VELOCITY 1 LLC

THE NEW PARADIGM FOR 21ST CENTURY AVIATION

A Proposal to Conduct Research

The V1 Concept
of
Air Transportation Management

Commoditizing Runway and Airspace Capacity:

Completing the Deregulation of Air Transportation

Edition 1.1

Velocity 1 LLC
www.velocity-1.com

This page intentionally left blank.

"We can't solve problems by using the same kind of thinking we used when we created them."

Albert Einstein

"We need fundamental change, not a system of extensions. We can and must offer new solutions and encourage more leadership to make air transportation a reliable and pleasant experience again."

Mary Peters
U.S. Secretary of Transportation

"The fundamentals of our economy don't work without air travel."

W. James McNerney, Jr.
CEO
Boeing Aircraft Co.

"Throughout the history of economic development, the evolving demands of mankind have always usurped the status quo. History is replete with the wreckage of fixed systems of development which did not embrace human choice at the granular level and therefore could not adapt to change. For decades, the status quo in air traffic control has been the pursuit of greater fixed and centrally controlled processing capacity for the purpose of managing the ever-greater volume of passengers and freight which are generated by economic growth. Yet, despite the enormous quantities of resources expended in this pursuit, economic growth in the U.S. and the world have repeatedly overtaken advances in air traffic control capacity. It is time for a change in the status quo."

Excerpt –
The V1 Concept of Air Transportation Management

Table of Contents

This page intentionally left blank.

..

Note

As of this writing, worldwide economic and geo-political conditions affecting the U.S. air transportation industry have been referred to as a 'perfect storm'. In aggregate, depressed pricing power, caused by chronic over-capacity, is once again generating anemic revenue for the industry. As a result, carriers lack the traction to increase prices against an unprecedented world-wide spike in the cost of crude oil and an even greater spike in the cost of refined jet fuel. Adding grease to this slippery slope, ridership is predicted to decline in the coming year as the U.S. economy contracts in the wake of collapsing credit; itself the result of gluttony in the mortgage industry which precipitated over-capacity in the housing market and a free fall in home equity value nation-wide.

In the face of all this, air transportation providers are reducing capacity. Worldwide, 46 million seats have been taken out of service.[1] In the U.S. domestic market, some operators are choosing to do this through internal options while others, such as Delta Air Lines and Northwest Airlines, push for re-gaining pricing power through the capacity control and economies-of-scale expected from their proposed merger.

Despite the pronounced downturn which has been precipitated by prevailing economic conditions, it is perceived that the air transportation industry is once again experiencing a cyclical event, the length of which will only be determined by the length of the global financial crisis. As indicated below, the industry is expected to recover with even greater carrying capacity than in the past.

Hence:

> "The airlines' quick decision to cut capacity coincided with one of the happier side-effects of looming economic grief. Fuel, by far the biggest cost for airlines, has plunged in price. Oil, which fetched nearly $147 a barrel in July is now hovering around $70. British Airways, Lufthansa, Singapore Airlines and others have begun to cut fuel surcharges." [2]

And:

> "While airlines are announcing reductions in service, and air traffic overall is down, it is likely that the busiest and most congested airports, particularly in the New York/New Jersey region, will not see a significant reduction. Even if they do see a downturn in the short run, history tells us that the aviation industry is very cyclical and that service will eventually return to — and exceed — the record levels we saw last year." [3]

Therefore, given this opportune time of slack in air transportation capacity, and during the development of the Next Generation Air Transportation System, we propose that the commoditization of runway and airspace capacity be investigated as a critically necessary market-based augmentation for air transportation management in the 21st century.

---

[1] Flying Through the Storm, The Economist. October 22, 2008.

[2] Ibid.

[3] Statement of Henry Krakowski, Chief Operating Officer, Air Traffic Organization. Before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Aviation Operations, Safety, and Security on the Outlook for Summer Air Transportation: Addressing Congestion and Delay. July 15, 2008.

This page intentionally left blank.

EXECUTIVE SUMMARY

The V1 Concept of Air Transportation Management is intended to start a collaborative and expansive conversation in the realm of air transportation management for the 21st century. It proposes going beyond the status quo of simply increasing air traffic control capacity through a taxed and regulated system, or attempting to control consumption through a 'demand managed' system. Instead, it proposes embracing self-governing air transportation management through the application of free market principles and consumer choice. The ultimate purpose is to develop a sustainable solution for the chronically recurring losses of economic productivity and capital which are caused by delays and inefficiencies in the air transportation industry. Accordingly, Velocity 1 LLC intends to pursue federally sponsored research for investigating the effect this concept would have on the air transportation industry, and expansion of U.S. GDP

The Problem

The U.S. air transportation industry has enjoyed the largely unconstrained consumption of runway and airspace capacity for almost 100 years. Due to their direct control under Federal Aviation Administration (FAA) regulations, growth in the consumption of these two constrained primary aviation resources has remained ungoverned by free-market principles. Taxation for their consumption has been a poor governor of quantity demanded due to its displacement from consumer choice and the actual point of consumption of resources. Taxation has also been an inefficient enabler for the increase of quantity supplied. This combination of dynamics has caused over-consumption of resources to the point of scarcity in several markets. The air transportation congestion which has resulted is an unacceptable squandering of U.S. economic productivity.

On July 15, 2008, the Government Accountability Office (GAO) corroborated an earlier report by the Senate Joint Economic Committee. This report stated that commercial air transportation delays in 2007 had robbed the U.S. economy of as much as $41 billion in economic productivity and 320 million passenger delay hours, or roughly 36,500 person-years.[4]

[4] Testimony Before the Subcommittee on Aviation Operations, Safety, and Security, Committee on Commerce, Science, and Transportation. U.S. Senate GAO-08-934T.

Responding to political pressure to 'fix' the air transportation industry, the U.S. Department of Transportation (DOT) and the FAA continue to focus on increasing capacity by developing the Next Generation Air Transportation System. 'NextGen' is expected to increase air traffic control capacity by a factor of 2 to 3 times. However, it is not expected to be fully operational until 2025. In the interim, the DOT has begun to implement various new practices within a spectrum of 'demand management'. These practices include terminal area slots, slot auctions, caps, and user fees. We concur that the combined effectiveness of all these measures is a step in the right direction. However, in an economic sense, continually increasing capacity (quantity supplied) in a system of displaced taxation, or restricting consumption (quantity demanded) through 'demand management' programs, are both flawed and economically non-sustainable solutions for an industry which serves as a critical enabler of economic development.

A Shift in Paradigm

The V1 Concept of Air Transportation Management offers an alternative. It recognizes that a nationalized system of air traffic control cannot sustain the pro-active strategic integrity needed to anticipate where industry growth will occur. Nor can it sustain the reactive tactical flexibility needed to match or exceed traffic congestion with auxiliary processing capacity (slack) when it does occur. Stemming from this recognition, the concept identifies three major determinants of air transportation throughput and proposes an economically sound and sustainable method for ensuring their interactive efficiency in the production of air transportation throughput. These three determinants are:

1. Runway environment capacity
2. Safe-separation airspace capacity
3. Air transportation industry seat & freight capacity

Of the three determinants listed, only seat & freight capacity was made accountable to the free market by the Airline Deregulation Act of 1978. The remaining two determinants, runway environment capacity and safe-separation airspace capacity, have continued to exist as primary aviation resources which must be consumed to provide the utility of air transportation, but have remained fully controlled (rationed) by federal aviation regulations.

The uni-dimensional success of (partial) deregulation changed the game of air transportation. It maximized the provision and consumption of seat & freight capacity beyond the ability of runway environment capacity and safe-separation airspace capacity to readily accommodate it. Notwithstanding the current contraction occurring in seat & freight capacity throughout the industry, the persistent strain in air traffic control operations over the past 30 years has demonstrated the fault in not also applying free market principles toward the other two determinants of air transportation throughput.

In order to accommodate how the game has changed, we need a paradigm shift in the prevailing concept of air transportation. Due to the overwhelming consumption of primary aviation resources in several domestic markets, the provision and consumption of these resources must continue to move away from a taxed and regulated system. Provision and consumption must also move past the half-measure of 'demand management'. It is time to embrace *commoditization* of runway environment capacity and safe-separation airspace capacity as a free-market solution to air transportation congestion.

The V1 Concept of Air Transportation Management is a design which embraces the human capacity to self-regulate consumption of resources by choosing at the individual level when, where and how to consume. The commoditization of the two primary aviation resources, using economic principles inherent in a free market, would make *consumer choice* the integrating principle in an organic process of self-regulation. In so doing, the concept will allow consumers to *choose the future* of air transportation as it evolves, through the natural forces of supply and demand, rather than tasking a central organization to establish a hard design which requires *prediction and control of the future*. Pushing back against the necessity of this shift, we may anticipate an entrenched culture which seems to favor the unquestioned pursuit of increased air transportation capacity over a process which would efficiently channel growth through consumer choice.

Expanding the Idea

Just as a market for the trade of land area grew across North America throughout the 17th and 18th centuries, the current state of technological development makes it possible to develop a market for the trade of runway environment capacity and safe-separation airspace capacity. Accordingly, *The V1 Concept of Air Transportation Management* proposes that these two primary aviation resources now be recognized as *virtually* tangible, transiently consumed, recyclable commodities which can be traded in granular units just like land. Or more appropriately, just like the *virtually* tangible commodities of airborne seat & freight capacity. This trade would set stabilizing market prices for granular units of these resources. Price would govern the quantity demanded for aviation resource capacity while simultaneously generating the revenue required for increasing the quantity supplied. Air transportation operators would be driven by market forces to operate large-gauge air vehicles for the purpose of dividing resource costs among as many units of seat & freight capacity as possible. Therefore, unitary consumption of the two primary aviation resources, per seat or unit of freight volume, would decrease while simultaneously allowing for increased air transportation throughput.

The commoditization of runway environment (RE) capacity and safe-separation airspace (SSA) capacity is not intended to be a stand-alone replacement to the deployment of the Next Generation Air Transportation System. It is introduced as a market-based *augmentation* to NextGen which is necessary for ensuring adequate governance of the two primary aviation resources for the 21st century.

One Dozen Advantages

The V1 Concept of Air Transportation Management has the potential to create an expansive list of advantages over the current practice of centralized air traffic control. The concept also offers a self-sustaining, market-based augmentation for the autonomous air traffic control principles being proposed by NextGen. Following are a dozen of these advantages.

