container. Punctures, cuts, etc. could damage the outside. The Aeroscraft concept is a rigid hull structure with a truss system to hold the composite panels (non-rigid envelopes stretched over a rigid skeleton). Multiple helium containers hold the gas inside the rigid structure.

Some of the materials under consideration and testing are presented in Figure 2. The composite panels would be used to cover the outside. On the right hand side is an example of the material that would be used for the truss structures. Multiple helium compartments increase the airship's safety by dividing the main envelope into sections. The structural integrity and reliability are provided by the design of the Aeroscraft. This is achieved through the use of a semi-monocoque structure with a rigid all composite hull. The rigid envelope protects each non-rigid helium compartment from any damage

from the outside and is a sealed loop. In case of an emergency, such as a leak, the rigid hull provides a second level of safety.

Figure 2: Skin Panel and Truss Tubing



The unique features of an Aeroscraft make it adaptable to an extreme range of possible uses. Characteristics such as lift, vertical take off and landing capabilities, ability to hover for extended periods of time, lack of the need for airport facilities, all-weather operations and superb safety contribute to the versatility that allows it to serve a multi-functional role over all air market segments in the logistic applications in the North. This market analysis considers the Aeroscraft not as an entity in itself, but as a vital component of an overall transportation system. Some of the applications include energy and electrification construction, shipment of pieces in the largest possible form to be quickly reassembled once they reach their destination, oil and gas industry, and the mining industry. We might maximize the payload coming home from the north if we are dealing with high-grade oils and precious metals. Fishing provides many uses such as surveys of the fleet, changing of crews, and packing. The timber industry has come forward with interest in the technology. Environmental protection, air pollution control, tourism and passenger traffic are other uses. The large amount of cargo-based space allows the Aeroscraft to be configured into a multitude of different applications, whether for freight or a luxury tour craft for use in the eco-tourism industry.

Northern remote and inaccessible areas require the development of reliable and effective transportation network for all year operations. Also important are the development of new methods of exploration, shipment of equipment, and backhaul applications. In conclusion, should we be successful in the revival of airships, it will be because they solve today's transportation problems, and not because they compete with existing types of long-range aircraft. Throughout the symposium we have heard the need demonstrated. We have been presented with the many alternative designs and concepts. The technology is available; funding might be the last piece of the puzzle.

Gil Costin (Keynote Speaker)

CEO

Millennium Airship Inc.

This is Millennium Airships first public exposure at an industry trade show. We are here quite simply because we want to make ourselves known now. We feel that we have gone far enough with our design; we have talked to enough people with regards to the feasibility of our design. If it had been only the airship industry that was going to be at this symposium, we would not be here. We are here because the end user is here. We feel we have a very viable concept with regards to LTA flight and freight carrying capacity.

Conventional airship design is quickly going to become a thing of the past, other than for tourism and advertising. An airship to haul cargo is going to have specific mission diversity. We are building, marketing, and will operate the world's first all-weather, amphibious, semi-rigid, multi-mission, ultra heavy-lift ship. The largest will have a 300 tonne net lift capacity, roll-on, roll-off. An artist's rendering is presented in Figure 1.

Figure 1: SkyFreighter



We need financial support to develop our aircraft. In the past a lot of money has been poured into operations and developments that have failed. Especially operating in the far north, it needs to be a durable aircraft. It needs to be made of materials that will last and are repairable. Our initial primary goal was to get rid of the need for the standard tether mast and expensive ground crew associated with all airship operations today.

It also has to be completely amphibious. Seven tenths of this world is covered by water. It is logical conclusion to have the aircraft operating on and off the water the majority of the time, or at least being operated in an area accessible to water. Most importantly, it has to be operationally cost effective in today's market. These folks here are trying to make delivery of goods to the far north more accessible, cheaper to the end user.

Thrust-wing technology will allow the pilots to have complete control of the aircraft through from lift-off to landing. It will also allow the pilots to be able to land the aircraft within confined areas while addressing a crosswind.

Thrust-wing technology is a simple process. Turbo jet engines are housed within the aircraft. Each wing has a vector thrust port on a trailing edge pretty much the entire distance of the outer rotating portion. There is an opening at the end of each thrust-wing

that allows thrust to be ejected perpendicular from the aircraft, thus creating a bow/stern thrust system. Thrust can be controlled by the pilot through the ITAMM system, which is a computer-guided fly-by-wire system. The pilot can literally spin the aircraft on its vertical axis if he needs to.

The aircraft will be wide, stable, amphibious, and it has to be rugged for hauling freight. It is going to get beat up, so it has to be made of a material that is repairable. We decided that carbon fiber composite was the obvious for the hull/keel construction and also for the engine room, nose and tail up to the empennage. To take off, the forward thrusters are lowered to break surface tension and get the aircraft out of the water.

Do you need us? I think that those who deliver goods to the north need us. We know that Air Parcel Express does. We know that the freight company out of Bangkok, Thailand who also gave us another letter of intent for three aircraft, one smaller one and two big ones, and the Malaysian Government definitely need us. They just reiterated their commitment to acquire the Eco Ark, which is basically a research vessel.

Questions

Q: This question is addressed to all members of the panel. There has been a fair bit of discussion about financial support. Would the intent be that the airship manufacturers would sell an airship to a commercial operator and they would operate the airship, or would this be a leasing arrangement? The business arrangement really changes the nature of the financial support, whether your customer is a purchaser or a leaser. How does it work?

A: (Fred Edworthy) We are a producer and we have always been that way with the traditional airships that we have as of today. Rather than some other people who build and operate them, our preference would certainly be to sell them through a leasing company and/or directly to the end user supplying them with the training and back up that they need.

A: (Gennady Verba) We have a leasing company that supports our activities, so we can either sell airships or lease them for a long term.

A: (Gil Costin) As far as we are concerned, we are the manufacturers and operators. We may contract some airship services to supply our pilots but I do not see, at least in the short term, where we will be selling these aircraft, because they are just a little bit different. I do not think they are going to be any more difficult to fly, as a matter of fact they might be simpler to fly than a standard airship, but that is our thrust right now.

A: (Gordon Taylor) The reality for most manufacturers, including the people who have just spoken, is that there are not enough pilots. We are a manufacturer. We supply the product to the market, but generally the customer then turns around and says, 'who is going to fly it for us?' So out of necessity, with our various iterations of airships for the last 30 years, we end up doing it. Ultimately, we would like to handle it as summed up by Gennady. We would produce the product and then have GE capital or somebody like that provide lease financing.

Q: A question for Worldwide Aeros. There appears to be what was described on the diagram of the Aeroscraft as an air barrier. When I look at the design I see something of a hybrid that looks not unlike metal clad designs of the past. There are gas cells within a rigid framework. Is that air barrier simply that? Is it a ballonnet?

A: (Fred Edworthy) You are right in that context. There is no need for ballonnet because you are not using the envelope to develop the integral shape of your craft. You are relying on the composite body to do that and the airbags are inside. You would not have the need for ballonnet.

Q: Gordon, this morning you gave us some indication of relative costs for the Sky Cat 20. Is that regardless of short haul, long haul, or mid-range, if it is variable based upon that? Where are your break points for what you call short haul and long haul?

A: (Gordon Taylor) Basically what we did was utilize an 80 percent load factor across the board and all products. If you are doing a lot of short haul, then obviously it goes up.

Q: For the gentleman from Sky Freighter, what might you use for alternate ballast in the high Arctic when water is not available for 11 months of the year and in the sub-Arctic when it is not available for seven months of the year.

A: (Gil Costin) This is always a big question. Of course, you may be looking at a situation where you cannot operate fully loaded. It is also utilizing the gas heating process where you achieve an excessive amount of lift from heating the gas and the ballonnet. I propose heating both and I may be naïve in that regard. I think it is not unsolvable. But we have a little work to do on it.

