Market potential for transport airships in service to Hong Kong

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Abstract: Air transport has developed steadily over the past 70 years into a mature industry. It could now be subject to disruption because technological advances are leading to the development of transport airships. The emergence of transport airships has the potential to create a significant expansion of the trans-oceanic air freight markets, increase geographical coverage and alter world trade patterns. This paper explores the current state of the Hong Kong airfreight industry and examines how transport airships could influence the future of Hong Kong aviation services. A new conceptual model, the value-density cargo pyramid, is developed to conduct comparative analysis among dedicated cargo airplanes, sea-air logistics, sea containers and transport airships, notably in the busy trade corridors between Hong Kong and Europe, as well as, Hong Kong and North America. Based on reasonable assumptions, transport airships could capture up to a half of the existing ‘dedicated cargo aircraft’ capacity. The race is on to create this new transportation mode and first-movers will have an advantage. This paper provides valuable insights on an immense opportunity that awaits Asian shippers and could take Hong Kong and all of Asia to a new higher level of development and economic prosperity.

Keywords: transport airships; innovation; value-density cargo pyramid; Hong Kong.

1 Introduction

Airships are the most promising mode of freight transport that has yet to experience widespread use. Transport airships could fly over land or sea, which makes them a challenge to both airfreight and ocean container shipping. They could also overfly ports and deliver to inland distribution centres that obviate the need for trucking or rail moves to the hinterland. The transport airship is a disruptive technology that has the potential to modify freight transport markets, change geographical advantage and alter world trade patterns.

Technological changes that lower transportation costs can stimulate a rapid growth of trade because new opportunities are created. Shippers want to use more of the new transportation alternative because lower freight costs translate into higher profits for their production. At the same time, consumers who find that the prices of their purchases have decreased because of the lower cost transport want to increase consumption. Consequently, transportation innovations generate a double stimulus for trade and demand for their services (Kindleberger, 1962). This paper explores the potential market for large transport airships that could soon enter service, and the suitability of Hong Kong as an airship transportation hub.

Every mode of transport has its niche. Transport airships will not be carrying heavy low-value commodities, like coal, or extremely time sensitive air cargo, like human organ transplants. In this study, we develop a value-density cargo pyramid to conduct comparative analysis among dedicated cargo airplanes, sea-air logistics, sea containers and transport airships, notably in the busy trade corridors between Hong Kong and
Europe, and Hong Kong and North America. This paper provides valuable insights on an immense opportunity that awaits Asian shippers and could take Hong Kong and all of Asia to a new higher level of development and economic prosperity. The discussion begins with some background on the development of the air transport industry.

1.1 Development of world air freight markets

The transportation system links geographically separated partners and facilities in a firm’s supply chain. Hence, transportation encourages the creation of time and place utility (Coyle et al., 2013). During the last half of the 20th century, air transport emerged to facilitate trade between persons and to establish the foundation of global supply chains. Increased population mobility achieved through air transport allowed site selection in response to consumer functions and dispersion of urban population agglomerations.

Isard and Isard (1945) foresaw the development for air transportation in global trade. They proposed that the reduction in the cost of air transport would lead to increased geographic specification, generate mass production economies and reallocate market areas, source material and labour at the lowest cost around the world. Few predictions have been as prescient or taken longer to mature.

Cargo airplanes exhibit significant economies of size. Table 1 summarises the costs of air transport from 1920 to the post-World War 2 period. Over this 25 year period, the size of airplane payloads increased from less than 1,000 pounds to 16,000 pounds. Correspondingly, the cost of air transport fell from 72.7 to 9.5 cents per ton-mile. However, trend extrapolated failed to continue over the next 25 years (Isard and Isard, 1945).