1. Ubiquitous Utilities
   The primary aviation resources of RE capacity and SSA capacity would become ubiquitous utilities in a free market. They would be provided by privatized entities and would share market characteristics common to other utilities such as water, electricity, radio frequency bandwidth, and communications. Recognizing that aviation resources require an exacting degree of public safety, they would remain as critically supervised as privatized nuclear power facilities. The DOT and the FAA would retain ultimate control for enacting and enforcing legislated aviation safety regulations.

2. <u>Tradable Commodities, Increased GDP</u>
   A new commodity market would be invented. Granular units of RE capacity or SSA capacity, or complete 4-dimensional trajectories of both, would be traded for current and future consumption by aviation enterprises. Market-based mitigation of air transportation congestion would merely be the first byproduct of such a market. The economic multiplier caused by this trade could cause a substantial increase in GDP.

3. <u>Supply and Demand Accountable to the Market</u>
   Quantities of RE capacity and SSA capacity would become accountable to the free market. These primary aviation resources would cease being viewed as nebulous and infinitely expandable. Their opaque costs would become transparent. They would no longer be perceived as 'free' due to the consequence of displaced taxation. Therefore, demand would no longer be unlimited. Congestion would be self-regulating through market forces. Airline schedules would be spread more evenly over all 24 hours in a day to accommodate various markets by price.

4. <u>Quantity Demanded Governed by Price</u>
   The consumption (quantity demanded) of RE capacity and SSA capacity would become market-governed through price instead of being strictly rationed through regulation. Specifically, consumption of these two resources would no longer be controlled solely through air traffic control procedures and Federal Aviation Regulations (F.A.R's).

5. <u>Quantity Supplied Provided by Free-Market Premiums</u>
   The provision (quantity supplied) of RE capacity and SSA capacity would become self-funding through the economic efficiency of market premiums instead of through the inefficiency of taxation and federal spending. The presence of premiums above the cost of provision would indicate demand for, and provide the free-market funding for, a greater supply of capacity by specific market.

6. <u>Price would Govern Choice by the Service Provider</u>
   The market-based *price* for the consumption of primary aviation resources would become a direct *cost* of doing business to providers of air transportation services. This market-based cost would <u>replace</u> the ineffective and inefficient taxation of aviation fuel for the provision and

consumption of aviation resources. It would therefore directly govern specific choices for the consumption of aviation resources by service providers.

7. Price would Govern Choice by the End-Consumer
The market-based *price* for the consumption of primary aviation resources would become a *cost* to the end-consumer of seat & freight capacity. This market-based cost would replace the ineffective and inefficient taxation of airfare and airfreight for the provision and consumption of aviation resources. It would therefore directly govern specific choices for the consumption of aviation resources by end-consumers. Choices would range by time of day and city-pair markets at all levels of consumption, from service provider to end-consumer.

8. Reduced Prices through Deregulation and Privatization
Provision of RE capacity and SSA capacity would become deregulated and privatized. The air traffic control function of the FAA would become the product of one or more public utilities governed by a public utility commission (PUC). The price for the consumption of primary aviation resources would be reduced through free-market influences. This would occur in the same manner as the reduction of prices for seat and freight capacity following the implementation of the Airline Deregulation Act of 1978. Profit above the cost of providing primary aviation resources would be determined by the PUC, as with other utilities. In this regard, market pressure would be maintained on providers of capacity to control the cost of provision.

9. Natural Selection of Large-Gauge Aircraft, More Throughput
Free-market forces would naturally encourage the use of larger air vehicles with greater carrying capacity for ensuring competitive division of the costs incurred for the consumption of primary aviation resources. This would generate greater throughput of passengers and freight per specific units of RE capacity and SSA capacity consumed.

10. Transparent Costs for Subsidized Routes
The federally subsidized operation of small-gauge aircraft to underserved markets would become more transparent. These subsidies would become more easily comparable to alternative free-market funding options.

11. Transparent Costs for Alternative Transportation
The true and total cost for fixed-wing air transportation to fixed-airport locations would become more transparent since price would include the cost for the consumption of primary aviation resources. The implementation of alternatives such as commercial tilt-rotor or high speed rail services to city centers would become more easily comparable. In certain high-density markets, possibly under 250 miles between city-pairs, these two alternatives would compete strongly against air transportation, further mitigating runway and airspace congestion.

12. Restoration
Air transportation would once again become a time-efficient travel option.

Closing
This proposal is a concept document. It identifies runway environment capacity and safe-separation airspace capacity as commodities and initiates an investigation of basic economic principles in proposing that they be traded as such.

Scott R. Davies
CEO
Velocity 1 LLC

PART I: Conventions of *The V1 Concept of Air Transportation Management*

ECONOMICS OVERVIEW

The economic laws of supply and demand in a free market establish that the quantity supplied of a resource, as well as the quantity demanded, are each governed by price. A positive cause-and-effect relationship exists between price and its influence on quantity supplied. A negative or inverse relationship exists between price and its influence on quantity demanded.

Given particular sets of variables which define the aggregate market supply and market demand of a resource, these variables must be assumed to be temporarily constant in order to analyze the effect of price on supply and demand. In this analysis, as the price consumers are willing to pay for consumption of a resource increases, so does the quantity supplied by providers. Alternatively, as the price consumers are willing to pay falls, so does quantity supplied. Quantity demanded is the inverse of this relationship. Again, holding all other variables constant, as the price providers require for the supply of a resource increases, the quantity demanded by consumers decreases. As the price providers require decreases, quantity demanded increases.

While price is a *determinant* of both the quantity supplied and the quantity demanded for a resource, it is also a *reflection* of the market equilibrium point where quantity supplied equals quantity demanded.

It is specifically important to note the inverse relationship between price and quantity demanded. Taken to the extreme, when a resource of widely perceived value is made available to the market for an *actual or perceived* price of zero (free to the consumer), quantity demanded becomes unconstrained and theoretically unlimited. Market demand can remain even after the resource has been *exhausted*. This is an important point relative to the supply of primary aviation resources, which will be addressed later on in detail.

DETERMINANTS AND RESOURCES

The Three Determinants of Air Transportation Throughput

For the purpose of this research proposal, we have isolated three determinants of air transportation throughput. They are as follows:

1. Runway environment (RE) capacity.
2. Safe-separation airspace (SSA) capacity.
3. Air transportation industry seat & freight capacity.

There are some important distinctions which must be made which relate to these three determinants. They are as follows:

1. The supply and demand of each determinant is an industry-wide aggregate of its particular utility.
2. Each determinant is *economically independent* of the others regarding the dynamics which define its free-market supply and demand.
3. All three determinants are *functionally interdependent* regarding the generation of air transportation throughput.

In the list of the three determinants on the previous page, they have been arranged in *decreasing* order of their influence in constricting air transportation throughput. Using a rationale which will be expanded in *Part II*, runway environment (RE) capacity is considered to be the most constricting. Seat & freight capacity is considered to be the least constricting. Also, the three determinants have been arranged in *increasing* order of their adaptability toward a change in market demand for air transportation. RE capacity is the least adaptable. Seat & freight capacity is the most adaptable. (See *Figure 1,* below.)

<u>Figure 1.</u> Influence of the three determinants on air transportation throughput.

Most Constricting — Air Transportation Throughput — *Least Constricting* →

Least Adaptable — *Most Adaptable*

RE Capacity — SSA Capacity — Seat & Freight Capacity

The Two Primary Aviation Resources

Of the three determinants of air transportation throughput discussed above, we have identified RE capacity and SSA capacity as two primary aviation resources. These resources must be fabricated from the most primary natural resources of land space and airspace. They are transiently consumed in the production of air transportation throughput. However, unlike primary resources which are consumed in a typical free market, these two resources remain highly regulated.

This concept paper proposes that research be conducted to determine the influence on air transportation throughput where RE capacity and SSA capacity would both be recognized as sharing attributes commonly related to seat & freight capacity. These shared attributes are as follows:

1. *(Virtually)* tangible
2. Transiently consumable
3. Divisible into granular units
4. Tradable in a free market
5. Recyclable for rapid and sequential consumption

Recognition of these attributes with regard to RE capacity and SSA capacity would allow these resources to become deregulated and freely accountable to the market, just like seat & freight capacity.

Distinctions of the Two Primary Aviation Resources

The V1 Concept of Air Transportation Management proposes the following distinctions bearing on the commoditization of the two primary aviation resources.

RE Capacity:

- The 2-dimensional area of land space is a *natural* resource. It defines the footprint of a runway environment. The 3-dimensional volume of a runway environment and its throughput are both *fabricated* resources. They define runway environment capacity.

- For the purpose of this paper, the term 'runway environment' will refer to a complete and unitary system of elements required by Federal Aviation Regulations (F.A.R.'s) for facilitating departures and arrivals of air vehicles in terminal airspace. Beyond the obvious requirement of a high-weight-bearing surface of proper construction, this may include an extensive array of air navigation and lighting systems for the guidance of air vehicles approaching and departing the runway. The runway environment also includes the tower-controlled airspace immediately encompassing the environment footprint. Hence, a runway environment, while grounded to the land mass, is a 3-dimensional resource in its entirety. For reasons of compatibility, we have chosen to define the dimensions of this airspace using the official F.A.R. dimensions for an *airport traffic area*. These dimensions typically encompass an altitude of 3,000 feet above ground level for a radius of 5 nautical miles from the airport center point.

SSA Capacity:

- The 3-dimensional volume of atmospheric airspace is a *natural* resource. The 3-dimensional volume of safe-separation airspace and its throughput are both *fabricated* resources. They define safe-separation airspace capacity.

- 'Safe-separation airspace' is not an official term used by F.A.R.'s to describe air traffic control or to define airspace. It is a term introduced by this document. SSA distinguishes the fabricated subset of naturally occurring airspace which is provided by air traffic control services and transiently consumed by air vehicles for the prevention of airborne collision. SSA is used in favor of the official term of 'controlled airspace' in order to distinguish the 20th century concept of *air traffic control* from the 21st century concept of *holistic air transportation management* being proposed herein.