Q: I direct this question to the panel but also with the side question over to the end users. End users identified yesterday movement requirements in generic terms, some weight, some cube, some types of things to move and mentioned fuel which was a new one to me. We have producers with designs that refer to high volume and in shorthand we talk about weight capacity of each lift platform. But I think something that would be helpful would be to define more closely what the exact dimensions of the payload bay are that you are contemplating. I ask that primarily in your first stage to give us a better feel for the actual target market that you are looking at. The first step is to determine what is commercially viable for you both in volume and/or weight and type of movement, and then see if that actually jives with what industry might be looking for, whether it be high volume, low weight or some specific product such as fuel. Help us all get a more precise target for those stepping-stones of development.

A: (Gordon Taylor) I am going to use the Sky Cat 20 as an example. The Sky Cat 20 has evolved from something called an AT-04, which was a 50 passenger traditional airship with a bow thruster. When we started doing development work with lifting body technologies, we realized that there was a huge potential market for this so we started

with the Sky Cat 15. The Sky Cat 15 was basically two AT-04s, seven tonne load. This became our benchmark.

We did market studies and we had a number of colleagues visit us from that funny shaped building in Washington. They asked us why we were doing the Sky Cat 15 and we explained how we came to the idea. They said, 'there is a thing called the standard ISO container that we want, and your thing will not quite fit it.' So we stretched the payload, and made other changes. The new military benchmark is a 20 tonne payload and that is how we got the Sky Cat 20. In other words the market has moved us to the point where we can carry 22 tonnes. It will take an 8 ½ x 8 x 20 foot container times two. The shape of Sky Cat allows us to handle and suit the passenger carrying capacity better. So we have ended up with the same outsized payload module.

I gave you the statistics this morning and I have had a couple of people approach me. We see a minimum market of 375 of those units, which is certainly volume production. It has been an interactive process going over five and a half years. If someone produces a ten tonne model, it will be cheaper. If you are involved with airships, you know that smaller does not necessarily get better. A 20 to 22 tonne payload is one and a half times the payload volume of a C-130.

A: (Gennady Verba) It is really hard to satisfy everybody, especially here in the north with different types of cargos and different needs. One example is our smallest cargo airship, MD-900. The idea of changeable modules; if you need a passenger airship, you connect a passenger module. If you need a cargo compartment, we have a cargo compartment. If you have a low-density cargo, we can connect an extended cargo compartment. This multi-purpose technology will be implemented on the next 25 tonnes model.

A: (Fred Edworthy) We have to stay within the infrastructure that already exists today. We would build our first models in the standard ISO container freight configuration, so

you could take them off a truck, train, etc. and stay within the existing infrastructure. We would have to address any special cargo applications that may be required beyond that.

A: (Gil Costin) I agree with that. We are trying to address a market where we are dealing with project cargo, unusual shapes, bulk, and cubes, not necessarily containerized. I do not think you could actually fill up containers. There would need to be two small containers and a lot of space left over. But if you are hauling project cargo, such as a rig, it may be really worthwhile. On the smaller aircraft, as Fred was saying, we need to stick with the standard modal sizes that are available today. At some point, the cargo is going to have to get on a truck and it is going to have to go down a road.

Session 7: HIGH ALTITUDE SHIPS

Kerry Boucher, P.Eng., M.Sc (moderator)
VP Engineering & Quality
Standard Aero Canada

I would like to thank everyone for the opportunity to participate in this symposium. We are here in session seven to go into another topic that we believe is a potential opportunity for lighter-than-air airships; the application of high altitude vehicles.

Steven L. Krause
Unmanned Systems International Program Director, Integrated Defense Systems
The Boeing Company USA

The Boeing Company is divided relatively evenly between commercial customers and defense. We do about \$1 billion worth of business per week.

I would like to talk to you today from the perspective of the unmanned systems unit, which is relatively new, where some of our stratospheric airship work is being done. We are beginning to see autonomous operations of aerial vehicles that are cooperative and adaptive. These technologies may be taking us to a place where it becomes possible to do things in the stratosphere with lighter-than-air vehicles that have been difficult until now.

We have not made a decision to enter the airship business, despite some press releases from companies you may have seen over the past few months. We are watching the money, just like that oft-quoted Wild West outlaw, who when asked why he robbed banks replied, “because that’s where the money is.”

We do not know whether this market will develop. The potential for the technology to solve urgent customer needs is obviously enormous and this conference has demonstrated it very clearly over the last couple of days. But it is only real if we can get the technology right, if we can get the cost right, and if we can perform. Just imagine what breakthrough capabilities we can achieve for our customers with a system that delivers lift essentially for free.

The Boeing Company’s interest in airships is not really new. In the 1980s we were engaged in an airship project with the US Navy, but when we finally understood that our aircraft performed a little too much like a submarine, we graciously withdrew from the program. But we do have some substantial, relevant and successful experience in the field. We also have substantial experience with high altitude aircraft and satellites, communication and surveillance payloads.

In order to develop the market and to deliver the promise in this lighter than air technology, we have to overcome some real hurdles. There are reasons for optimism, however.

Our partnership with a little company called Insitu based on the West Coast is one example. This alliance will deliver transformational surveillance capability to our defense customers for prices a little bit less than you would expect to pay for an ordinary luxury vehicle.

MMIST, a nimble small company based in Ottawa, has figured out how to drop payloads from very high altitudes with pinpoint accuracy for a fraction of the cost of conventional methods.

Or think about Albuquerque-based Eclipse. If they succeed in achieving 50 – 70 percent reduction in the cost of a general aviation jet, and their investors think they will, the shape of travel on our planet will be transformed.

There is a transformational change ahead of us.

One reason I enjoy working in the aerospace industry is because it is populated by people who love the product. Building flying machines is not like manufacturing pencils. Some of the worst damage I have seen in this industry has been caused by people who thought they could run the company as though they were flipping hamburgers or selling soap.

But our customers do not necessarily share our enthusiasm for our products. When I was a boy the meanest cut we could think up on the playground to skewer a rival was to say that your face is ugly and your grandmother dresses you funny. In the airship community we must realize that some of our customers just think that our product is ugly. The reason is not so much cosmetic, but more a result of the fact that every time a newspaper or television reporter wants to talk about airships, somebody always sticks in the Hindenburg aflame.

It takes more courage than it should for our customers to consider lighter-than-air solutions. Developing breakthrough technologies, which is absolutely a benchmark for us, will not be enough. We also have to earn their respect and confidence.

The lighter-than-air industry is more community than it is an industry. It has been led by visionaries who are passionate about the possibilities. But only a few have developed strong businesses that deliver healthy revenues and earnings. Some of these are here at the conference.

Even healthy companies in this business tend to be relatively small. They are quick and creative but they lack the financial muscle to pull off big projects. Consider the recent experience of 72,000 German investors and others who put more than \$300 million into a

sparkling start-up in Brandenburg, Germany. They were sharply disappointed when the business failed to fly off the drawing board, much less out of that magnificent hangar.

This market lacks a critical mass. What are there, between 25 and 50 operating airships in the world? As a result, the infrastructure required to make this business work is sparse. Assembling and sustaining the right technical expertise is also a challenge. We are grappling with this at the Boeing Company. We estimate there may be only 200 or 300 lighter-than-air capable engineers in the world. Our customers understand this. So they worry that we may struggle to keep talent together long enough to perform some of these long-term and difficult projects. Then there is that “giggle factor.” Our track record at delivering on promises is not what it should be and only consistent performance is going to fix this.

The planets may finally be aligning for the technologies that many of us believe have such great promise in this area. Think, for example, what we could do for the US Navy. They have a huge challenge ahead of them. They have to operate carrier battle groups at a global scale. One key purpose of operating those carrier battle groups is to project power.