Table 1  Costs of air transport, 1920–1945

<table>
<thead>
<tr>
<th>Aircraft payload lbs</th>
<th>Direct cost in cents, capacity payload</th>
<th>Total cost (direct* and indirect) in cents, capacity payload</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per mile</td>
<td>Per ton-mile</td>
</tr>
<tr>
<td>DH (1920)</td>
<td>600</td>
<td>26.4</td>
</tr>
<tr>
<td>Boeing 40 (mid-20s)</td>
<td>1,200</td>
<td>20.2</td>
</tr>
<tr>
<td>Ford (1925)</td>
<td>3,200</td>
<td>34.1</td>
</tr>
<tr>
<td>Lockheed Vega (1929)</td>
<td>1,350</td>
<td>15.1</td>
</tr>
<tr>
<td>Boeing 247 (1933)</td>
<td>2,800</td>
<td>21.1</td>
</tr>
<tr>
<td>Douglas DC-3 (1936)</td>
<td>5,000</td>
<td>26.7</td>
</tr>
<tr>
<td>Post-war aircraft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(two to four years after war)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger</td>
<td>12,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Cargo</td>
<td>16,000</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: *Direct costs include fuel cost, pilot salaries, maintenance cost, depreciation, insurance and cash reserve

Source: Isard and Isard (1945)

Larger cargo airplanes were available, but the air cargo industry was built on the venerable DC-3. Following the war, a surfeit of these airplanes was available at little more than scrap prices. Even as late as the 1960s, 2,500 DC-3s were still operating and as
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Davies (1994) points out, no commercially successful cargo airplane design emerged during the decade of the 1970s, either. The U.S. Airline Deregulation Act of 1978 stimulated competition lowered air fares and disrupted the market. The increased passenger service options and wide-bodied airplanes created more belly cargo space.

The market for dedicated cargo airplanes remained highly specialised, with some general freight carriers, like Flying Tigers and Seaboard World Airlines, which offered scheduled commercial services. They also offered charted cargo flights and specific services, such as live animal transport. Flying Tigers was the first to engage the use of wide-bodied jet freighters in the mid-1970s. In the competition following deregulation, Flying Tigers and Seaboard World Airlines merged in 1980, and it was purchased by Federal Express in the late-1980s.

The introduction of wide-bodied passenger jet planes also expanded the available belly space for cargo. The replacement of the narrow-bodied jets, like the Boeing 707 and DC-8s, led to a new trend of conversion of older passenger jets into cargo carriage. Of course cargo versions of the wide-bodied airplanes also became available, such as the front-loading Boeing 747, but many more Boeing 747 cargo airplanes are former passenger models that have been converted.

Over the past 35 years the air freight market has experienced the growth predicted earlier. Some large passenger airlines have cargo subsidiaries, like Emirates, Cathay Pacific, Lufthansa and Korean Airlines. And, some dedicated cargo airlines have been successful, like CargoLux. The most significant change was the introduction of the integrators, like FedEx Corporation, United Parcel Service (UPS), DHL Express and TNT Express that have created new courier package air cargo markets. The jet airplane has knitted together the trans-oceanic markets for high value and expedited cargoes.

Air transport is considered a barometer of the global economy in the 21st century. Most air-shipped products have high value, high priority or extreme perishability (Coyle et al., 2013). Air transport supports a wide variety of industries pertaining to food, flowers, clothes, entertainment, technology and leisure. Although air cargo volume represents only 0.5% of global trade by weight, by value air transport generates 34.6% (USD 6.4 trillion) of global trade. Air freight traffic is forecasted to outpace passenger traffic growth in most major world markets. The average annual traffic growth rate (2011–2030) of the Asia-Europe air cargo market could reach 6.2%, while the Asia-North America air cargo market is expected to grow by 6.1% yearly. Globally, the growth rate of airfreight demand now exceeds passenger demand growth (International Civil Aviation Organization, 2013).

A number of supply chain challenges are emerging among the Asian, European and North American trading partners with respect to air transport. The list includes directional imbalances, surface competition, airport curfews, terrorism, fuel prices, air and surface labour stoppages, lack of airport access, currency revaluations, trade restrictions and environmental regulations (International Civil Aviation Organization, 2013).

Of all the issues raised above, the impact of jet airplanes on the environment is the most intractable and serious threat to the growth of air transport. Grote et al. (2014) observe that the world’s airlines burn five million barrels of oil daily, and that their contribution to anthropogenic CO₂ emissions is increasing. “Even if all the mitigation measures currently on the table were to be successfully implemented, it is doubtful that a reduction in civil aviation’s overall absolute CO₂ emissions could be achieved if forecast traffic-growth in the sector is realised” (Grote et al., 2014). The need to cut carbon
emissions will ultimately cause the cost of flying jet airplanes to rise and consequently, air freight rates to increase.