TAXATION OF CONTROLLED RESOURCES CONSUMED IN A FREE MARKET

The V1 Concept of Air Transportation Management proposes that the sum of taxes paid as the price for consumption of primary aviation resources does not influence consumer choice. Nor does it adequately provide increased capacity. Therefore, taxation is a poor economic governor of consumption (quantity demanded) and an inefficient enabler of capacity (quantity supplied).

Taxation of Airfare and its Affect on Consumer Demand
Taxes levied on *passenger airfare* for the consumption of nationalized primary aviation resources are not a direct cost to commercial operators in the generation of air transportation throughput. Therefore, they are not quoted in air transportation prices as part of the competitive cost structure of the provider. They are instead tacked on in the small print of a quoted fare and are largely viewed by the end-consumer as simply bothersome fees. As a result of this structure, a consumer of air transportation services may ultimately choose to consume high or low demand aviation resources, by any geographic market or time of day, regardless of the taxes he or she has paid.

It may also be argued that a consumer who pays up-front taxes for the consumption of nationalized primary aviation resources may sense some level of entitlement to consume those resources in any manner and volume deemed personally appropriate, without regard to actual cost incurred or tax paid. In its most extreme manifestation, this sense of entitlement may actually cause the consumer to view taxed resources as virtually 'free'. Recall that within the economic law of demand, when a resource of value is perceived as 'free', the quantity demanded becomes theoretically unlimited because no direct governor in the form of price exists.

Aside from its inadequate governance of consumer demand, taxation of airfare for the consumption of nationalized primary aviation resources may actually increase provider costs. As proposed above, the ultimate consumer of aviation resources does not pay a full accounting for the cost of consumption. This leads to over-consumption which leads to congestion and delays. Ultimately, the air transportation provider ends up absorbing this cost in the form of a delayed operation.

Taxation of Fuel and its Affect on Consumer Demand
Applying the same rationale from above, taxation of *jet fuel and aviation gasoline* for the consumption of nationalized primary aviation resources is also a poor governor of quantity demanded. Although these taxes are a cost to all aviation operators, their payment is displaced from the actual point of consumption of the two primary aviation resources. Therefore, taxation of fuel isolates the price paid for aviation resource consumption from actual consumer choice. To illustrate, the operator of an air vehicle may choose to consume high or low demand aviation resources, by geographic location or time of day, regardless of taxes paid for fuel.

Further, since the high cost of fuel is pushed higher through taxation, it may be argued that the demand for 'least cost routing' by aircrews and their dispatchers may actually increase demand for particular cost-favorable points of airspace at particular points in time. By reasoning that an enterprise has paid its taxes, air vehicle operators may feel entitled to the consumption of nationalized aviation resources on-demand. This sense of entitlement is the status quo in airspace consumption today. It drives the necessity for air traffic controllers to provide all manner of traffic de-confliction in the form of ground-stops, airborne holding, traffic metering, spacing vectors, speed reductions, etc. In this environment, safety is paramount. Operational efficiency is often a distant second. Moment-by-moment determination of which operator paid more taxes for fuel, and is therefore more entitled to consume aviation resources on-demand, *does not enter the equation.*

In a way, air transportation providers have been victims of *The Airline Deregulation Act of 1978*. Providers pay copious taxes on the fuel they consume as payment for the consumption of *regulated* aviation resources. However, they find it difficult to pass this cost of doing business on to the end consumer in the *free market* for seat & freight capacity. This lack of pricing power is due to the over-supply of seat & freight capacity, and the excessively low prices which have ensued, in the wake of the partial deregulation of the industry in 1978. The solution for this quandary, often provided by industry watchers, is self-regulation of seat & freight capacity by providers. It is interesting to note, however, that the disciplined and wide-spread application of this practice would once again qualify air transportation as a cartel, which it was, *prior* to deregulation.

Due to all of the dynamics mentioned above, and most importantly because it does not influence the chosen time or location of consumption, taxation is a poor governor of quantity demanded in the consumption of nationalized primary aviation resources.

Taxation as an Enabler of Aviation Resource Supply

It can also be largely argued that taxation is a highly inefficient enabler of quantity supplied for RE capacity and SSA capacity. Examples of inefficiently spent taxpayer funds throughout the history of taxation are profligate. Notwithstanding recent successes in the development of NextGen, the FAA in particular has spent decades and tens of billions of dollars attempting to keep pace with demand by generating ever-greater capacity in runway environments and safe-separation airspace. Historically speaking, the economic *efficiency* of these expenditures has been questionable.

PART II: *Overview of The V1 Concept of Air Transportation Management*

In transportation, as in many other things, ***change*** is the only constant.

From dugouts and canoes plying eastern lakes and streams by paddle;
To barges traversing the length of the Erie Canal by mule;
To paddle-wheelers navigating the Mississippi and Ohio rivers by steam.

From Conestoga wagons headed west from Kansas City on the Oregon Trail;
To steam trains passing Promontory Point on the intercontinental railroad;
To automobiles traveling the Eisenhower Interstate Highway System, coast to coast.

From biplanes navigating airmail routes via bon fire beacons throughout the Midwest;
To 'Super Connie' recips navigating airways via radio beacons, non-stop from New York to San Francisco;
To Boeing 747 jets navigating direct polar routes via GPS satellites, non-stop from New York to Hong Kong.

The world's people and its commerce are in constant evolutionary motion. Demands on how transportation resources will be consumed, will continue to grow … and ***change.***

It is Time for a Change in the Status Quo

Throughout the history of economic development, the evolving demands of mankind have always usurped the status quo. History is replete with the wreckage of fixed systems of development which did not embrace human choice at the granular level and therefore could not adapt to change. For decades, the status quo in air traffic control has been the pursuit of greater fixed and centrally controlled processing capacity for the purpose of managing the ever-greater volume of passengers and freight which are generated by economic growth. Yet, despite the enormous quantities of resources expended in this pursuit, economic growth in the U.S. and the world have repeatedly overtaken advances in air traffic control capacity. It is time for a change in the status quo.

The V1 Concept of Air Transportation Management is not an air traffic control concept. As implied by its title, it is a holistic air transportation management concept. It recognizes the primary air transportation resources of RE capacity and SSA capacity as *virtually* tangible, transiently consumed, recyclable commodities, which may be traded in granular units. Accordingly, the concept proposes that the minute-by-minute consumption of these two primary aviation resources would be more efficiently governed by free-market principles which embrace human choice, rather than through the inefficiencies of taxation and centralized regulation. The DOT and the FAA would be freed to focus on the overarching governance of national airspace and would maintain ultimate control of aviation safety parameters.

By the convention illustrated above, air vehicle operators would seek to sequence their operations through the least-cost consumption of *all* resources, to include the two primary aviation resources. The decades-old function of centralized air traffic control (ATC) would be distributed to the efficiencies of the market and could ultimately become privatized in the form of a group of public utilities governed by the FAA. This would put pressure on ATC cost structures and operational practices to weed out inefficiencies in the same manner as deregulation of the air carriers did 30 years ago.

A Comparable Precedence in Paradigm Shift

As previously discussed, *The V1 Concept of Air Transportation Management* proposes that the 3-dimensional resources of RE capacity and SSA capacity are both currently consumed at no direct monetary cost to the consumer *at the point of consumption*. This is similar to the manner in which 2-dimensional land area in North America was once transiently consumed at no direct monetary cost to the consumer prior to the 17th century.

Recall that when a resource of widely perceived value is ‘free’, demand becomes theoretically unlimited. Accordingly, as the perceived value of land area in North America caused demand for its long-term ownership (consumption) to rise throughout the 17th century, land area became a tradable commodity under the principals of a free market. Price came to govern rising demand. Land area was transformed from existing as a transiently consumed ‘free’ resource, to becoming a commodity of long-term ownership (consumption).

Imagine if states had chosen to allow the consumption of land area to remain ‘free’ through displaced taxation, and instead had attempted to govern its unitary consumption through regulation and control without the use of market principles. The consumption of particular parcels of land with high perceived value would be congested and highly rationed. This demonstrates the severity of the paradigm shift necessary for governing the consumption of RE capacity and SSA capacity for the 21st century.

It should not be construed that this concept is proposing the long-term ownership (consumption) of atmospheric airspace by any entity other than the United States of America. *The V1 Concept of Air Transportation Management* recognizes the U.S. Government’s eminent domain over the expanse of national atmospheric airspace as a sovereign national asset. However, the concept also recognizes the inherent utility of air transportation as a means to deliver passengers and freight to their destinations in minimal (transient) time. With regard to both of these issues, the concept proposes that granular units of the two primary aviation resources be commoditized for *transient* consumption. Transient consumption is defined as the amount of time it would take an air vehicle to consume the utility of a unit of RE capacity or SSA capacity, before recycling that unit to inventory for further consumption by other air vehicles. This would facilitate the use of free market principles for governing air traffic de-confliction for particular units of primary aviation resources in high demand.

In its current form, *The V1 Concept of Air Transportation Management* applies only to the exploitation of RE capacity and SSA capacity in high density airspace for the pursuit of commerce. As currently conceived, the concept would apply free-market de-confliction of air traffic in high-density terminal area 'stovepipes', extending from the surface to 18,000 feet, as well as all high-density airspace above this flight level. It is proposed that the concept would initially apply in markets such as the northeast corridor, Atlanta, Chicago, Los Angeles, and the largely perceived black hole of air transportation, New York City.

Exceptions to the exposure of market cost for the consumption of primary aviation resources by the various types of air vehicle operators would be a matter for deep investigation. It is recognized that commercial air carriers, business jet operators, and general aviation enthusiasts all have vastly different requirements. Consumption of resources by the U.S. military is not addressed in this document.

The Inherent Flaw in *The Airline Deregulation Act of 1978*

The current era of air transportation is only fractionally deregulated. It places heavy demand on the two primary aviation resources, which have remained fully regulated. In several markets, this demand continues to consume these resources to the point of scarcity. The economic laws of supply and demand would dictate that this scarcity would cause resource prices to increase. Yet notwithstanding recent increases in air transportation prices due to the increased cost of jet fuel, the price for the commodity of air transportation throughout the 30 years of deregulation has remained popularly affordable. *The V1 Concept of Air Transportation Management* proposes this prolonged under-pricing has not accounted for the consumption of the two constrained and sometimes scarce resources of RE capacity and SSA capacity.