What they are interested in putting on carrier decks is not surveillance vehicles. Those are not power projecting systems. They want to put the business end of the navy on the carrier deck. What they really need for maritime airborne surveillance and control is some kind of a system or platform or vehicle that they can launch when the carriers leave port that will keep up with them at 20 to 30 knots for nine months. I cannot think of many better technologies than this one.

If you want to talk to the Boeing Company in this area, you need to know how we think about entering a new business area. We are open for business and we are looking aggressively at new areas of business. We are interested in working with serious people to devise exciting, breakthrough solutions that address urgent customer needs. We will

apply proven, rigorous management tools to deliver promises and we will deliver healthy margins to our customers or we will not enter the business.

You will not be surprised to hear me say that we are not easy to work with. We are slow. Some of this is just size and bureaucracy. My first boss in the company who understood us very well used to say of us, that we might start late but we sure work slow.

But this deliberate pace is also the result of the fact that we have a lot on the line. Our reputation for safety, reliability and performance is our lifeblood. This business does not tolerate surprises. So we insist on rigorous risk assessments. We doubt everything you tell us and we demand more control than you want to give us.

We are also in business with a capital B. You will hear us say over and over, show me the money. Many of our executives carry a little card in our wallet to help us remember why we are employed. It is entitled *The Four Second Warton MBA*. This is handed out at our leadership center to all of our executives who go through two weeks of what we like to call charm school. It has four principles: You want to make money; You want to do it often; You want to do it with other peoples' money; and You want to convince Wall Street that you can do it over and over. That is how we think.

We have a lot to offer this industry. We will know we are making progress when our government customers begin to apply real money to this area of technology. My guess is that if that happens, there will be airships flying all over the place including into the Arctic.

Ronald G. E. Browning
Director of Business Development
Lockheed Martin Company

Proceedings withheld at speaker's request.

Session 8: DECISION-MAKERS' PANEL

**The Honourable Scott Smith
Minister
Manitoba Transportation & Government Services**

It is a pleasure to be back again as you wrap up the conference today. I think there has been a lot of intellectual gain at this conference. Airship technology is by no means a new concept. This is something that has been around for a great number of years. I have been told by a collection of folks who have an interest in this type of transportation internationally that this has been one of the best conferences. Airships have a great deal of potential. I had the good fortune and great opportunity to listen to a couple of the keynote speakers yesterday morning and Richard Van Treuren added some perspective on questions and considerations that I had.

My observations on the information presented and general discussions with attendees over the last couple of days have highlighted the potential impact that airships could have. The technology to some degree is here now. The possibility for commercial application has been discussed widely at your conference and the potential for commercial application is a real possibility. We already see day-to-day usage in many venues.

The potential exists in a lot of different areas. Research and development must be given consideration to move this project forward. We know the potential and possibility are there, but if you are talking corporate buy-in, you need to develop a business case to move ahead.

Look at the potential of the new materials that we saw yesterday morning. In the last decade it has changed a great deal. The perception that most of us think about is the 30 seconds of film clips of the Hindenburg that are played over and over. We need to get the idea out there that we are not talking about hydrogen-filled skins made of the materials that were used back in 1937. We use helium and modern materials. I look at this as a real opportunity here in Manitoba.

I believe Manitoba is leading the nation in alternative fuel sources. We buy into the Kyoto agreement with the Canadian government. I think this fits very nicely into our future. A real potential that I see, and I had a quick opportunity to speak with my friend Mayor Mike Spence from Churchill, is for tourism in cold weather conditions in the northern region of Manitoba. People can walk around in airships, not be strapped in a seat, and as Richard Van Treuren mentioned, stuck shoulder to shoulder against the fuselage of an airplane. The tourism industry is a real potential.

I think that there should be continued communication with the minds that we have had at this symposium. The University of Manitoba would be one of those resources we could use. Nobody wants to commit the money but certainly the next step, I believe, is research and development of business plans for commercial use. Canadian aviation regulations would be a piece that we need to consider.

One thing we did not talk about was the potential of where we would load and drop. The point-to-point movement of airships would be a huge potential for on time delivery for a lot of the organizations, and they would pay premium prices for it. Obviously there will have to be loading and drop-off cargo areas identified. Northern Manitoba has underused airports and facilities, and large projects that could utilize this technology. I think, quite frankly, that the technology is just about here. It is a matter of developing the partners in a business case to move ahead and see where it would suit.

I believe Manitoba would be an excellent place to start some type of pilot project. I know the volumes and the potential lifting capabilities of the airships we talked about would have to be developed, which will be costly. On a smaller scale, the research and development, the potential of what the business case could be, the regulations that we could deal with on the front end and developing the partnership are issues. I believe there has been a great deal of movement ahead nationally and internationally on this project, and in some capacity the Province of Manitoba would be quite interested in moving ahead.

In Manitoba, especially in northern communities, the potential does exist. The fueling, cargo locations, and other things must be dealt with on the front end. I have a lot of other points, but I do not want to take any more time. I hope we have a question and answer period, as I would be more than happy to address questions that anyone would have at that time. Thanks very much for your knowledge, for becoming part of this in Winnipeg. I hope everyone stays in contact and this project does not die out, and that everyone feels that a lot of good ideas have been generated. I believe that there needs to be a framework specified in terms of where we go from here, and the Province would like to be part of that. Thank you very much.

Mike Spence
Mayor of Churchill

First, I must commend the University of Manitoba. Dr. Prentice, you did an excellent job of pulling us together, of creating a vision and helping the industry. I understand it is the first time that the industry, end users and government are together in one room addressing and building on a vision that is important to all of us. The challenges that we all face are challenges that are realistic. Challenges that at the end of the day we will walk away with, which will result in ideas.

I arrived late yesterday afternoon to take part in last evening and today. I was very impressed with what I have heard and seen, and with the networking that goes on behind the scenes. One of the presenters indicated to me that this is the first time that the industry has been brought together with potential users and government, and that is important. As Manitobans, we are warm, we are friendly (remember “Friendly Manitoba”), and we are prepared to get involved and create an atmosphere so we can all be successful in building airships. From where I come from, the community of Churchill, I was very impressed to hear that the gentleman from the US military had put together a photo that was presented yesterday. It was an airship that arrived in Churchill in 1948 to be involved in search and rescue. Today I heard of great opportunities. The opportunity that I see that is close to home is eco-tourism. It is achievable, the airship technology is

there and together as business and government we can create the opportunity so that we can sail into the air and showcase our unique wildlife resources.

In respect to the opportunity for telecommunications, that is reachable as well. In respect to the large airships for lifting, as you know within northern Manitoba and northern Canada we have many problems facing our transportation needs. Climate change is upon us. The winter roads into the outlying communities in northern Manitoba are a challenge, as is the cost of living. These are all challenges that we are going to overcome, but at the end of the day we need to continue to work together and find a solution whether it be a business case solution, to make sure that we can continue and be a part of this vision.

David W. Faurschou, MLA
Opposition Transportation Critic
Manitoba Legislative Assembly

I truly appreciate the opportunity to have attended the symposium since its outset. I really appreciated Richard Van Treuren's presentation that gave us 'the rest of the story' as far as the Hindenburg was concerned. Hopefully that can be passed on and some of the misunderstanding from that event can be cleared up. Right from the very outset, I have been interested in this mode of conveyance of goods and services. I remember going through my dad's Popular Mechanics that dated back into the 1930s and 1940s and his service in the Air Force, which reinforced his ideas in me through his tales of the lighter-than-air concept of transportation. I have also had the pleasure of being a student of Professor Prentice and again reinforcing my interest in this particular mode of travel.

I do want to take this opportunity to congratulate Dr. Prentice. As a Logistics student, I learned that the definition of logistics is the delivery of goods and services in the desired quality and quantity on time. Dr. Prentice, you have succeeded and surpassed this requirement with such a successful symposium.

I also want to take this opportunity to congratulate and to thank all those who have made presentations during the course of the last two and a half days, which I have enjoyed thoroughly, and also to the sponsors that made this symposium possible. It is to their

credit that they have recognized the importance of networking and have provided the means for us to come together.