It may be impossible to envision a world that would give up jet passenger services, but most cargo does not require jet speeds. Moreover the jet airplanes used for dedicated freight transportation are often the oldest and least fuel efficient aircraft. This is the segment of the air transport market that might be replaced by transport airships. Not only do airships burn less fuel than jet aircraft, they can accommodate large, low pressure hydrogen fuel tanks without compromising space available for cargo. The potential for a zero-carbon emissions transport airship is already within the reach of existing technology.

1.2 Transport airship technology

Both technical and economic reasons lie behind the 80-year delay in the commercialisation of large freight carrying airships. The principal reason is the huge military investments that were made in fixed-wing aircraft development during the World War 2 and the Cold War period. The aviation industry experienced a turning point in 1949 with the introduction of the British de Havilland Comet, the first modern jet airliner. Subsequently, in the mid-1950s, Boeing and Douglas adapted jet engines and design advances of former military aircrafts into civilian passenger airliners (Wells and Wensveen, 2004).

As explained by Davies (1994) “the [jet] engine efficiency and consequent effect on lower costs, combined with the benefits of higher utilization and productivity” made air transport more economic and affordable to the masses. During this period, fuel was cheap, carbon emissions were of no concern, travellers were focused on speed, trained pilots were plentiful, former military runways became civilian airports and the myriad of airplane safety problems experienced during the pre-war period had been resolved. Hence, no compelling reasons existed to build rigid airships again.

In the 1930s, the German Zeppelins were able to offer 70 tons of useful lift and travel at 80 miles per hour across the Atlantic Ocean on a regular schedule. All the advances of modern aviation can be applied to a new generation of transport airships. The competitive advantages they could offer are striking. Capital costs of the airship are much lower than airplanes and their cargo capacity can be much greater. While airships are much slower than jet airplanes, speed is usually less important for freight transport than cost. Airships consume only one quarter of the fuel needed for an airplane, and as mentioned earlier, they could operate on hydrogen with zero carbon emissions.

The competition for the dominant design of a transport airship is producing many different variants. Two of the most important elements are buoyancy control and structure. The structural issues revolve around whether the airship will have a rigid, or semi-rigid, structure like a pre-World War 2 airship, or an inflatable non-rigid envelope with gondola and engines attached (blimp). Each design has merits as well as drawbacks. For example, a rigid structure is much heavier than an inflatable blimp envelope. Consequently, rigid airships must be bigger to carry the same weight, but they are also more robust and less sensitive to temperature changes. Another advantage of the rigid
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Airship is that the lifting gas is contained at atmospheric pressure, whereas the gas inside a blimp must be pressurised to maintain its shape. Consequently, the semi-rigid airships and blimps leak more than the rigid airship designs (Prentice and Knotts, 2014).

The natural buoyancy of an airship reduces the energy needed to transport freight. Just as salt-water ships float on the sea, airships float in an ocean of air without the need for any power to overcome the force of gravity. If cargo is removed however, some method must be used to control the ascendency of the vehicle. Buoyancy control can be obtained in many ways, from releasing gas, pressurising gas, heating gas, adding/subtracting ballast or using the engines to force the airship up or down. The other approach is to employ a heavier-than-air design that avoids the need for ballast. In this case the airships have to obtain enough lift from engine thrust to carry the cargo. When unloaded the airship remains heavier-than-air eliminating the need for ballast. All these methods are being explored.

Transport airships become much more productive as they become larger. The decline in average total cost is quite sharp as they increase in size. Figure 1 presents an illustration of the Varialift airship that is being developed in the UK. The picture contains two airships. The smaller version (on the right) is designed to lift 50 tonnes and the larger one (on the left) will carry 250 tonnes. These vehicles have very large cargo bays that actually form an important part of the vehicle’s structure. They are also very large. The smaller ARH-50 is 150 metres long and 52 metres wide, while the larger ARH-250 is 300 metres long and 110 metres wide. The benefits of size are obvious. While the larger airship is twice the size, it will carry five times the cargo weight, and ten times the cargo volume. On the cost side, the larger airship burns about 2.5 times as much fuel. Crew size is basically the same.

