What Will the mining sector in Canada look like at the mid-point of the 21st century? No doubt, it will be larger. The burgeoning demand from the emerging Asian giants of China and India will be served mainly by new mineral extraction. Relatively high commodity prices will have pushed mineral development to technology’s limit. Like the petroleum industry, mining is going to depend more on the frontier areas of the planet with poor infrastructure for new reserves. Canada is in a good position to benefit from increased resource demand, especially in the largely untapped Northwest Territories and Nunavut.

Mining development in remote areas has many challenges, but the cost of transportation has to be near the top of the list. Transportation infrastructure is expensive to build, particularly where environmental requirements, native land claims and permafrost soils are involved. The distances are long and maintenance costs are substantial. Once the mineral resource is exhausted, all-weather roads and air strips become stranded assets and may be subject to remediation. It can cost more to decommission roads and return the landscape to nature than the original costs of construction.

What if it were possible to fly base metal concentrates to a rail head? Airplanes are used to fly out diamonds and precious metals, but the volume and value of base metals make airplanes uneconomic. How would the economics of mining base metals in remote places change if the costs of air transport could be halved?

The idea of using a lighter-than-air vehicle for mining in Canada dates back to the 19th century. Joseph de l’Etolle proposed the “Klondike balloon” to revolutionize
When the idea of airship mining is presented, the reaction is likely to be skepticism. No more airships are carrying minerals through the sky today than in de l’Etoile’s time. But much has changed in the last 100 years that make the day closer that large cargo carrying airships could be available, if not inevitable. The use of airships for hauling mineral concentrates could be one of the primary uses for this technology by 2015.

Large transport airships are technically feasible to build today. Advances in the strength of light weight materials, computerized control systems to vector thrust and advanced engineering design tools have overcome all the technical issues that impeded airship landing and safety concerns. Several prototypes and instrumented models have been tested that can take-off and land without teams of ground-handlers holding ropes. The principles of airship flight, mooring and operations were all established in the 1930s by the giant Zeppelins. Technological advances are now pushing cargo airships towards a tipping point where supply will be racing to keep up with demand.

Approximately 16 projects in eight different countries are underway that have built and flown airships. Significantly, aerospace companies like Boeing and Lockheed-Martin have become engaged in the race to develop this new generation of airships. This helps bolster business confidence because these companies have the financial resources and the engineering talent to lead the development of commercial airships.

The economics of airships have changed dramatically since the last generation of large airships. Environmental concerns have changed the demand for airships. Transport airships burn less fuel because the lift is free. They do not cause much ground disturbance because they do not require prepared landing sites. Cargo can be exchanged on any flat area, body of water or frozen lake.

Lower relative costs are a second strength of airship transportation. With the exception of a few mooring masts and hangars, transport airships have no ground based assets. Essentially, the vehicle is the infrastructure. This also means that airships are not subject to stranded asset costs which are typical of other means of transport in remote areas. The mining industry presents a market in which transport airships have a clear cost advantage.

New technology is adopted first in the supply chains where it creates the most value. It is interesting to note the management benefits of airships to the mining industry. Typically, mining road construction requires several years before environmental approvals and construction can be completed. Airships would allow surface operations to commence as soon as a pit can be opened and a concentrator can be constructed. A shorter lead time to market allows producers to capture the higher prices that typically coincide with the early years of commodity cycles.

A second management benefit of airships is the greater ability to lower risk associated with debt financing. With no fixed infrastructure a transport airship can be redeployed quickly to whichever mine site is most profitable. Mine operations that become marginal when mineral prices fall can be suspended because they do not have to service the debt on the road. When economics improve, mine operations can be re-initiated.

As long as mineral deposits were available in areas with established road or rail infrastructure, no compelling reason existed to consider airships. The shift of attention to remote area mining is creating the demand to explore new alternatives. At the present time, transport to remote locations is expensive, inefficient and unreliable. Airships could offer the mining industry a more sustainable means of transport. A compelling reason to embrace airships is coming, and first-mover advantages will exist.

Socially, transport airships could promote more sustainable mining communities. The North is littered with abandoned communities that failed when the ore bodies were exhausted. Even established centres like Thompson, Manitoba, face a difficult future when the nickel deposits they are depleted. Airships could convert such communities to mining hubs with many satellite mines in the 200 kilometer radius. All the mining families and supply businesses could reside in the established centre. The airships could take fresh crews and supplies to the mine, and return with concentrates and relief crews. In the case of Thompson, the existing mill
facilities could be utilized when the current reserves are exhausted.