Lastly, I would like to thank all of you who have come to Winnipeg to be in attendance at this symposium. This has afforded us all the opportunity to get to know those who have very diverse interests but all have one common ideal, and that is to support this mode of transportation. To provide what is necessary to the growth of our nation and the global economy as a whole. I do believe that this technology will have that impact. I do believe this is a new area of exploration. Government has always played a part in exploring new areas, from the very beginning of this new land when the governments of England, France and Spain sponsored the exploration of our continent. I believe that nothing has changed from 500 years ago; this is just another area that we need to explore and government needs to play a part. This is why I am so pleased to see government department personnel attending this symposium and showing support for this advancement in technology that will have a wide-ranging impact on virtually everything that we in this province, nation and world would like to see happen.

As one person put it earlier in the symposium, "In the north we are only picking the fruit from the bottom of the tree." We have so many resources in the north that remain untapped simply because we do not possess the technology in conveyance of the goods and services that ultimately will extract that resource and put it to use globally. I do believe lighter-than-air technology will be developed to address the concerns that we all have in safety, security and preservation of the freedom that we all aspire to maintain. The efforts of NORAD and the lighter-than-air surveillance platforms will, as a result, also provide us with the technology that will advance into cargo conveyance.

Ladies and gentlemen, thank you all for taking time out of your busy schedules because each and every individual that I have met here in the last two and a half days is extraordinarily involved in pursuits that are wide ranging and diverse. It is a credit to all of you for taking that time to come together in this very magnificent venue, the Fort Garry Hotel in Winnipeg, Manitoba. Thank you very much.

**The Honourable Jon Gerrard
Manitoba Legislative Assembly
Leader, Liberal Party of Manitoba**

It is a pleasure and honour to be here. Now I took in only parts of the symposium and had a chance to talk to a number of people. Let me talk in fairly practical terms. What are the next steps? What is the role of government? One of the issues that surrounds the development of this industry in Canada is the regulatory environment. I was challenged by Al last night that the Canadian bureaucracy would in no way have things organized before about five years. That it would take that long to have all the fine work and the regulations, primarily federal in terms of aerospace, but there are some important provincial aspects as well, in place. I challenged, after I had talked Al, a representative from Transport Canada in the regulatory area in Ottawa and he assured me that if the industry was ready to move, they would move very quickly. There are indeed regulations in Europe that are ready to go and that it would be very quick if the industry were ready to adopt those regulations or make some modifications. So one issue clearly in terms of the role of government is getting the regulations sorted out, doing so with some reasonable speed, and making sure that people are aware that it can and will be done on short order.

One of the things that the symposium has brought out is the important role of government in research and development. This is a fundamental role for government and there are huge host of unanswered questions in terms of what is going to be the optimum size of ship. Mike was talking about an airship for tourism, but clearly if we are looking at transportation in the north is it going to be optimum to be working at 20 tonne or 40 tonne or 60 tonne or 100 tonne or what? Where is the lead in? The research around those sorts of questions, logistic questions, is clearly important.

How does that apply in Manitoba? Why should Manitoba, for example, be a province where this should be a lead? We should be a lead player because of the geography and because of the opportunities here. There are issues that require research and development, things that need to be better understood and better known, for example materials and ground infrastructure. I think that the provincial government in particular

has a role in education. We have a Transport Institute here and I offer congratulations to those involved, to Barry Prentice and all the others from the Transport Institute for bringing this symposium here and playing the lead role. Public education as well as education in house among industry and other players is pretty important. If in fact this is going to be a real industry for this province, one needs to move forward in terms of supporting the development of educational aspects in coordination with support for research and development. Whether it be the Transport Institute at the University of Manitoba or the University of Winnipeg or Brandon or the new university that the province is considering in Thompson. Whatever that may be that support for education in this area so there is a better base of understanding is clearly an important provincial role.

One might ask, why Manitoba? I think that one can look back at the development of the airline industry in this country and the role that Manitoba, Winnipeg and the region around here played in the early development of the aircraft and transportation. You do not have to go very far from Winnipeg into northwestern Ontario near Red Lake to Gold Pines. For a year or two in the 1930s because of the development of gold mines, Gold Pines had either the first or the second largest cargo airfreight airport anywhere in the world and that happened because of the needs and demands of the mining industry at that point. This illustrates the needs of industry when developing a remote location. There is a considerable amount of cargo that needs to be transported in and out. You combine that need with what we have in terms of existing needs in isolated northern communities and there is clearly a major opportunity here in Manitoba, in central Canada to develop this industry and play a central role just because of the logistics, the economics, and the opportunity. So it is a challenge to industry, to government, to those at the university to see what we can do to make that happen. Thank you.

Questions

Q: We have heard a lot about the biggest benefits of airships being in their savings and infrastructure. Government is a major funder of infrastructure and just thinking within Manitoba, the rough guess of the cost of the northern airports and the winter roads program must be something in the order of \$10 to \$20 million a year. From a straight

business case, of R & D investment into the new technology that would potentially save those costs, how would the government approach valuing that, through that kind of approach never mind all the other benefits from year round service and socio-economically and so on, in order to justify the government putting some real money into getting an airship in Manitoba off the ground?

A: (Scott Smith) The question you raise is not a new one. Obviously the connectivity of a rural communities and how to do that in an economically feasible way is a challenge that we have addressed with both fixed wing and other means. But you raise a question of a socio-economic and commercial potential. The Province is always looking for partnerships and ways to develop the social side, that is a given. But certainly it has to be a business case that is feasible. I do not think there is anyone in the room who would not like to have more research and development dollars invested. There is an amount of money that is there, it is a fixed amount of money, but I think prior to getting into the research and development you really need to look at the front end. The potential is there but I think as part of the research and development you need to develop the ability on a business case of what is the need, what are we talking about? Are you talking about, comparing apples with apples or are you talking about a broad overview of the entire industry. This industry is national and international, but I think Manitoba has the expertise and with the development that we have here in our aerospace industry, we have a resource that is fantastic. The Province of Manitoba would view private partners that want to identify the need for the development as being a positive. The role of the Province would not be as the driver, but as a partner. I certainly think that the possibilities exist both on the economical side and the social side, so the Province is interested.

A: (Jon Gerrard) I would like to comment very briefly. Governments, in the way they work, very often support one industry versus another and transportation is a good example. There are a lot more dollars provincially that are spent on building roads than on building railways. One of the important issues from a provincial perspective is what the procurement policy is going to be in terms of transporting goods, and they are going

to be biased in terms of procuring road infrastructure versus airship infrastructure. Is there going to be a bias in terms of who and what is supported, in terms of how you deliver and purchase shipping of cargo into remote communities? Those are things that government could clarify and maybe help the development of an industry at the same time.

CLOSING REMARKS

Dr. Barry E. Prentice
Director, Transport Institute
I.H. Asper School of Business University of Manitoba

I hope that one of the outcomes of this symposium is a start to dispelling the myths that have plagued the airship industry. It is a process, it is going to take longer, but I think we have a good start on it. We have been able to attract government and business together for a common purpose of finding a solution to the logistical problems of the north. The opportunity to discuss how we can accelerate their economic growth and promote the usage of airship technology has been beneficial. We have certainly seen a lot of potential needs and we have heard from the providers. It was the intent of this conference to provide a first hard look at cargo airships, but it is only the beginning. One of my good friends says the two hardest things in the world are to get something started, and to get something stopped. Well we have done the first one. We have it started and I think it is going to be awfully hard to get it stopped now. I am looking forward to working with all of you in the future as we explore the applications for airships in the arctic.