Figure 1  ARH-250 and Arh-50 Varialifter airships (see online version for colours)

Any airship greater than 50 tonnes lift could cross the Pacific Ocean, but in order to compete with fixed-wing aircraft they must be larger, and likely in the 150–250 tonne range. The reason is utilisation. The large rigid airships of the 1930s cruised at approximately 135 km/ph, which was the most economical in terms of fuel consumption.
This may change with better engines, but in any case, it is only one-sixth the speed of a Boeing 747 airplane. So, in the time required for the airship to complete one circuit, the airplane might do five or six roundtrips. The airplane may be four times more expensive to purchase and burn four times more fuel, but unless the airship carries more than twice the freight, the unit freight cost is not necessarily less. Of course this ignores the nature of the cargo which is the subject of the next section.

Direct comparisons between modes of transport are generally imperfect. Figure 2 presents a rough comparison of tonne-kilometres costs for different modes of transport. While the cardinal order may hold, the relative differences between the modes will depend on the specific mission and vehicles size. Generally, speaking the cost transport increases with speed. In this example, the slowest transport is ocean shipping and it is ten times less expensive than airships. Similarly, airplanes are much faster than airships, but at three times the cost.

**Figure 2** Representative freight costs per tonne-kilometre by Airlander Hybrid airship and other modes of transport (see online version for colours)

Rates calculated in dollars per tonne-kilometre do not necessarily tell the whole story. Airships are slower than airplanes, but their enormous size permits large cargo bays. Whereas an airplane can reach its volume limit (cube-out), before it weighs-out, an airship has the capacity to carry very low density cargo. It is also true that an airplane cannot load any cargo that does not fit through its door. Transport airships are being designed with large cargo doors that can accept difficult, awkward pieces of freight. Transport airships could reduce economic barriers for the carriage of low-density and low value-perishable cargoes. This is a sizeable market, and one that does not necessarily erode the markets of established carriers.
The prior generation of large rigid airships proved that they could cross oceans successfully. In 1919, the British R34 was the first aircraft to cross the Atlantic Ocean in both directions. In the 1930s, the German Zeppelin Company began scheduled passenger flights across the North Atlantic in the summer and the South Atlantic to Brazil in the winter months. These aircraft were piloted without the benefit of any weather forecasting (Van Treuren, 2009).

From 1940 to 1962, the U.S. Navy operated over 300 large blimps (about ten tons lift) for coastal control and submarine patrol. The endurance records set during this period still stand. The U.S. Navy blimps flew in hurricanes and in the North Atlantic when all other aircraft were grounded. Weather is always a concern for any aircraft, but the records support the view that large transport airships can operate safely on trans-oceanic routes.

While weather is not a problem per se, headwinds do affect the time and cost of operating airships. Research involving weather forecasting and route mapping has been developed to maximise the efficiency of airships on long distance routes. The objective is to take advantage of tailwinds to cross the ocean faster (Hochstetler, 2007). By taking a computer guided course that is continuously updated, a five day flight following the Great Circle Route can be cut by 13 hours with consequent fuel savings.

A question that has vexed airship investors for years is the potential size of the market for transport airships. It is beyond the resources of the authors to estimate the demand for a non-existent vehicle, but we can set out the methodology by which such demand could be considered.

2 Conceptual economic model

Inter-continental freight markets cannot offer the variety of options available to shippers in continental markets. On the continents, shippers can choose from barge or coastal shipping, truck, rail and pipelines, as well as airplane transport. Virtually every combination of price and time is available to continental shippers. In the case of trans-oceanic transport however, only two extremes exist: slow and inexpensive marine transport, or very fast, expensive airplanes. Transport airships offer a mid-range of speed and cost for ocean transport that is not currently available.

The latent demand for another option between the extremes of marine and air transport is illustrated by the sea-air shipping combination of ocean container and jet aircraft delivery. Goods are shipped from Hong Kong to European cities via Dubai in about 14 days. The first leg from Hong Kong to Dubai is by container ship, from where the goods are trans-shipped to air cargo jets and flown to their European destination. This service is advertised to be at least seven days faster than the sea route and 30% less expensive than a pure air freight option. Goods from Hong Kong can also be flown on to North America via Dubai in a total time of 15 days, or travel east across the Pacific and trans-ship via Vancouver to North America in 18 days.