Simply put, *The Airline Deregulation Act of 1978* did not go far enough. While the modern commercial air transportation industry is often referred to as de-regulated and generally understood to be a free market, there exists an inherent flaw. This flaw appears as the detachment between the *deregulated, free market principles,* which are used to provide seat & freight capacity for air transportation, and the *regulated control* of the two primary aviation resources which must be consumed. Consider the following illustration:

The commodity of a scheduled passenger seat or specific freight volume, departing at a particular time from point 'A' and destined for point 'B', must transiently occupy (consume) specific units of RE capacity and SSA capacity in sequential points of time along the route of flight. Within the market defined by the city pair of 'A' and 'B', the price for one unit of seat or freight capacity is based strictly on the competitive environment and cost structure of the commercial provider. Due to the displaced taxation for consumption of controlled aviation resources, this competitive environment, cost structure, and the resulting price do not directly account for the consumption of the constrained and sometimes scarce supplies of RE capacity and SSA capacity. This lack of free market integrity has the effect of producing commercial air vehicles full of passengers and freight in a *deregulated market*, which must transition to a *regulated* *environment* to consume the primary resources of RE capacity and SSA capacity. The result is a daily backlog of free market production which is isolated (detached) from its free-market-imposed demands on these constrained and sometimes scarce resources. After three decades of operating under these dynamics, the inherent flaw in opening only a portion of the air transportation industry to market forces has caused the consumption of primary resources to exceed the supply in several markets.

This page intentionally left blank.

PART III: Analysis of the Inherent Flaw in *The Airline Deregulation Act of 1978*

CHARACTERISTICS AFFECTING THE SUPPLY AND DEMAND OF THE THREE DETERMINANTS OF AIR TRANSPORTATION THROUGHPUT

Recall that in a free market, a collection of market forces defines the aggregate supply for a particular resource. Likewise, a separate collection of market forces defines the aggregate demand. Given these aggregate market forces, price is a determinant of the quantity supplied by manufacturers as well as the quantity demanded by consumers. In turn, where the aggregate market forces of supply and demand are in equilibrium, price and quantity are reflections of this equilibrium.

The two primary aviation resources of RE capacity and SSA capacity exist in controlled environments. Accordingly, as co-determinants of air transportation throughput, *The V1 Concept of Air Transportation Management* has proposed that they are isolated (economically detached) from the free market production of seat & freight capacity. Since these two resources are economically detached, price in the air transportation market is not a determinant for their quantity supplied nor their quantity demanded. As a result, air transportation throughput is economically inefficient and therefore, non-sustainable.

So that we might understand the magnitude of this inefficiency, it will be important to identify the quantity demanded which is imposed on the controlled resources of RE capacity and SSA capacity by the free-market consumption of seat & freight capacity. To do this, we will construct a hypothetical model which will illustrate the difference between the natural market equilibrium quantities for each of the primary aviation resources and the artificial equilibrium quantities which are imposed on their supply by the free market consumption of seat & freight capacity.

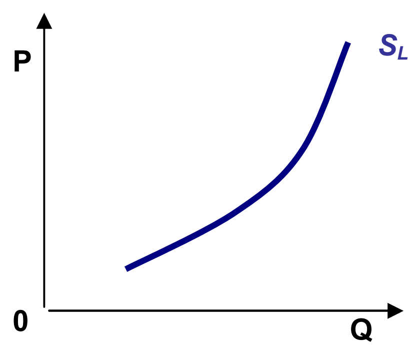
SUPPLY AND DEMAND OF THROUGHPUT DETERMINANT #1: RUNWAY ENVIRONMENT CAPACITY

The Economic Supply Function for Land Area

Before discussing the economic properties of RE capacity, it will be important to discuss the properties of land itself. Land area is a two-dimensional natural resource which is largely finite.[5] Unlike the three-dimensional natural resource of atmospheric airspace, a market for the trade of land area, as a commodity for long-term ownership (consumption), has existed in North America since the early 17th century. Also unlike atmospheric airspace, the market for land area allows it to be horded in an economic sense, thereby controlling price by controlling supply. As a result of these market dynamics, the supply of land area may be considered as price inelastic, where a given percentage change in price results in a lesser percentage change in the quantity supplied. In other words, increasing units of price determine smaller marginal units of quantity supplied, in an overall progressive relationship. (See *Figure 2,* below.)

Figure 2. **The supply of land area may be considered as a classic supply curve, where increasing units of price determine smaller marginal units of quantity supplied, in an overall progressive relationship.**

Supply of Land



S_L	*- Supply of land.* *- Quantity supplied is theoretically price elastic to price inelastic.*
P	*- Price (Y-axis)*
Q	*- Quantity (X-axis)*

[5] Coastal airports sometimes have the option of 'manufacturing' land area using coastal landfill. Examples include New York's LaGuardia Airport, Tokyo's Osaka Int'l Airport and Seoul's Inchon Int'l Airport.

The Economic Supply Function for Runway Environment Capacity
RE capacity is a fabricated resource. It is the sum and product of four individual factors.

Where:

$$\text{Runway Environment Capacity} = (2D \times T_R) + (3D \times T_A)$$

Where:

2D The two-dimensional land area which defines the footprint of the runway environment.
3D The three-dimensional terminal safe-separation airspace which encompasses the footprint of the runway environment.
T_R The independent throughput of the runway.
T_A The independent throughput of the terminal safe-separation airspace.

The factor of throughput (T) is further defined as the number of air vehicles which can transit the two elements of a runway environment under F.A.R. parameters in a given unit of time.

Where:

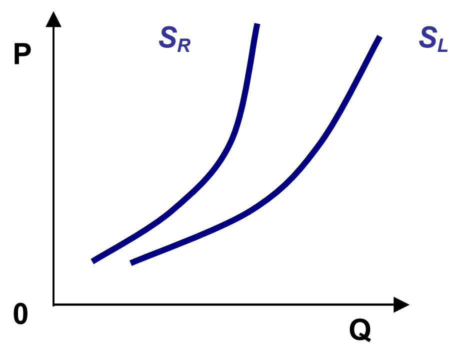
$$\text{Throughput (T)} = \text{Air Vehicle Units} / \text{Time}$$

Whereas the airspace component of a runway environment is a nationally controlled entity, its capacity (quantity supplied of 3D x T_A) has historically been completely within the domain of the federal government. By comparison, the capacity of the footprint area of the runway environment (quantity supplied of 2D x T_R) may be an arguably more complex issue because it is a product of both federal and local governments. Land for runways (2D) is locally controlled. Throughput of the runway environment (T_R) is largely controlled by F.A.R.'s, with at least some element of local political input.

As mentioned, land area for manufacturing runways is mostly finite. This limitation is further restricted by topographic or man-made obstructions which preclude the safe operation of air vehicles. In addition to these physical obstructions, local political issues such as environmental concerns and noise sensitivity may further restrict the availability of land area and terminal airspace for runway environment fabrication and throughput. In various geographic locations, some or all of these constraints may cause RE capacity (quantity supplied of (2D x T_R) + (3D x T_A)) to become somewhat insensitive to price (inelastic), or even completely insensitive to price (perfectly inelastic). Therefore, the supply curve representing RE capacity is very steep. (See *Figure 3,* below.)

Figure 3. **Physical, political and environmental issues may cause RE capacity (quantity supplied of (2D x T_R) + (3D x T_A)) to become somewhat insensitive to price (inelastic), or even completely insensitive to price (perfectly inelastic). Therefore, the supply curve representing RE capacity is very steep.**

Supply of Land & Runway Environment Capacity



S_L - *Supply of land.*
- *Quantity supplied is theoretically price elastic to price inelastic.*

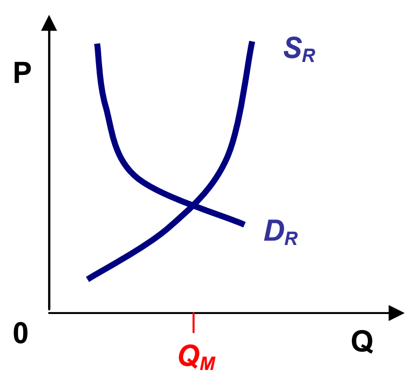
S_R - *Supply of runway environment capacity.*
- *Quantity supplied is theoretically price inelastic to perfectly price inelastic.*

The Economic Demand Function for Runway Environment Capacity
Local governments which control the land area available for runway construction are beholden to local sensitivities which may affect demand for RE capacity. These sensitivities may be the same as, or a subset of, the same sensitivities which affect supply. An additional element affecting RE capacity demand may be the financial cost to the local community. Cost may be particularly high in major metropolitan areas due to high demand for land for all manner of consumption.

Although increased RE capacity may be in high demand by consumers of air transportation services, local governments and the local issues they are beholden to are quite possibly a larger determinant of capacity supplied. Because of these local issues, the marginal change in RE capacity (quantity demanded of (2D x T_R) + (3D x T_A)) is considered to decline very quickly as price increases. The resulting demand curve representing RE capacity is very steep and may become perfectly inelastic to price above a certain threshold. Given all parameters proposed, the market equilibrium quantity for RE capacity exists at Q_M, where the RE demand function intersects the RE supply function. (See *Figure 4,* below.)

Figure 4. **Local sensitivities against various physical, political, environmental and financial costs of RE capacity (quantity demanded of (2D x T_R) + (3D x T_A)) cause the demand curve to be very steep. It may become perfectly inelastic to price above a certain threshold. Given all parameters proposed, the market equilibrium quantity for RE capacity exists at Q_M, where the RE demand function intersects the RE supply function.**

Supply and Demand of Runway Environment Capacity



S_R - ***Supply of runway environment capacity.***
- Quantity supplied is theoretically price inelastic to perfectly price inelastic.

D_R - ***Demand for runway environment capacity.***
- Quantity demanded is theoretically price elastic to perfectly price inelastic.

Q_M - ***Market equilibrium quantity for RE capacity.***

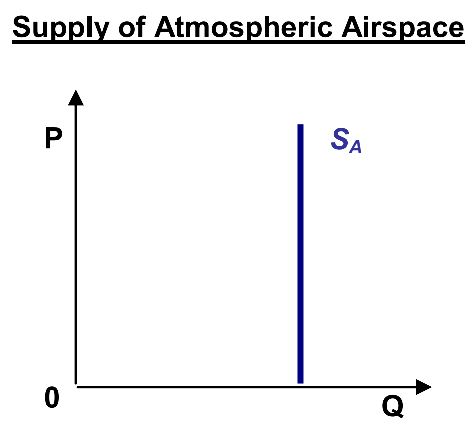
The Function of RE Capacity as a Determinant of Air Transportation Throughput

The economic function of RE capacity is the least adaptable and most constricting of air transportation throughput due do its highly fixed properties, long-term fabrication horizon, and predominantly price-inelastic supply function. In effect, RE capacity serves as the constriction in an hour glass amid the three determinants of air transportation throughput. It is through this constriction which the aggregate production of granular elements of seat & freight capacity must pass, to be disbursed into the capacity of safe-separation airspace. Therefore, RE capacity most often serves as the most constricting determinant of throughput.