I would like to end with a comment that was made at the opening of the International Airship Association conference at Cambridge this summer. In his opening address, Charlie Guthrie from Boeing observed that the airship industry needs a killer application, as in the lexicon of the electronics industry, to get it going. Mr. Guthrie did not define the attributes of the killer application, but I have been thinking about his words ever since. It occurs to me that there are at least three attributes of a killer application. The first is that you have to have high margins to bear the risk and attract the capital necessary to do something that is new and different. We certainly heard at this conference that there are some high margins in northern transportation. Northern Stores

offered a comparison of six to eight cents per pound to distribute goods in the south versus as much as \$3.50 per pound in the north by air. Even with winter roads it can cost as much as \$2.00 a pound to serve remote communities. These are obviously high margins. There is a lot of room for the airship industry to play with and offer better service than what is being done today.

The second criteria in my opinion, is that you have to have minimal competition so that the potential margins do not get bled immediately. There is not a lot of competition for what airships can do in the north. Certainly the only real competition is the once a year sealift, or re-supply by winter roads. In addition to their cost and operational uncertainty, shippers face the cost of carrying huge inventories and expediting articles that are found missing. I am sure that in every case when you have to buy everything one year ahead, there is something that you either forget or lose or gets damaged. Then you are left with expediting it in at high cost with airplanes. Consequently, a cargo airship has minimal competition in the north.

The third criteria and perhaps the most difficult to meet is a sufficient market size to justify assembly line production. Nobody is going to invest in all the effort it takes to develop an airship if one vehicle can do the whole job. The words that I heard used during the symposium were, "I don't want an airship, I want a fleet of airships." This was certainly music to my ears and I am sure it was to those who are interested in building airships. There is room in northern Canada for a fleet of airships and in fact what works here is going to work in many other places such as Siberia, Australia, southeast Asia, Africa and South America. There is the critical size of the market to make the airship industry happen. Canada's north presents that killer application. Seventy percent of this country has no roads. There is an opportunity for cargo carrying airships. Let me leave you with the four last words. The time is now.

2002 PARTICIPANTS

SPEAKERS

(in order of appearance)

Barry Prentice	Transport Institute
David Collenette	Minister of Transport
Scott Smith	Manitoba Transportation & Government Services
Barry Rempel	Winnipeg Airport Authority
Richard van Treuren	United Space Alliance
David E. Barlow	TCOM
Andrew Horosko	Manitoba Transportation & Government Services
Paul Smith	The North West Company
Brad Thiele	Cumberland Resources Ltd.
Cliff Abraham	Northern Transportation Company Ltd.
Jim Thomson	Ironlink
John Markowsky	Manitoba Hydro
Ian Goodwin	BHP Billiton Diamonds Inc.
John Skalski	Enbridge Pipelines Inc.
Al Phillips	Consultant Transport Institute
Walter B. Parker	Arctic Councils
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Lt. Col. Mike Woodgerd	U.S. Army
Dennis Wright	Freshwater Institute
Rudy Bartell	American Blimp Corp.
Scott Danneker	Zepplin Airships
Lei Harris	St. Andrews Biological Station
Glenn Beach	Paradigm Technologies
Gordon Taylor	ATG, UK
Gennady Verda	RosAeroSystems
Fred Edworthy	Worldwide Aeros Corp.
Kerry Boucher	Standard Aero Canada
Steven L. Krause	The Boeing Company
Ron Browning	Lockheed Martin
Doug Duncan	Consultant Transport Institute

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Armand Barbeau	Manitoba Aboriginal & Northern Affairs
Jim Bear	South East Tribal Council
Harvey Bostrom	Government of Manitoba
Eleanor Brockington	Manitoba Aboriginal & Northern Affairs
Richard Burelle	Manitoba Hydro
Manford Bussell	Churchill
Lynn Cabak	Manitoba Transportation and Government Services
Amar Chadha	Manitoba Transportation and Government Services
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Gil Costin	Millennium Airship Inc.
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Edward Hoch	Alaska Dirigibles
Geoffrey Horner	Transport Canada
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Standard Aero
Manitoba Transportation and
Government Services
Ministère des Transports du
Québec
Micro Pilot
Island Lake Tribal Council
Alom Group

Speaker Biographies

OCTOBER 23, 2002

BARRY PRENTICE DIRECTOR OF THE TRANSPORT INSTITUTE ASSOCIATE PROFESSOR, UNIVERSITY OF MANITOBA

BARRY PRENTICE is the Director of the Transport Institute and an Associate Professor, in the I.H. Asper School of Business.

Dr. Prentice has held a joint teaching and research appointment since 1985. His major research and teaching interests include logistics, transportation, agribusiness marketing and commercial trade policy.

From 1986-89, he was Professional Associate and Assistant Professor at the University of Manitoba and became Acting Director of the Transport Institute in 1991. He was appointed Director of the Transport Institute in April 1996.

Dr. Prentice has authored or co-authored more than 100 research reports, journal articles and contributions to books. His scholarly work has been recognized for excellence in national paper competitions and awards. In 1999, he was named Manitoba Transportation Person of the Year, by National Transportation Week. Dr. Prentice has participated in task forces, expert committees, and is frequently asked to speak on the topics of trade and transportation.

HONOURABLE SCOTT SMITH MINISTER MANITOBA TRANSPORTATION & GOVERNMENT SERVICES

SCOTT SMITH was appointed Minister of Transportation and Government Services and Minister responsible for the Manitoba Lotteries Corporation Act by Premier Gary Doer on September 25, 2002. Previously, he was Minister of Consumer and Corporate Affairs and Minister charged with the administration of the Liquor Control Act. He was first elected to the Manitoba legislature in the general election September 21, 1999 and served as legislative assistant to the Minister of Industry, Trade and Mines.

Prior to Mr. Smith's successful election in September 1999 as the MLA for Brandon West, he was a member of the Brandon city council where he held a number of positions including chair of the grants review committee, chair of the task force on impoverishment, and chair of the taxi review committee. Mr. Smith was also a member of the Recreation Centre Review Committee, the Brandon Chamber of Commerce, the

Brandon Economic Development Board, the Downtown Business Improvement Area, the board of the Brandon Family YMCA. He also served as treasurer on the board of directors of the Brandon Keystone Centre.

BARRY REMPEL
PRESIDENT & CHIEF EXECUTIVE OFFICER
WINNIPEG AIRPORTS AUTHORITY

BARRY REMPEL was appointed President and Chief Executive Officer of Winnipeg Airports Authority Inc. in April 2002. Prior to joining the Winnipeg Airports Authority as President & CEO, Mr. Rempel had an accomplished career spanning 27 years in aviation that included: President & CEO of Trademarks Development Corp (the land/business development subsidiary of the Calgary Airport Authority), and full executive responsibility for two independent operating divisions of Canadian Airlines International as Vice President, Cargo and Canadian North.

Elected to the Board of the Calgary Chamber of Commerce in 1998, he became Chairman in 2001. He also served for seven years with the Edmonton Chamber of Commerce, most notably as Chairman in 1994. Mr. Rempel has also served on the Board of Alberta Economic Development and is past president of the Northern Air Transport Association

A proponent of lifelong learning, Mr. Rempel has actively engaged in continuous education through a variety of formal and structured self-improvement courses and workshops. A graduate of the Executive Program at Queen's University in 1995, Mr. Rempel built upon previous accomplishments while studying Business Administration at the University of British Columbia, winning the top student award for marketing and retailing.

RICHARD VAN TREUREN
ASTRONAUT CHANGEOUT TECHNICIAN
UNITED SPACE ALLIANCE

RICHARD G. VAN TREUREN entered the US Navy in 1969, serving on Atlantic and Pacific aircraft carriers.

In 1979 Mr. Van Treuren joined the Space Shuttle contractor team, and today he is an astronaut changeout technician with the United Space Alliance, a joint venture of Lockheed-Martin and Boeing.

A longtime airship history fan, Mr. Van Treuren has produced books and videos on dirigibles, and in recent years has sought to correct the record in the areas of so-called hydrogen accidents and the role of the airship during World War II.