The full demand for transport airships is greater than just the sea-air component. Some products may be too low in value to justify the use of a sea-air combination, even at a 30% discount over direct air transport. Some merchandise may too perishable to withstand two weeks in transit. Finally, some cargoes may be too bulky to consider airplane transport. Transport airships could take the lower value goods moving by airfreight that are too perishable for sea-air, and the higher value goods moving by ocean
containers that are too low in value or too bulky for air transport. In addition, there is a third market segment that does not currently move into intercontinental trade because the product is too perishable for ocean transport, but too low in value to consider sea-air or pure air transport alternatives.

Figure 3 presents a conceptual model of the value-density cargo shipping pyramid that illustrates different transportation market segments, with and without transport airships. The pyramid in Figure 3(a) suggests the current pattern of shipping via air, sea-air, containers and bulk marine freight. The various cut-off points are estimates of transit time and cubic value volume that defines each market segment. The lower bound for dedicated cargo airplanes could be less than five days and above some minimum value, such as $15 per kilogram ($/kg). Also, the cubic capacity of airplanes may be such that the freight must be greater than some value per cubic centimetre ($/cc). The surcharge on cargo with a lower density would make it uneconomic.

Figure 3  Value-density cargo shipping pyramid, (a) current value-density pyramid transoceanic shipment (b) value-density pyramid with transport airships (see online version for colours)

The segment given to sea-air transport is smaller than illustrated in this conceptual model. We make no attempt in this paper to quantify the boundaries of this pyramid, which is a larger study on to itself.
Figure 3(b) illustrates the transoceanic shipping market with transport airships. These vehicles would take over all the sea-air market. Conceptually, transport airships would eat into the lower part of the existing cargo airplane market. A lot of freight does not have to be delivered in hours, if can be delivered in days rather than weeks. Many freight shippers would be happy to wait three or four days longer if the price were significantly lower. Air cargo moving in the belly holds of passenger airplanes would not likely be affected because this is a by-product that is priced to fill the available space.

Transport airships would also attract the higher value goods moving by ocean containers. Ocean shipping times from Asia to Europe or North America are at least 30 to 40 days from dispatch to receipt. This is long time for inventory-in-transit, but products that do not have the value to density ratio required to be shipped economically by jet aircraft have only the sea-air choice. A significant market should exist for transport that could offer five to ten day service, even if the cost is double or triple container shipping rates.

A third cargo category that would move by transport airship is trade newly generated by the opportunity of a faster, low cost shipping method. No attempt is made to draw the value-density pyramids according to scale, but it is reasonable to expect that transport airships would induce larger volumes of some trade goods, and open entirely new markets for others. For example, the types and volumes of perishable food products that move between Southeast Asia, Europe and North America are very limited (Prentice et al., 2004). Similarly, fully assembled upholstered furniture and large pieces of moulded plastic are seldom moved long distances. These and other goods could become as widely traded inter-continentally, as they are continentally traded today.

As an indication of market size, we examine the air freight market of Hong Kong in the next section. Hong Kong could become a representative air cargo market in the Asia Pacific regions for the following reasons (Hong Kong International Airport, 2014):

- free port policy
- strategic geographic location
- excellent connectivity and accessibility
- extensive IT application
- high safety and security
- sufficient cargo capacity
- efficient cargo operations
- competitive costs.

3 Hong Kong air cargo market

Hong Kong has been a gateway to China since the First Opium War (1839–1842) because of its excellent natural harbour and strategic location. The Hong Kong International Airport (HKIA) is located at the heart of the Asia Pacific region where jet aircraft can reach over half of the world’s population within five flying hours. Apart from its geographical advantages, Hong Kong has well-established financial, institutional and legislative settings, as well as, skilled labour and an entrepreneurial culture. The
transformation of Hong Kong from a regional relay hub into a world-class cargo centre was foreseen over 25 years ago (Wang, 1998).

Before 1978, China adopted a closed door policy that adversely affected the major economic linkage between China and the Western world. The centrally planned and self-sufficient economy limited the volume of trade via Hong Kong. The economic turning point emerged when Deng Xiaoping introduced the Open Door Policy in 1978 (Tang et al., 2014). The economic reform towards a ‘socialist market economy with Chinese characteristics’ resulted in an upward growth trend in air cargo (Wang, 1998; Tang et al., 2004).