SUPPLY AND DEMAND OF THROUGHPUT DETERMINANT #2: SAFE-SEPARATION AIRSPACE CAPACITY

The Economic Supply Function for Atmospheric Airspace
Before discussing the economic properties of safe-separation airspace, it is important to discuss the properties of atmospheric airspace; it's most basic element. Atmospheric airspace is a three-dimensional natural resource. Like many natural resources, it is finite. Unlike most natural resources, it cannot be grown, harvested, mined or manufactured to increase supply. Most importantly, in the context of a free market, it cannot be horded to control supply because no market for doing so exists. Therefore, the supply of natural atmospheric airspace is not a function of free market influences which would normally define a classic supply curve. Instead, since the supply of this resource is independent of price, it is economically defined as perfectly price inelastic (insensitive to price). Its supply 'curve' exists as a vertical line at a fixed quantity of cubic space. (See *Figure 5*, below.)

Figure 5. **The finite supply of naturally occurring atmospheric airspace volume is independent of price and is therefore perfectly price inelastic.**



S_A - ***Supply of naturally occurring atmospheric airspace.***
- Finite quantity supplied does not vary with price.
- Quantity supplied is theoretically perfectly price inelastic.

The Economic Supply Function for Safe-separation Airspace Capacity
SSA capacity is a fabricated resource. It is a product of three-dimensional airspace (3D), and throughput (T).

Where:

Safe-separation Airspace Capacity = 3D x T

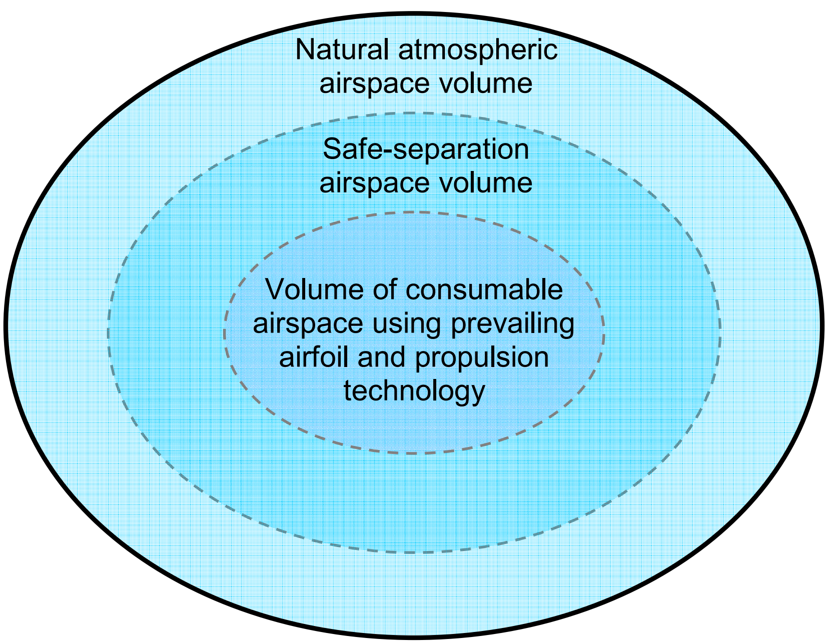
The factor of three-dimensional airspace (3D) is a volumetric quantity which is further defined by the combination of two elements:

1. The limit of atmospheric airspace which is consumable using prevailing propulsion and airfoil technologies. This subset generally exists within the altitude band from sea level to 41,000 feet for most air-carrier-class jets, and up to 45,000 feet for some business-class jets.
2. The application of navigation, communication, and surveillance technologies for defining airspace and providing safe-separation. This application process is governed by national policy in the form of Federal Aviation Regulations (F.A.R.'s). Given the subset of consumable atmospheric airspace, F.A.R.'s are arguably the single largest determinant of SSA capacity.

The factor of throughput (T) is further defined as the number of air vehicles which can transit a unit of SSA, under F.A.R. parameters in a given unit of time.
Where:

Throughput (T) = Air Vehicle Units / Time

The following graphic presentation illustrates the relationship between the three different types of airspace volume addressed above. Note that the outward natural limit of atmospheric airspace is fixed (finite) while the other two boundaries are variable, as a function of technology, economic sustainability, and imposed socio-cultural limitations.

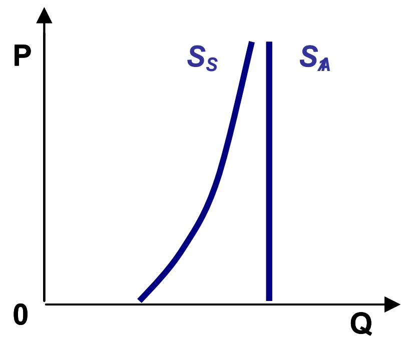


The 3D portion of SSA capacity can exist in any quantity expandable between zero and the finite limit of natural atmospheric airspace usable by air vehicles, as explained above. The throughput portion of SSA capacity can exist as any value made possible by the reduction of 3D volume which is required to be consumed per air vehicle under F.A.R. safety parameters. Both of these determinants of SSA capacity are responsive to technological advances.

The capacity of SSA (quantity supplied of 3D x T) is a function of monetary flow (price). This flow provides for the development, operation, and depreciation of the navigation, communication and surveillance technologies which are required for its fabrication. Applying the law of supply, it is proposed that increasing quantities of monetary flow have historically resulted in increasing SSA capacity, but in decreasing marginal units per unit of monetary flow. Therefore, in comparison to the vertical supply line which represents atmospheric airspace volume, the supply 'line' representing SSA capacity is defined as a curve. The greater the provision of funds for fabricating SSA capacity, the greater its capacity grows, albeit in smaller marginal units, until it reaches the outward natural limit of atmospheric airspace (3D) or the inward saturation limit of throughput (T). (See *Figure 6*, below.)

Figure 6. **The capacity of SSA (quantity supplied of 3D x T) is proportional to monetary flow (price), but in decreasing marginal units per unit of price (P). However, capacity (Q) cannot exceed the finite supply of atmospheric airspace (3D) or the technological limits of throughput (T).**

Supply of Atmospheric Airspace & SSA Capacity



S_A *- Supply of naturally occurring atmospheric airspace.*
- Finite quantity supplied does not vary with price.
- Quantity supplied is theoretically perfectly price inelastic.

S_S *- Supply of safe-separation airspace*
- Variable quantity dependant on monetary flow (price).
- Quantity supplied is theoretically price inelastic.

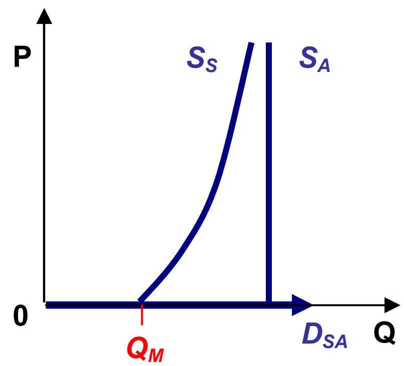
The Economic Demand Function for Safe-separation Airspace Capacity

As previously discussed, U.S. domestic safe-separation airspace is not offered for market. Instead, it is paid for through taxation. However, taxes levied for the consumption of SSA capacity (3D x T) are displaced from the specific point and time of consumption. Therefore, taxation is a poor governor of consumer choice for the quantity demanded of SSA capacity. With market price non-existent and with taxation a poor governor, the true governor of the quantity demanded of SSA capacity is rationing through regulatory control. This control takes the form of Federal Aviation Regulations (F.A.R.'s), which are enacted through representative government and enforced by the FAA.

F.A.R.'s control the quantity demanded of SSA capacity (3D x T) for the purpose of maintaining operational parameters of safety and throughput. No direct cost is imposed on the operation of air vehicles for the spatial and time-specific consumption of the utility of SSA capacity. Therefore, in an economic sense, safe-separation airspace may be perceived as 'free' by aviation consumers. Recall that when a resource of value is perceived as 'free', the quantity demanded becomes theoretically unlimited, even surpassing the exhaustion of quantity supplied. Given all dynamics proposed, the market equilibrium quantity for SSA capacity exists at Q_M, where the SSA demand function intersects the SSA supply function. (See *Figure 7,* below.)

Figure 7. **No direct cost is imposed on the operation of air vehicles for the consumption of SSA capacity. Therefore, in an economic sense, SSA capacity may be perceived as 'free' and the quantity demanded as theoretically unlimited, even surpassing the exhaustion of quantity supplied. Given all parameters proposed, the market equilibrium quantity for SSA capacity exists at Q_M, where the SSA demand function intersects the SSA supply function.**

Supply and Demand of Atmospheric Airspace and SSA Capacity



S_A	*- Supply of naturally occurring atmospheric airspace.* *- Finite quantity supplied does not vary with price.* *- Quantity supplied is theoretically perfectly price inelastic.*
S_S	*- Supply of safe-separation airspace* *- Variable quantity dependant on monetary flow (price).* *- Quantity supplied is theoretically price inelastic.*
D_{SA}	*- Demand for SSA and atmospheric airspace.* *- Perceived as 'free' (where P=0).* *- Quantity demanded is theoretically unlimited.*
Q_M	*- Market equilibrium quantity for SSA capacity.*

The Function of SSA Capacity as a Determinant of Air Transportation Throughput
The economic function of SSA capacity occupies the middle ground among the three determinants of air transportation throughput. SSA capacity is less constricting of throughput than RE capacity, but more constricting than the free-market production of seat & freight capacity.

Relative to RE capacity:

> Like runway environment capacity, safe-separation airspace capacity may have a long-term development horizon and be predominantly price-inelastic. However, safe-separation capacity is more intangible and less fixed than runway environment capacity, allowing it to be more adaptable and less constricting of throughput.