The diamond mines in the Northwest Territories are served remotely out the hub of Yellowknife. Fuel and storable supplies are brought in over ice roads, while perishable supplies, crews and diamonds are flown on airplanes. The problem with base metals is the volume of material. Cargo carrying airships could eliminate the need for ice roads and create the potential for satellite mining of base metals.

The advent of transport airships will alter the economics of mining in many ways. At the moment, only large deposits that can justify the expense of building infrastructure are economic to exploit. With airships, many rich, but small deposits throughout Canada could be developed as open pit operations. So-called pocket mining could be carried out in centres such as Val d’Or, Timmins, Thompson, Flin Flon, Prince Albert, Yellowknife and other places where airships could transship concentrates to truck and rail for movement to world markets.

The accompanying photographs of airship designs represent the developing branches of the technology. The Zeppelin NT07 is a pure airship, in the sense that it is lighter than air when loaded. It can take off slightly heavy using its propellers for extra thrust, but generally it carries water ballast when it does not have a passenger or cargo payload. In terms of structure the NT07 is semi-rigid. An internal frame carries half the load, and the rest is carried by the envelope.

In the photo from Friedrichshafen, Germany, the NT07 is landing to exchange passengers. Note that no ground crew is required to hold ropes. Sister ships are operating in passenger roles in San Francisco and Tokyo. Another NT07 operated for two years in Botswana as a survey platform for mineral exploration.

The Guardian Flight Systems Polar 400 airship is similar to the NT07, except it does not have any internal structure. Also, its propellers are hydraulically operated from a single engine and oil pump located in the gondola. Both the NT07 and the Polar 400 airships operate without any ground crews and can be moored to a simple docking mast.

Boeing Company [BA-NYSE] and SkyHook International have formed a partnership to build the first commercial airship-helicopter hybrid. The Skyhook HLV uses the buoyancy of the airship to lift all the deadweight of engines, fuel, structure, etc. The four large helicopter rotors are used to lift the payload. This vehicle is designed to lift 40 tons and travel under load 200 miles. The design of the SkyHook HLV has been frozen and the production schedule is planned for first delivery in 2014.

The SkyHook HLV will have some advantages in applications that require precision vertical pickup and placement of loads, as envisioned in pipeline construction. Other potential applications could be moving oil exploration rigs, mining camps, wind turbine blades and other heavy indivisible objects. The SkyHook HLV could also be used to ferry mineral concentrates to rail heads or port loading sites.

A catamaran style airplane-airship hybrid is under development in the U.S. by Lockheed-Martin, and in the U.K by Hybrid Air Vehicles. These aircraft are 20%-30% heavier than air and depend on their shape which is like a giant airfoil. They use a combination of aerodynamic lift, engine thrust and buoyancy to become airborne. For landing and maneuvering on the ground, the hybrid designs have modified hovercraft pads. Once positioned to load or unload cargo, the hovercraft fans are reversed to provide a suction that holds the vehicle in place.

A video of the Lockheed-Martin P-791 piloted prototype can be seen on YouTube\(^1\). The picture of the British HAV hybrid is an instrumented model. The catamaran hybrid requires a flat area to land and take-off but no prepared surfaces. The ability to operate without ballast makes it ideal for transferring loads to undeveloped sites. It is also designed for speed and distance that would make it ideal for moving large quantities of mineral concentrates to transshipment points.

The initial designs are for payloads of 25 to 50 tons, but plans are to create much larger versions in the 250 to 500 ton payload range. Representatives of these airship companies and others are coming to speak at the fifth Airships to the Arctic conference that will be held for the first time in Calgary, October 7-9, 2009 (www.airshipstotheartic.ca)

Sovereignty in the North is another issue that airships could help address. Canada’s land claims are fairly secure; however, dominion over the Northwest Passage and territorial lands under the sea are not fully acknowledged. Airships could provide more direct surveillance of the Arctic than satellite coverage and support commercial activity on the ground. Military presence and supply for Arctic operations from airships could greatly enhance Canadian security and protection for the environment.

The airship industry is approaching the “tipping point” where the technology will soon move from concept to reality. As soon as it does, it will open a floodgate of opportunity. Those who commit early will be rewarded as this industry gears-up to production to meet demand.\(^{1}\)

\(^1\) Chicago Daily Tribune, Nov 2, 1897, p. 7
\(^2\) http://www.youtube.com/user/LooDawgie

Dr. Barry E. Prentice is a Professor of Supply Chain Management, at the I. H. Asper School of Business, University of Manitoba, and President, ISO Polar Airships, a not-for-profit research institute.