In 1980, China established special economic zones in Shenzhen, Zhuhai, Shantou, Xiamen and Hainan to implement its policies. Hong Kong’s manufacturing sector moved northwards to China and then spread to the entire Pearl River Delta (PRD) region. This boosted the demand for air cargo through Hong Kong. In 1984, China further opened 14 coastal cities including Dalian, Qinhuangdao, Tainjin, Yantai, Qingdao, Lianyungang, Nantong, Shanghai, Ningbo, Wenzhou, Fuzhou, Guangzhou, Zhanjiang and Beihai. Hong Kong was positioned to absorb large amount of air cargoes from a vast hinterland, notably the PRD provinces. Table 2 illustrates the air cargo throughput at the HKIA since 1998 and now exceeds four million tons annually.

Table 2  The air cargo throughput at HKIA

<table>
<thead>
<tr>
<th>Year</th>
<th>Tonnage ('000 tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>1,629</td>
</tr>
<tr>
<td>1999</td>
<td>1,974</td>
</tr>
<tr>
<td>2000</td>
<td>2,241</td>
</tr>
<tr>
<td>2001</td>
<td>2,074</td>
</tr>
<tr>
<td>2002</td>
<td>2,479</td>
</tr>
<tr>
<td>2003</td>
<td>2,642</td>
</tr>
<tr>
<td>2004</td>
<td>3,090</td>
</tr>
<tr>
<td>2005</td>
<td>3,402</td>
</tr>
<tr>
<td>2006</td>
<td>3,579</td>
</tr>
<tr>
<td>2007</td>
<td>3,742</td>
</tr>
<tr>
<td>2008</td>
<td>3,627</td>
</tr>
<tr>
<td>2009</td>
<td>3,347</td>
</tr>
<tr>
<td>2010</td>
<td>4,128</td>
</tr>
<tr>
<td>2011</td>
<td>3,938</td>
</tr>
<tr>
<td>2012</td>
<td>4,025</td>
</tr>
<tr>
<td>2013</td>
<td>4,127</td>
</tr>
</tbody>
</table>

Source: Hong Kong International Airport (2014)

Hong Kong is the cargo hub for aviation logistics business among Southern China regions because of its excellent geographical location and comprehensive intermodal transportation system. Aviation logistics firms can shorten shipment time via Hong Kong (Lau, 2009). Compared with Manila, the required flight time is 10% shorter; compared with Taiwan, the required flight time is 6% shorter; compared with Singapore, the required flight time is 36% shorter. The total fuel cost that could be saved is HKD 40
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million per year (Schwieterman, 1993). Further details on the locational advantage on Hong Kong as an air transport hub are presented in the Appendix.

Transport airships could be seen as either a threat or an opportunity to the HKIA. On the one hand, transport airships could replace many cargo airplanes, or worse the airships could fly beyond Hong Kong and land closer to the ultimate markets. On the other hand, if this technology is coming anyway, then a wise manager would develop a strategy to maximise its use.

It would appear that Hong Kong has more to gain than potentially lose. First, as an established air cargo hub, Hong Kong has many feeder routes and businesses involved in logistics. Like all transport hubs, the long distance between major centres will be served by very large transport airships, while the feeder routes use smaller vehicles. The hubs are consolidation and sorting centres that make most efficient use of the larger vehicles and reduce the cost of shipping from smaller centres. There is no reason why Hong Kong could not evolve to be the largest transport airship hub in Southeast Asia.

Second, effective hubs are those that offer trans-shipment opportunities. With the availability of ocean container, road routes and air transport, Hong Kong is well-positioned to offer trans-shipment services via large airships. It might be that goods delivered across the ocean in a transport airship could be delivered in the belly freight of a flight to Nimbo, or other smaller Chinese second tier of cities.

Finally, Hong Kong has time to prepare itself for the opportunities that transport airships provide. Although airships are very large, they can operate from the shore as easily as from an airport. However, they need many services that airports offer, from security to re-fuelling. This is a new industry that is likely to create many more jobs than it eliminates. Those locations that take a proactive stance can be expected to benefit the most from the first-mover advantage that new technology offers.