Relative to seat & freight capacity:

> The operational disposition of navigation, communication, and surveillance technologies which define SSA capacity are not as adaptable to changes in the air transportation industry as the disposition of a fleet of air vehicles. The technology required for increased SSA capacity cannot be put into service in a matter months. Nor is it stood down when the air transportation industry suffers a cyclical downturn.

This page intentionally left blank.

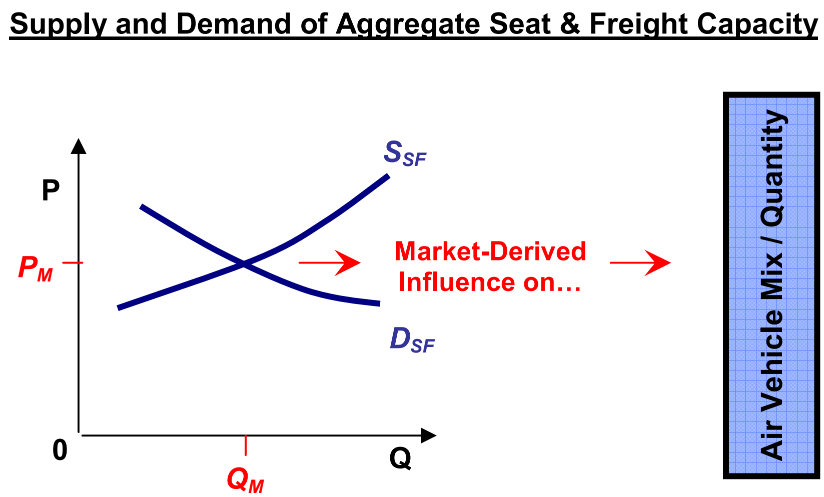
SUPPLY AND DEMAND OF THROUGHPUT DETERMINANT #3: SEAT & FREIGHT CAPACITY

Economic Supply and Demand Functions for Seat & Freight Capacity
In the previous two sections, we discussed the market forces which may determine the supply and demand functions for RE capacity and SSA capacity. Recall that no free-market trade of these resources currently exists. However, free-market production of seat & freight capacity does exist. We'll now turn to developing a graphical depiction of the supply and demand functions for this determinant of air transportation throughput.

Air transportation pricing is complex. It is comprised of a mix of forces which includes hub and spoke strategies, yield management, labor issues, fuel prices, and the cyclical entry and exit of providers, to name a few. In addition to this complex mix of forces, the industry itself is highly cyclical. It ebbs and flows, sometimes with pronounced leverage relative to the general economic tide of the nation. Despite all of this we will propose for the purposes of this paper that the aggregate supply and demand functions for air carrier seat & freight capacity are price elastic, as is typical in a free market environment. Accordingly, they each appear as classic supply curves. Given a snapshot of market capacity, a particular percentage increase in price results in a greater percentage decrease in quantity demanded. Likewise, the same percentage decrease in price results in a greater percentage increase in quantity supplied. Equilibrium price and quantity are indicated as P_M and Q_M, respectively.

Market equilibrium capacity influences the chosen mix and quantity of air vehicles which must be provided by air transportation operators to satisfy the quantity demanded for seat & freight capacity. This mix bears directly on the aggregate volume of RE capacity and SSA capacity which must be consumed to meet the seat & freight capacity market equilibrium quantity demanded. (See *Figure 8*, below.)

Figure 8. **Supply and demand functions for seat & freight capacity are price elastic. Equilibrium price and quantity are indicated as P_M and Q_M respectively. Market equilibrium quantity demanded influences the air transportation operators' choice of air vehicle mix and quantity, which in turn determines the aggregate consumption of RE capacity and SSA capacity.**



S_{SF} - *Supply of seat & freight capacity.*
- *Quantity supplied is theoretically price elastic.*

D_{SF} - *Demand for seat & freight capacity.*
- *Quantity demanded is theoretically price elastic.*

Q_M - *Aggregate Market equilibrium quantity for seat & freight capacity.*

P_M - *Aggregate Market equilibrium price for seat & freight capacity.*

The Function of Seat & Freight Capacity as a Determinant of Air Transportation Throughput

Of the three economic functions we have examined, seat & freight capacity is the most adaptable and least constricting of air transportation throughput. Air transportation providers may choose the quantity and mix of air vehicles they intend to operate based on a wide range of factors. Some of these factors may include the operator's capitalization, access to credit, operational constraints, and the market in which they intend to compete. Most importantly, this standing quantity and mix of air vehicles may be changed as industry conditions warrant. It is common practice in the air transportation industry to furlough and recall aircrews as economic conditions warrant. Air vehicles which are leased may be returned to the leasing company. Air vehicles which are owned may be stored and preserved in desert locations. Such air vehicles often increase in value. (Investment banks around the world rushed to purchase surplus commercial air vehicles following the events of September 11, 2001.)

This page intentionally left blank.

ANALYSIS: MARKET EQUILIBRIUM OF THE THREE DETERMINANTS OF AIR TRANSPORTATION THROUGHPUT VS. IMPOSED EQUILIBRIUM ON THE TWO PRIMARY AVIATION RESOURCES

We have now proposed and developed some basic theory in determining the supply and demand functions and independent market equilibrium quantities for runway environment capacity, safe-separation airspace capacity, and seat & freight capacity. Recall that the purpose for developing these functions stems from the recognition of RE capacity and SSA capacity as primary resources which must be consumed in the process of generating air transportation throughput, but that the consumption of these resources is not directly governed by price.

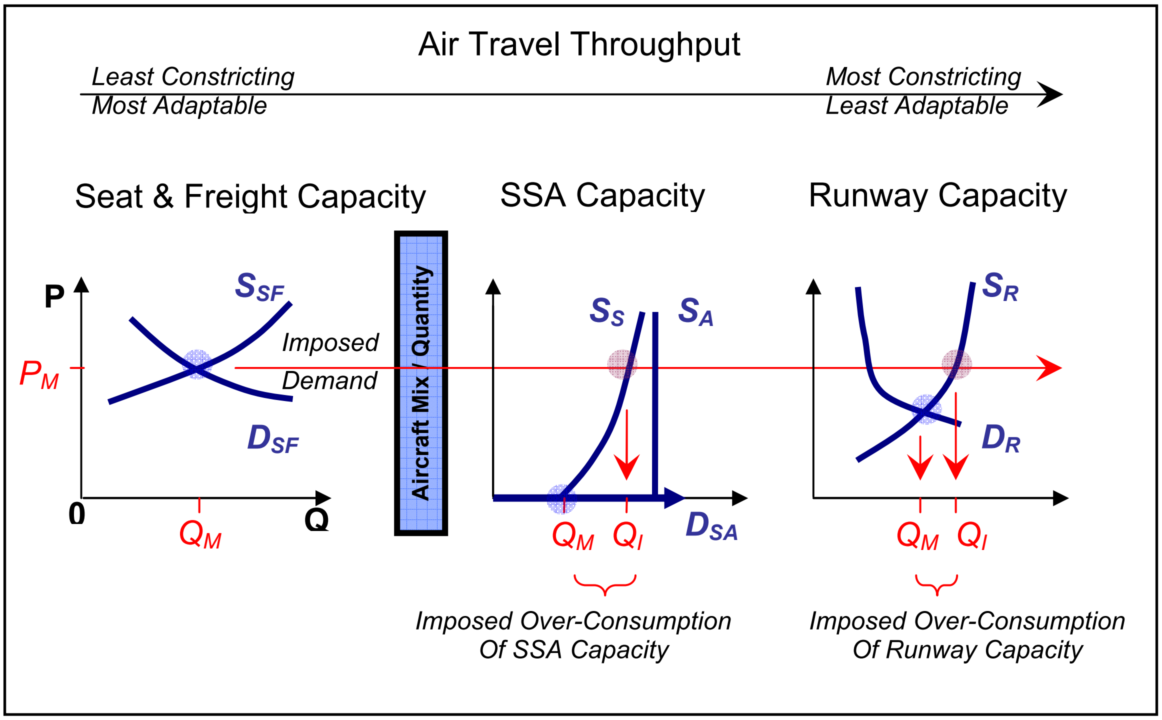
To understand the impact of this disconnect, *The V1 Concept of Air Transportation Management* proposes a theoretical comparison of independent market equilibrium versus imposed equilibrium. This is illustrated in *Figure 8*, below.

The Cause of Air Transportation Congestion - Illustrated
Of the three economic functions analyzed, recall that the most adaptive in generating air transportation throughput is seat & freight capacity. The most restrictive is RE capacity. In an arrangement representative of 'the tail wagging the dog', *Figure 9*, below, illustrates the functions for seat & freight capacity, SSA capacity, and RE capacity from left to right. This illustrates how the most adaptable resource (seat & freight capacity) drives the over-consumption of less adaptable resources.

Most importantly*, Figure 9* illustrates how the market equilibrium quantity for aggregate seat & freight capacity bears in relation to the detached market equilibrium quantities for RE capacity and SSA capacity. The Y-axis (P) is proposed to be a commonly adjusted price scale for each of the three functions, where aggregate seat and freight units serve as the common denominator. The red horizontal arrow, therefore, indicates the *imposed demand* of seat and freight equilibrium capacity on the detached resources of RE capacity and SSA capacity. Since this arrow represents market-imposed demand, an imposed equilibrium exits where it intersects the supply curves which represent SSA capacity (S_S) and RE capacity (S_R).

Recall that in each depiction, Q_M represents the *market equilibrium quantity*. This quantity is independently determined for each of the two primary aviation resources by the intersection of their particular supply and demand functions. By the same application, Q_I represents the *imposed equilibrium quantity*. Imposed quantity exists where the horizontal arrow depicting the influence of seat & freight market equilibrium intersects each supply curve for RE capacity and SSA capacity. The key distinction to be observed in this illustration is the difference between the two equilibrium quantities (*market* and *imposed*) for RE capacity and SSA capacity. This difference is a graphical illustration of how airspace and runway congestion occur. It demonstrates the inherent flaw in deregulating only a portion of the air transportation industry, and leaving two primary resources to be centrally controlled through displaced taxation and regulation.