DAVID E. BARLOW
PRESIDENT
TCOM, LP

DAVID E. BARLOW became President of TCOM in June 1997. Prior to that he was the Chief Financial Officer and Executive Vice President, having joined TCOM in February 1990.

From 1968 to 1990, Mr. Barlow held numerous financial positions at Westinghouse including from 1988 to 1990, Controller of Financial Operations and Business Analysis for the Electronic Systems Group (i.e., the \$3.0 billion defence operation of Westinghouse).

While at Westinghouse, Mr. Barlow served on the Board of Directors of the following companies: WEXICO, Inc. (i.e., a Westinghouse/Saudi joint venture) and WOSCO, Inc. (i.e. Westinghouse's Overseas Services Company).

ANDREW HOROSKI
DEPUTY MINISTER
MANITOBA TRANSPORTATION & GOVERNMENT SERVICES

ANDREW T. HOROSKI has a M.Sc. in Civil Engineering from the University of Saskatchewan, majoring in Transportation and Regional Economic Planning. Mr. Horoski is the Deputy Minister of Manitoba Transportation and Government Services, a position he has held since 1993.

Throughout his career, Mr. Horosko has been associated with the National Academy of Sciences in Washington, D.C., Saskatchewan Highways and Transportation, Department of Northern Saskatchewan, University of Saskatchewan and Chevron Standard Ltd. of Calgary. His professional affiliations include the Transportation Association of Canada (TAC), Canadian Strategic Highway Research Program (C-SHRP), American Association of State Highway and Transportation Officials and the United States Transportation Research Board (TRB). He is a member of the RMC, TTCC, and Board of Directors of ISIS Canada.

PAUL SMITH
VICE PRESIDENT, LOGISTICS & SUPPLY CHAIN SERVICES
THE NORTH WEST COMPANY

PAUL SMITH has a 23-year career with The North West Company and its predecessor, Hudson's Bay Company. Currently the Vice President, Logistics and Supply Chain Services, Paul has experienced a multi-disciplined path to that position.

Starting in the stores as a food clerk in Pinawa, he moved through progressively responsible store positions in northern Saskatchewan and Manitoba. His last store manager posting was for 6 ½ years in Norway House, Manitoba.

Since moving to North West Company's Winnipeg-based corporate office, Mr. Smith has spent time in Training & Development, Store Operations as a field executive, and in the Information Services department as a director responsible for North West Company's Point-Of-Sale support and operations in the company 170 store network.

BRAD THIELE
VP MEADOWBANK PROJECT DEVELOPMENT
CUMBERLAND RESOURCES LTD.

BRAD THIELE is a graduate mining engineer from the University of Saskatchewan with 35 years of experience in the mining industry shared equally between open pit and underground operations. Mr. Thiele has functioned in senior management and consulting roles since 1978.

His northern exposure to mining includes approximately six years of operations engineering and supervision in locations such as Lynn Lake, Manitoba, several mines in the Yukon Territory, Fort McMurray, Alberta, northern Saskatchewan uranium mines and Cordova Alaska.

He is currently overseeing the Meadowbank gold project, near Baker Lake, Nunavut, through feasibility with the expectation of construction in 2005 and 2006, and aiming for production in early 2007. The Meadowbank Gold Project is modeled to be a 250,000-ounce per year producer, with air and winter road access only.

S. CLIFFORD ABRAHAM
PRESIDENT
NORTHERN TRANSPORTATION COMPANY LTD.

S. CLIFFORD ABRAHAM joined NTCL and was appointed President in September of 2001. He brings to the Company and its clients over 20 years' experience in most facets of the marine transportation field, including 13 years at the CEO/COO level with major domestic and international ship owners in both Canada and the United States. During much of this time he was directly responsible for developing and managing his firms' business with major industrial and crown corporations, while other areas of focus have included finance, personnel and traffic.

Mr. Abraham holds a BA from the University of Toronto, an MBA from York University, and has completed industry-related courses in a variety of specialized areas. He is a director of the Council of Marine Carriers (Vancouver), a member of Lloyd's

Register Canadian Committee (Montreal), and a past director of the International Association of Dry Cargo Ship owners (London).

JIM THOMSON
GENERAL MANAGER
IRONLINK TRANSPORTATION MANAGEMENT

JIM THOMSON is the General Manager of a Calgary based third party logistics company known as Ironlink Transportation Management. Ironlink, which is a subsidiary of a TSE listed transportation software company called Moveitonline, provides transportation related services to several oil and gas and energy related companies.

Mr. Thomson is a Chartered Accountant and has worked in several business development roles for both transportation and energy companies. Transportation companies he has worked for include Trimac Transportation, who provide truck transportation for bulk commodities, and Gibson Petroleum who are a large western Canadian based crude hauler. While working for Westcoast Energy, Mr. Thomson developed an electronic trading system for natural gas that pre-dated today's e-commerce. Over \$100 billion worth of natural gas has since traded electronically. Other consulting assignments have included BP Canada, TransCanada Pipelines, Hatch Engineering, the Canadian Grain Commission and Palliser Grain. In a more traditional Chartered Accounting role, Mr. Thomson served as a Controller for a large Ottawa based real estate company and a Vancouver real estate developer.

JOHN W. MARKOWSKY, P.Eng.
MANAGER OF MAJOR PROJECTS PLANNING
MANITOBA HYDRO

JOHN W. MARKOWSKY has over twenty-five years experience in all phases of the development of Large Engineering Projects. For the last Fifteen years he has worked primarily on the planning and construction phases of hydroelectric generating stations. During this period John worked on projects in remote locations in Northern Canada, Africa, India, and South East Asia.

Mr. Markowsky holds a Bachelor of Science in Civil Engineering from the University of Manitoba, a Masters of Construction Management from the University of Waterloo and an MBA from Athabasca University.

He is currently the manager of Major Projects Planning for Manitoba Hydro, and is responsible for the planning of the construction phase for planned future hydro-electric generating sites in Northern Manitoba.

IAN M. GOODWIN
MINE MANAGER
EKATI DIAMOND MINE™
BHP BILLITON DIAMONDS INC.

IAN M. GOODWIN has over 28 years experience in the mining industry, including 21 years with BHP Billiton.

He has spent the major portion of his career overseas involved with the development and operation of a number of the world's premier mining operations. Work locations have included Australia, United States and Canada with brief periods in Chile, Peru and Papua New Guinea.

Mr. Goodwin came to Canada in 1998 as the Maintenance & Supply Manager for the Ekati Diamond Mine™, the first Diamond Mine in Canada. He was involved in the construction of the mine and was a member of the management team when the mine started full production in October 1998. He has been the Mine Manager since 2000.

Mr. Goodwin is a member of the Canadian Institute of Mining and the Australian Institute of Purchasing and Materials Management.

B. JOHN SKALSKI
MANAGER, GAS PIPELINE TECHNICAL SERVICES
ENBRIDGE PIPELINES INC.

B. JOHN SKALSKI is a Mechanical Engineer by training, with over 15 years of direct Enbridge employment experience to complement his prior 10 years of engineering consulting and work with a gas distribution and transmission utility.

Mr. Skalski has applied his design, construction and project management experience on every major Enbridge project over his 15-year career. This included projects such as the 868 km Norman Wells to Zama pipeline, the various mainline pipeline additions between Gretna Manitoba and Edmonton Alberta, the 600 km OCENSA pipeline project in Colombia, South America and construction of the Vector gas transmission pipeline system between Chicago, Illinois and Dawn, Ontario.

AL J. PHILLIPS
PROFESSIONAL ASSOCIATE
TRANSPORT INSTITUTE

Al J. Phillips has been a Professional Associate with the Transport Institute since May 1999.

His specialties include resource economics, agricultural input analysis, research design and primary data collection methods. His current interests include the evolution of the relationship between plant genetics and crop protection chemistry and the effects of such developments on supply and distribution systems.