4 Conclusions

Our paper identifies a new research agenda in the development of transportation and the aviation industry. Transport airships are soon to become a reality and trans-oceanic trade routes are extremely attractive for their use because of the limited options open to shippers: slow and cheap marine, or fast and very expensive aircraft. The new technology of transport airships will definitely influence the future of aviation industry (Wells and Wensveen, 2004), notably in Hong Kong. Transport airships could take at least half of the existing ‘dedicated cargo aircraft’ capacity. Obviously, belly freight on passenger airliners would not be affected because it is a by-product of the passenger service. An estimate of the space available in cargo airplanes, multiplied by the daily ton-miles for each aircraft would provide a target for the future transport airship demand.

Density and value have an impact on modal choice. Whatever the size of the sea-air market, just below its current density-value cut off is a much larger airship transport market of products that currently move in ocean containers. Higher value-low density ocean container freight could migrate to transport airships. In addition, some products go by sea because of their bulkiness and shape. The exact volume of traffic that would migrate from ocean containers to transport airships is open to conjecture. One factor that might influence this volume is port congestion and labour disputes. Transport airships do not need to stop at the coast, or at established airports for that matter. They could...
continue inland to new locations that are developed expressly to transfer goods from transport airships to trucks for final delivery.

Another potential market for transport airships is the demand created by the stimulation of trade. For example, buyers who can only purchase products for special occasions or seasonally, e.g. strawberries, want to buy more because the improvement of transportation has lowered its price and they can be sourced from more locations year-round. Similarly, the sellers benefit from the lower cost of transport because they get paid more for what they produce. Consequently, the double stimulus of supply and demand, yield a large market increase for the new mode of transport.

The double stimulus of trade is not a zero-sum game in which the gains to the airship are losses from airplanes or ocean containers. Although the magnitude is unpredictable, entirely new demands can be anticipated that do not even exist today. A case might be made for bulky, labour-intensive manufactured products that are now sold only on a local basis, such as upholstered sofas.

Both technical and economic reasons lie behind the 80-year delay in the commercialisation of large freight carrying airships, but in the 21st century no obvious technological barriers remain. The race is on to create this new transportation mode and the first-movers will have an advantage. Ultimately, it is our prognostication that when the transport airship industry matures, it will be as large as the current commercial airline industry.

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Notes

1 Details on the sea-air service and a map of the routes can be found at http://www.emirates.com.hk/cargoflow.htm. Everest Logistics also offers a sea-air service from Shenzhen to over 60 destinations in Latin America via LAX and MIA. They claim to be 60% cheaper than Airfreight and 60% faster than LCL (http://www.evereastlogistics.com).

Appendix

From the geographical perspective, Hong Kong is located at an optimal location in Asia Pacific region for air transport. Air logistics firms can deliver cargo to over half of the world’s population within five flying hours. The shorter flight hours allow the air logistics firms to achieve the greatest cost advantage by using HKIA. The airport is also located with 12 to 15 hours flight time to all the major financial and commercial centres of the world. To explain this in detail, the flight hours between Asian hubs and intercontinental hubs and the flight hours between regional hubs are presented in Table A1 and Table A2, respectively.

According to the HKIA (2014), the HKIA is connected to over 180 locations in over 50 countries. Thus, HKIA can attract more than 100 airlines (including 19 freighters) operated in HKIA. Aircraft land on and off the airport around 1,000 times per day. In order to achieve sustainable competitive advantage, the Airport Authority Hong Kong invested HKD 4.5 billion to enlarge its apron for new large aircraft A380 and the low cost carrier. Ten additional cargo stands have been built in 2007. In addition, the third runway is planned for launch in 2023. HKIA anticipates that the cargo volumes will average 6% growth per year in the coming 20 years (Hong Kong International Airport, 2007).
### Flight hours between Asian hubs and intercontinental hubs

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<tr>
<th></th>
<th>Hong Kong</th>
<th>Shanghai</th>
<th>Guang-zhou</th>
<th>Singapore</th>
<th>Seoul</th>
<th>Taipei</th>
<th>Bangkok</th>
<th>Tokyo</th>
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*Source: Cathay Pacific Airways Limited (2006)*
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Source: Cathay Pacific Airways Limited (2006)