Figure 9. **The tail wags the dog. A theoretical evaluation of how the market equilibrium quantity for aggregate seat & freight capacity *imposes* over-consumption (Q_I) of RE capacity and SSA capacity, beyond the market equilibrium quantity for each resource (Q_M). (*See key at bottom of page.*)**



Key: Figure 9

Seat & Freight Capacity		SSA Capacity		RE capacity	
S_{SF}	Market supply function for seat and freight capacity.	S_S	Market supply function for safe-separation airspace capacity.	S_R	Market supply function for runway environment capacity.
		S_A	Market supply function for atmospheric airspace capacity.		
D_{SF}	Market demand function for seat and freight capacity.	D_{SA}	Market demand function for SSA and atmospheric airspace capacity.	D_R	Market demand function for runway environment capacity.
Q_M	Market equilibrium quantity.	Q_M	Market equilibrium quantity.	Q_M	Market equilibrium quantity.
		Q_I	Imposed equilibrium quantity.	Q_I	Imposed equilibrium quantity.
P_M	Market equilibrium price.				

The Cure for Air Transportation Congestion - Illustrated

As indicated in *Figure 9,* above, the production of seat & freight capacity is the most adaptive and least constricting resource for generating air transportation throughput. SSA capacity is less adaptive and more constricting. RE capacity is the least adaptive and most constricting resource of the three. This is due to its fixed properties, long-term development horizon, and predominantly price-inelastic supply function.

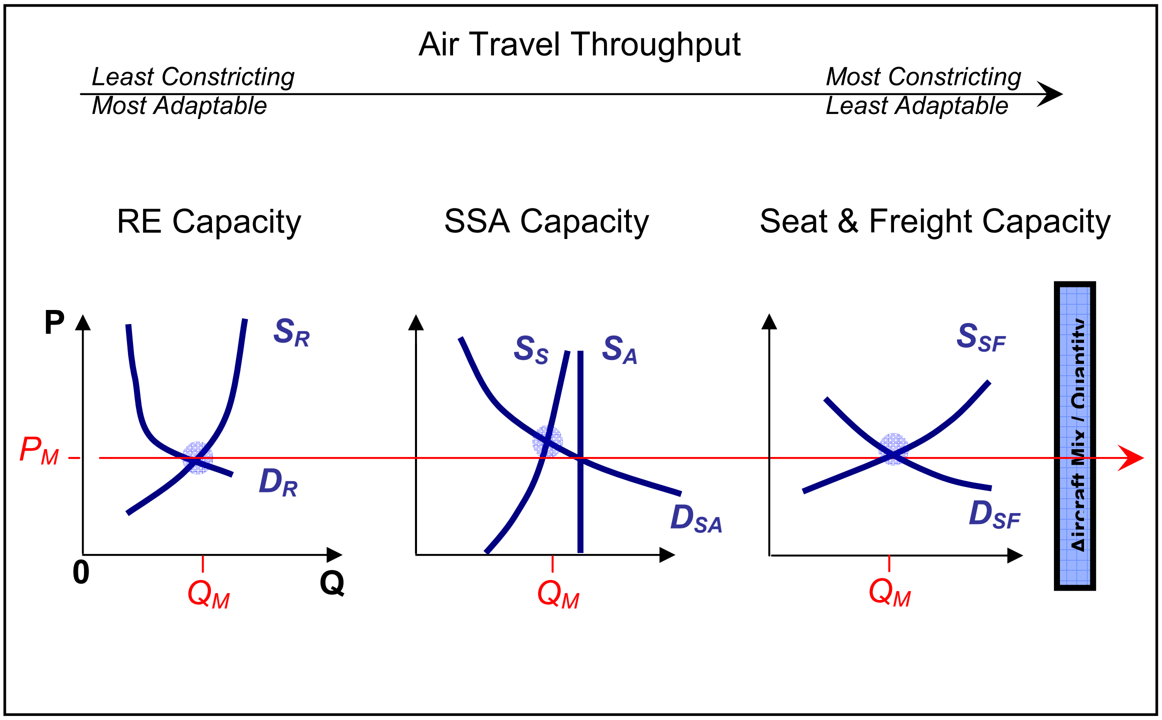
To make the throughput-constricting resources of RE capacity and SSA capacity adaptive to the production of seat & freight capacity, these resources should be made accountable to the free market. In this manor, RE runway and SSA capacity would serve as *determinants* of throughput rather than as over-consumed *absorbers* of throughput.

By including the direct cost for the consumption of RE capacity and SSA capacity in the price for seat & freight capacity, the market equilibrium quantities for all three determinants of air transportation throughput would be brought into alignment. This would provide the following evolutionary and sustainable benefits in air transportation:

- Human choice would be accommodated at the granular level throughout the entire system of air transportation.
- The quantity supplied of aviation resources would be efficiently enabled through market premiums in a free market.
- Excess capacity (slack) in each one of the three determinants would be the product of free market forces.
- Air transportation providers would be encouraged to operate larger-gauge aircraft for the purpose of facilitating competitive division of resource costs. This would naturally govern the quantity demanded of aviation resources without stifling throughput of seat & freight capacity.
- Imposed over-consumption of primary aviation resources would be corrected.
- Delays would be mitigated, as would their corresponding drain on the air transportation industry, consumer productivity, and GDP.

In *Figure 10*, below, the three determinants of air transportation throughput have been arranged from left to right, in order of their constriction and adaptability relative to air transportation throughput.

Figure 10. **The dog wags the tail. By including the direct cost for the consumption of RE capacity and SSA capacity in the price for seat & freight capacity, the market equilibrium quantities for all three determinants would be brought into alignment. Increased throughput would be naturally accommodated by larger-gauge aircraft. (*See key at bottom of page.)***



Key: Figure 10

Seat & Freight Capacity		SSA Capacity		RE capacity	
S_{SF}	Market supply function for seat and freight capacity.	S_S	Market supply function for safe-separation airspace capacity.	S_R	Market supply function for runway environment capacity.
		S_A	Market supply function for atmospheric airspace capacity.		
D_{SF}	Market demand function for seat and freight capacity.	D_{SA}	Market demand function for SSA and atmospheric airspace capacity.	D_R	Market demand function for runway environment capacity.
Q_M	Market equilibrium quantity.	Q_M	Market equilibrium quantity.	Q_M	Market equilibrium quantity.
		Q_I	Imposed equilibrium quantity.	Q_I	Imposed equilibrium quantity.
P_M	Market equilibrium price.				

PART IV: Implementation

THE CONSUMPTION OF RE CAPACITY AND SSA CAPACITY AS PROPOSED BY *THE V1 CONCEPT OF AIR TRANSPORTATION MANAGEMENT*

Introduction of the 4D Trajectory
Up until this point, we have evaluated the primary aviation resources of RE capacity and SSA capacity independently for the purpose of understanding their detached market equilibrium quantities versus imposed equilibrium quantities. We have defined the capacity of a runway environment to be its footprint area times its throughput of air vehicles, *plus* the corresponding airspace volume times the throughput of air vehicles.
Where:

$$\text{RE Capacity} = (2D \times T_R) + (3D \times T_A)$$

Also, we have defined the capacity of safe-separation airspace to be its volume times the throughput of air vehicles.
Where:

$$\text{SSA Capacity} = 3D \times T$$

From this point forward, we will be discussing the consumption of primary aviation resources as a single combined trajectory. This trajectory will include all 3-dimensional phases of flight from initiation of the take off roll, through climb, cruise, descent, approach, landing, and roll out. And since this trajectory will be planned to occur at a specified time, it will also encompass the fourth dimension of time. Hence, the intended flight path of an air vehicle will be referred to as a 4D trajectory.

Characteristics of the 4D Trajectory as a Commodity
The detachment of costs associated with the fabrication of RE capacity and SSA capacity from the point and time of their consumption, has lead to chronic over-consumption and under-supply of these resources in several markets. Despite continuous increases in capacity, derived from vast improvements in human, technological and operational efficiencies, air transportation delays continue to rob the U.S. economy of productivity.

The V1 Concept of Air Transportation Management proposes a paradigm shift which would move away from the status quo of fixed and centrally regulated air traffic control, toward a sustained evolutionary system of market-based air transportation management. Under this concept, granular units of RE capacity and SSA capacity would be combined as commercially provided resources, in 4D trajectories, which would then be traded as commodities in whole or in part.

Modern navigation and surveillance technology can define 3D airspace volume, 2D runway area, and their respective throughput capacities, as tangibly as a 17th-century surveyor could once define 2D land area. Or, proposing a likeness which is more relevant to aviation; the *virtually* tangible resources of empty RE capacity and SSA capacity can be just as easily defined as the *virtually* tangible commodities of empty seat & freight capacity. As commodities, RE capacity and SSA capacity could be viewed as sharing the same centuries-old attributes as the 2D commodity of land area, as well as the decades-old attributes of seat & freight capacity. These shared attributes include:

1. *(Virtually)* tangible
2. Transiently consumable
3. Divisible into granular units
4. Tradable in a free market
5. Recyclable for rapid and sequential consumption

Accordingly, and because RE capacity and SSA capacity are detached from the aggregate market price of the free-market industry which consumes them, *The V1 Concept of Air Transportation Management* proposes that these two resources should also be exposed to the free market, to be transiently consumed as 4D trajectories. This would complete the deregulation of air transportation, which was only partly begun by the Airline Deregulation Act of 1978.

Characteristics of Granular Units of SSA

The granular unit of safe-separation airspace which is currently required under federal aviation regulations takes the form of a squat cylinder surrounding each air vehicle. In very general terms, for each air vehicle operating in the upper route structure, the dimensions of this cylinder are defined as 1000 feet above and below the individual air vehicle's altitude and extending for a radius of 5 nautical miles. This comprises a volume of airspace of approximately 25 cubic nautical miles. For each air vehicle operating in the low altitude terminal areas, the cylinder is smaller as a reflection of the slower speeds flown by air vehicles at lower altitudes. This cylinder is defined as 1000 feet above and below the individual air vehicle's altitude and extending for a radius of only 3 nautical miles. This comprises a volume of airspace of approximately 9.5 cubic nautical miles.

As a natural consequence of the radar-based system which has been the mainstay of air traffic control since World War II, the volume of SSA allotted each air vehicle has been largely perceived to be a 'safety bubble' surrounding each vehicle. This 'bubble' transits the void of atmospheric airspace at the same forward speed as the air vehicle it protects. This is a point of key distinction to be made between the *unitary air traffic control mindset* of the 20th century and the *holistic airspace management mindset* for the 21st century being proposed here.