Mr. Phillips brings 18 years experience in the agricultural market research and data analysis sectors to the Transport Institute. In the past, he served as Vice-President and Agricultural Division Manager of one of the leading Canadian agricultural marketing research firms. He later co-founded A.J. Phillips & Associates, a private consulting firm, assisting a variety of clients in product communications, positioning and marketing.

Mr. Phillips is a professional agrolgist (P.Ag.) in the Province of Manitoba, a Certified Agricultural Consultant (CAC), and holds a M.Sc. in Agricultural Economics from the University of Guelph, a B.A. in Economics and a BSA in Animal Science from the University of Manitoba.

WALTER B. PARKER

CHAIRMAN

ARCTIC COUNCILS

WALTER B. PARKER has been involved in planning in Alaska and the Arctic since 1946. He has a B.A. in history and in anthropology, and an Honorary Doctorate in Science from the University of Alaska. He also has a Certificate in Administrative Management from Syracuse University's Maxwell School and has taken graduate courses at the Sino-Soviet Institute at George Washington University.

Mr. Parker is primarily known for his background in transportation, telecommunications, land use planning and oil spill response. Mr. Parker and his wife founded Parker Associates, Inc., working on transportation and communications issues primarily.

In 1974 he was requested to join the Alaska State Pipeline Office as Environmental Consultant to the Governor, William Egan, and Director of Technical Staff. At this time he was also a delegate to the Law of the Sea Conference. In December 1974, he was asked to become Highway Commissioner and form a state Department of Transportation. He also chaired the Alaska Telecommunications Task Force.

In March 1976, Mr. Parker was asked to serve as State Chairman of the Joint Federal/State Land Use Planning Commission for Alaska. In 1989, Governor Cowper appointed Mr. Parker as Chairman of the Alaska Oil Spill Commission. Subsequently, he became Chair of the Alaska Hazardous Substance Spill Technology Review Council that examined oil spills and other hazardous substances in Alaska. In 1995, he was appointed by President Clinton as a Commissioner on the U.S. Arctic Research Commission. This led to appointment to the U.S. delegation to the Arctic Environmental Protection Strategy Working Group on Emergency Preparation, Prevention and Response in 1995, where he still serves. Later, he became a delegate to the Senior Arctic Officials and the

Sustainable Development Working Group where he still serves. He has chaired the Circumpolar Infrastructure Task Force for the Council since 2000.

CHARLES J. HUNTER
DIRECTOR CORA
1 CAD/CANR HQ

CHARLES J. HUNTER attended the University of Manitoba where he received his BSc and MSc degrees in Statistics.

Mr. Hunter joined the Department of National Defence's Operational Research and Analysis Establishment in July 1983. He was initially appointed to the Directorate of Mathematics and Statistics in Ottawa, where he worked on statistical data analysis problems and provided experimental designs for equipment trials. One of his first projects was an evaluation of the potential environmental hazards posed by testing the Air-Launched Cruise missile over Canadian soil.

In 1986, he was promoted to a Defence Scientist 3 (DS-3), and transferred to Air Transport Group HQ, in Trenton, Ontario. While at ATGHQ he developed location accuracy models for search and rescue satellite distress data, plus he studied CC130 performance characteristics and airlift operations. Mr. Hunter was posted to Air Command HQ (AIRCOM HQ, Winnipeg) in 1988. In 1992 he was promoted to DS-4 and appointed as the Director of Operational Research at Fighter Group /CANR HQ, in North Bay, Ont. Mr. Hunter closed the OR branch in 1996 and he was posted back to AIRCOM HQ. In 1997, he received the Deputy Minister's Commendation and was promoted to DS-5 in 1998. He is presently the Director of the Centre for Operational Research and Analysis at 1 Canadian Air Division /Canadian NORAD Region HQ, here in Winnipeg.

LIEUTENANT COLONEL MICHAEL WOODGERD
TRANSPORTATION CORPS OFFICER
CENTER FOR ARMY ANALYSIS, UNITES STATES ARMY

LTC MICHEAL WOODGERD is the US Army's recognized expert in Lighter-Than-Air (LTA) and Ultra Large Airlifters (ULAs). In 2001, he earned the Wilbur Payne award for the top individual Operations Research project throughout the US Army for his self initiated "CargoLifter Aerial Transport System (CATS)" study which examined the feasibility and utility of ULAs in military deployments.

LTC Woodgerd is a Transportation Corps officer who has served in various command and staff positions in the US, Germany and Korea, with primary expertise in strategic deployment using military and commercial airlift and sealift. He also has an extensive background in writing future operational concepts and doctrine, including authorship of the US Army's capstone doctrinal manual for multinational operations.

A 1982 graduate of the United States Military Academy, LTC Woodgerd also earned a Masters Degree in Systems Technology from the Naval Postgraduate School in 1991. Currently assigned to the Center for Army Analysis (CAA) in Fort Belvoir, VA, he is continuing his support to the Department of Defence on LTA issues as well as other advanced mobility concepts.

OCTOBER 24, 2002

DENNIS G. WRIGHT
COORDINATOR, ENVIRONMENTAL AFFAIRS
ENVIRONMENTAL SCIENCE DIVISION
DEPARTMENT OF FISHERIES AND OCEANS
CENTRAL AND ARCTIC REGION

DENNIS G. WRIGHT has been a biologist with Canada's Department of Fisheries and Oceans since 1973. Following graduation from the University of Guelph in Guelph, Ontario with a B. Sc. (Hons Zoology) and a M. Sc. (Zoology), he joined the Dept. of Fisheries and Oceans and became involved in examining the impacts of hydrocarbon exploration, production and transportation on fish and fish habitat. Mr. Wright has been involved in the coordination and delivery of Environmental Emergency Response programs within the Central and Arctic region of DFO and has participated in large-scale land use planning initiatives within the NWT and Nunavut.

In addition to these responsibilities for, Mr. Wright is actively involved in trans-border water diversion issues, the prevention of the introduction of non-native aquatic species and in the development of guidelines for the safe use of explosives in and near fish habitat.

RUDY BARTELL
ENGINEERING MANAGER
AMERICAN BLIMP CORPORATION

RUDY BARTELL has twenty-three years experience in the aviation industry including program and corporate management, aerospace R & D and flight-testing. He has an aeronautical engineering diploma from the Southern Alberta Institute of Technology and a B.S. aerospace engineering from the University of Kansas.

After graduating from SAIT he worked for several years in the Experimental Department at Canadair Ltd. in Montreal. He followed this with several years as flight test engineer and program manager in eleven flight test programs while at Kohlman Systems Research in Lawrence, Kansas.

His last twelve years have been in the Lighter-Than-Air industry. As Engineering Manager at American Blimp Corporation he was responsible for Type Certification of two airship types in eight countries. He has had the opportunity to be involved in every aspect of airships from notional design studies to ongoing operational aspects.

In 1990 the US Federal Aviation Administration, authorizing him to approve data on behalf of the FAA, appointed Mr. Bartel a Designated Engineering Representative.

SCOTT DANNEKER
AIRSHIP PILOT
ZEPPELIN AIRSHIPS

SCOTT DANNEKER has served for 17 years as an airship pilot. He received his airship flight training as an employee of Airship Industries USA, Inc., and was promoted to the position of "Senior Pilot." In this capacity, Mr. Danneker commanded several traveling airship operations in North America and Europe, and supervised the training of new airship pilots.

Mr. Danneker was later employed as a test pilot by Westinghouse Airships Inc. and participated in the certification flight test program for the Sentinel 1000 airship, surveillance and communications trials for the US Navy, and trials to assess the practicality of underway replenishment and tethering at sea. He personally directed the operational testing of a "bow-thruster" that was designed to improve the low speed directional control of the airship.

Mr. Danneker served as test pilot for Zeppelin for 4 years during the developmental and certification flight test phases of the LZ-N07 airship and was in command of this airship on its inaugural flight on 18 September 1997. He developed the operational procedures currently in use on this airship.

Since 2001 he has acted as a contract airship pilot and consultant for Zeppelin, Airship Management Services (AMS) and briefly for Cargo-Lifter. He is the Secretary of the AIAA LTA Technical Committee. Mr. Danneker is licensed to fly airships in the United States, United Kingdom, Germany and Japan.

LEI HARRIS
SPECIES AT RISK BIOLOGIST
ST. ANDREWS BIOLOGICAL STATION
DEPARTMENT OF FISHERIES AND OCEANS

LEI HARRIS obtained her B.Sc. in Biology from Concordia University in Montreal and her M.Sc. in Zoology from the University of Manitoba.

Ms. Harris's past work has focused on marine ecology and fisheries. She is currently working for Fisheries and Oceans Canada as a Species at Risk Biologist at the St. Andrews Biological Station in New Brunswick. Her responsibilities include whale research, marine fish evaluations, and general conservation biology issues.

Ms. Harris's recent work on the North Atlantic right whale featured the use of a lighter-than-air platform as a means of videotaping the whales' response to vessels.

GLENN BEACH
PRESIDENT
PARADIGNE TECHNOLOGIES LLC

GLENN BEACH began his career working with Westinghouse Defence in 1977. A principle development conceived by Mr. Beach was the creation of Kevlar strength member tether cables.

Between 1988 and 1989, Mr. Beach was assigned to live and work in London, England as the manager of Airship Technology to represent Westinghouse Defence on the U.S. Navy Airship program. Upon returning to the United States in December 1989, Mr. Beach became an owner and Vice-President of Engineering for TCOM LP.

In 1998, Mr. Beach left his position at TCOM to assume a position as an advisor to CargoLifter AG in Germany, where he conceived the idea for the CL75 cargo transport system. In July 2001, Mr. Beach returned to the United States as Vice-President of Engineering for CargoLifter, Inc. In May 2002, Mr. Beach resigned from CargoLifter, Inc. and became an independent consultant to industry. He is currently President of Paradigm Technologies, LLC located in the State of Maryland, USA.

Mr. Beach holds a degree in Mechanical Engineering from the University of Maryland, and studied business courses in post-graduate school at Johns Hopkins University. Mr. Beach holds six patents and has published several papers on LTA systems and hardware over the span of his career.

GORDON TAYLOR
DIRECTOR OF SALES & MARKETING
ADVANCE TECHNOLOGIES GROUP

GORDON TAYLOR is the Director of Sales and Marketing at Advanced Technologies Group based in Bedford, England. He has worked as a senior executive in the aerospace sector in North America and with a regional airline and manufacturer in a financial and marketing, capacity, notably de Havilland Canada (now a part of Bombardier).

From 1985 to 1998 he was engaged in corporate finance, mergers and acquisitions and equity fundings in the City of London. He joined ATG in 1999 and successfully led the first major stage of investment in ATG.

GENNADY VERDA
PRESIDENT
ROSAEROSYSTEMS

FRED EDWORTHY
VP PROGRAMS & BUSINESS DEVELOPMENT
WORLDWIDE AEROS CORP.

FRED EDWORTHY is the vice president of programs and business development at Worldwide Aeros Corp., Canoga Park, California. As well, he has served as president of Aeros Flightcam Inc. since joining the Aeros organization in 1999.

Between 1989 and 1998 Mr. Edworthy was the President and General Manager of a complex tourist and lodge operations on the Pacific North Coast, where he directed the building and expansion of the business through a wide range of responsibilities including government liaison, and aggressive participation in the industry interest organizations.

Prior, Fred was President and CEO of a group of Companies that included restaurants and fishing vessels. His entrepreneurial endeavors have allowed him to work and live in diverse areas of the globe including the Canadian Maritimes, Manitoba, B.C., the country of Turkey, as well as Southern California. He is currently directing his time and energy to solving major transportation problems through the creative uses of lighter than air technologies.

KERRY BOUCHER, P.Eng., M.Sc
VP ENGINEERING & QUALITY
STANDARD AERO CANADA

KERRY BOUCHER holds a Mechanical Engineering degree, M.Sc. in Engineering, Fluid Dynamics, specializing in Aerodynamics.

Mr. Boucher has experience across multiple industries working for Government agencies, consultants, and private industry. He has worked on projects throughout North America, South America, EU, Far East, and Pacific Rim.

Mr. Boucher's project responsibilities included:

- * CANDU Nuclear power-plant research, development and design.
- * Mining, Petrochemical, and Manufacturing system development, design and construction management.
- * Engineering Design Lead and Project consultant.
- * Director of Engineering Departments.
- * Business redesign and operations management for Aerospace manufacturing

environment.

- * General Management for Maintenance, Repair and Overhaul of gas turbine engine power-plant systems and accessories.
- * Executive Management responsible for corporate technical direction through management of engineering, quality, and technical resources.

STEVEN L. KRAUSE
UNMANNED SYSTEMS INTERNATIONAL PROGRAMS
DIRECTOR, INTEGRATED DEFENCE SYSTEMS
THE BOEING COMPANY USA

STEVEN L. KRAUSE joined The Boeing Company (McDonnell Douglas) in 1982. He led McDonnell Aircraft Company military business development in Europe and the Pacific and later served as director of worldwide business development for McDonnell Douglas Helicopter Systems. He was transferred to Long Beach, California in 1996 where he assumed strategic sales and marketing responsibilities at Douglas Aircraft Company. Following the merger of The Boeing Company and McDonnell Douglas Corporation, Mr. Krause was assigned to the military aircraft and missile systems business as general manager of international business development. Most recently he led Boeing's Joint Strike Fighter international program team in Seattle, Washington. In his current assignment, Mr. Krause is responsible for the development, capture and execution of international unmanned systems programs for Boeing's Integrated Defence Advanced Systems organization. Mr. Krause and his family have completed foreign assignments in Saudi Arabia, Korea and Germany.

Mr. Krause was graduated *summa cum laude* from William Jewell College with a B.A. in communication and political science. He received a M.S. in public administration from the University of Missouri and served for five years on the research staff of the Missouri legislature.

RONALD G.E. BROWNING
DIRECTOR OF BUSINESS DEVELOPMENT
LOCKHEED MARTIN COMPANY

RONALD G. E. BROWNING is the Director of Business Development for surveillance systems at Lockheed Martin Naval Electronics & Surveillance Systems in Akron, OH. He is responsible for the worldwide marketing of lighter-than-air surveillance systems including airship and aerostat systems.

Prior to being named to his current position in 1995, Browning served in several program director assignments including the Digital Topographic Support System, Vertical Launch ASROC, and the GZ-22 advanced airship program, which he led from concept definition through FAA type certification. He has also served as project engineer on a variety of airship evaluations for the U.S. Navy, NASA, the U.S. Coast Guard, and U.S. Customs

Service. Before joining Lockheed Martin in 1979, Browning spent seven years dealing with major transportation systems at Alberta Transportation and Canadian National.

Mr. Browning graduated from Carleton University in Ottawa with a degree in civil engineering and has subsequently earned a master's in civil engineering from the University of Alberta and a master's in business administration from Kent State University. He is a member of the American Institute of Aeronautics and Astronautics (AIAA) technical committee on lighter-than-air systems.

DOUGLAS B. DUNCAN, CA
CONSULTANT
DOUGLAS B. DUNCAN & ASSOCIATES

DOUGLAS B. DUNCAN has extensive experience in railway management and transportation issues in Canada. Over 28 years at Canadian National Railway, his responsibilities included financial planning, strategic and business planning, change management and transportation policy and regulation. Combined with his experience as a Chartered Accountant in public practice, Doug has a broad perspective on the marketplace. Doug currently contracts to the Transport Institute, University of Manitoba in the role of Strategy and Business Development Advisor.

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