The V1 Concept of Air Transportation Management proposes that the entire volume of SSA, as a subset of atmospheric airspace, would cease being perceived as an open void populated with air vehicles and their 'safety bubbles'. Instead, the concept proposes, as one of several options conceivable through modern technology, that the expanse of SSA would be divided into 3-dimensional granular units. Each granular unit would match the volume of individual SSA required to surround each air vehicle by prevailing F.A.R.'s. (This volume will most probably shrink as NextGen is implemented.) In this manner, the cylinder surrounding each air vehicle would transit each standing granular unit. The cost for the transient consumption of each granular unit of SSA would be the market price determined by the level of demand for the unit being consumed. Accordingly, an entire thread of granular units could be regarded and offered for trade as a single 4D trajectory.

The matter of dividing the entire expanse of SSA over the U.S. and accounting for its market price and consumption seems technologically feasible. The preponderance of modern navigation and telemetry equipment which is already present in the aviation industry, as well as technologies currently being developed for NextGen, could provide a solid foundation for realizing the advantages of the proposed concept. Linking the wide-ranging capabilities of these technologies could conceivably provide the aggregate utility required. A list of these technologies would include:

Automatic Dependent Surveillance-Broadcast (Transmission)	ADS-B (Out)
Automatic Dependent Surveillance-Broadcast (Receiver)	ADS-B (In)
Global Positioning Systems	GPS
Wide Area Augmentation Systems	WAAS
On-board Flight Management Systems	FMS
Required Navigation Performance	RNP
Inertial Navigation Systems	INS
Reduced Vertical Separation Minimums	RVSM
Area Navigation	RNAV
Traffic Collision Avoidance Systems	TCAS
Autonomous Traffic Collision Avoidance Systems	ATCAS

Free-Market Principles would Govern Supply and Demand Instead of F.A.R.'s

By application of free market principles, the price for the consumption of the two primary aviation resources would be directly determined by demand within specific markets. Some of the market dynamics affecting the demand for each granular unit would conceivably include spatial position and time of day (i.e. the travel market). The market price of certain units would also be affected by scarcity, posed by local political issues such as noise sensitivity.[6] Other market dynamics would be prevailing atmospheric conditions such as volcanic ash and weather systems. Predicted weather and actual weather would be very influential dynamics affecting the market price for a granular unit of SSA or RE capacity, or an entire 4D trajectory. Theoretically, this would be quite similar to the weather-related dynamics influencing many other commodity markets. (This is an expansive topic which will be touched upon later.) F.A.R.'s would not go away. But rather than serve as supply and demand rationing tools, F.A.R.'s would focus on implementing and enforcing aviation safety.

---

[6] In the future, noise sensitivity will be just as real an issue for high altitude units of SSA as for units in low altitude and terminal areas. Non-military supersonic air vehicles, and the sonic booms they generate, will most probably reappear, and in fact are already being developed in the form of modern business jets.

Air traffic control services would essentially be transformed into public utilities. These utilities would be governed by a public utility commission (PUC), possibly an entity of the DOT or the FAA. Safe-separation services and runway environment capacity would be provided by a free market of private enterprises accountable to the PUC. In recognition of the critical level of public safety which would be at risk, this structure of governance and accountability might resemble that of the Nuclear Regulatory Agency (NRA) and the collection of private operators of nuclear power plants which it governs.

Providers of RE capacity and SSA capacity would become accountable to the market. Competitive providers would be those who could operate with a cost efficient structure, providing the two primary aviation resources, in 4D trajectories, to F.A.R. specifications, for less than the market-demanded price. Four-dimensional trajectories in certain markets would command a premium above the cost of provision for their perceived value by location and time. Trajectories which would not generate market premiums would not be expanded, as they would not generate revenue to justify the cost of increased capacity. The choice by providers to subsidize underperforming trajectory markets would become more transparent to the public.

ADVANTAGES OF *THE V1 CONCEPT OF AIR TRANSPORTATION MANAGEMENT*

The V1 Concept of Air Transportation Management has the potential to create an expansive list of advantages over the current practice of centralized air traffic control. The concept also offers a self-sustaining, market-based augmentation for the autonomous air traffic control principles being proposed by NextGen. Following are a dozen of these advantages.

1. Ubiquitous Utilities
   The primary aviation resources of RE capacity and SSA capacity would become ubiquitous utilities in a free market. They would be provided by privatized entities and would share market characteristics common to other utilities such as water, electricity, radio frequency bandwidth, and communications. Recognizing that aviation resources require an exacting degree of public safety, they would remain as critically supervised as privatized nuclear power facilities. The DOT and the FAA would retain ultimate control for enacting and enforcing legislated aviation safety regulations.

2. Tradable Commodities, Increased GDP
   A new commodity market would be invented. Granular units of RE capacity or SSA capacity, or complete 4-dimensional trajectories of both, would be traded for current and future consumption by aviation enterprises. Market-based mitigation of air transportation congestion would merely be the first byproduct of such a market. The economic multiplier caused by this trade could cause a substantial increase in GDP.

3. Supply and Demand Accountable to the Market
   Quantities of RE capacity and SSA capacity would become accountable to the free market. These Primary aviation resources would cease being viewed as nebulous and infinitely expandable. Their opaque costs would become transparent. They would no longer be perceived as 'free' due to the consequence of displaced taxation. Therefore, demand would no longer be unlimited. Congestion would be self-regulating through market forces. Airline schedules would be spread more evenly over all 24 hours in a day to accommodate various markets by price.

4. Quantity Demanded and Price
   The consumption (quantity demanded) of RE capacity and SSA capacity would become market-governed through price instead of being rationed through regulation. Specifically, consumption of these two resources would no longer be controlled solely through air traffic control procedures and Federal Aviation Regulations (F.A.R's).

5. Quantity Supplied and Free-Market Premiums
   The provision (quantity supplied) of RE capacity and SSA capacity would become self-funding through the economic efficiency of market premiums instead of through the inefficiency of taxation and federal spending. The presence of premiums above the cost of provision would indicate demand for, and provide the free-market funding for, a greater supply of capacity by specific market.

6. Price Governing Choice by the Service Provider
   The market-based *price* for the consumption of primary aviation resources would become a direct *cost* of doing business to providers of air transportation services. This market-based cost would replace the ineffective and inefficient taxation of aviation fuel for the provision and consumption of these resources. It would therefore directly govern specific choices for the consumption of aviation resources by service providers.

7. Price Governing Choice by the End-Consumer
   The market-based *price* for the consumption of primary aviation resources would become a *cost* to the end-consumer of seat & freight capacity. This market-based cost would replace the ineffective and inefficient taxation of airfare and airfreight for the provision and consumption of these resources. It would therefore directly govern specific choices for the consumption of aviation resources by end-consumers. Choices would range by time of day and city-pair markets at all levels of consumption, from service provider to end-consumer.

8. Reduced Prices through Deregulation and Privatization
   Provision of RE capacity and SSA capacity would become deregulated and privatized. The air traffic control function of the FAA would become the product of one or more public utilities governed by a public utility commission (PUC). The price for the consumption of primary aviation resources would be reduced through free-

market influences. This would occur in the same manner as the reduction of prices for seat and freight capacity following the implementation of the Airline Deregulation Act of 1978. Profit above the cost of providing primary aviation resources would be determined by the PUC, as with other utilities. In this regard, market pressure would be maintained on providers of capacity to control the cost of provision.

9. Larger Aircraft Gauge, More Throughput
   Free-market forces would naturally encourage the use of larger air vehicles with greater carrying capacity for ensuring competitive division of the costs incurred for the consumption of primary aviation resources. This would generate greater throughput of passengers and freight per specific units of RE capacity and SSA capacity consumed.

10. Transparent Costs for Subsidized Routes
    The federally subsidized operation of small-gauge aircraft to underserved markets would become more transparent. These subsidies would become more easily comparable to alternative free-market funding options.

11. Transparent Costs for Alternative Transportation
    The true and total cost for fixed-wing air transportation to fixed-airport locations would become more transparent since price would include the cost for the consumption of primary aviation resources. The implementation of alternatives such as commercial tilt-rotor or high speed rail services to city centers would become more easily comparable. In certain high-density markets, possibly under 250 miles between city-pairs, these two alternatives would compete strongly against air transportation, further mitigating runway and airspace congestion.

12. Restoration
    Air transportation would once again become a time-efficient travel option.

ASSORTED FACTORS INFLUENCING *THE V1 CONCEPT OF AIR TRANSPORTATION MANAGEMENT*

Aviation Weather

In its worst form, weather can outright consume the capacity (utility) of the two primary aviation resources. In less extreme circumstances, weather can at least cause their utility to become impaired. By the term 'consume', it is inferred that weather which occupies a 4D segment of RE capacity or SSA capacity exceeds the operational capability of air vehicles to consume the utility of that capacity. By the term 'impair', it is inferred that weather has caused a disruption in an air vehicle's normal manner of consumption.

An example of 'weather consumption' would include thunderstorm conditions aloft or in the vicinity of a runway environment. The physical properties of thunderstorms exceed the capabilities of air vehicles to consume the utility of aviation resources.

An example of ‘weather impairment’ would include actively precipitating snow conditions at the ground level (footprint) of a runway environment. The mere presence of snow does not normally exceed the operational capability of most air vehicles. However, actively precipitating snow does require de-icing operations to prevent ‘weather consumption’. This displaces the time element of a planned 4D trajectory.

Conditions such as rain, fog, or crosswinds do not normally consume or impair the utility of RE capacity or SSA capacity in terms of air vehicle operational capability. However, these conditions may negatively impact the capacity of the primary aviation resources, thereby reducing throughput.

This relationship between weather and the utility of aviation resources is similar to the effect of weather in some commodity markets. As an example, consider an acre of corn growing in the heartland of Nebraska. Much like a 4D segment of aviation resources, an acre of corn is subject to loss or impairment of its utility due to weather. However, unlike aviation resources, the utility of an acre of corn acquires a market value (price) as it becomes traded in the commodities market. Most often, this utility is sold into the future for its value at harvest (initial consumption). The future value (price) of an acre of corn, divided into granular units of bushels, may be determined in part by the risk of its loss or impairment due to forecasted weather. Investors wishing to protect themselves further from any unforeseen whether-related losses may hedge their futures contract using substitute commodities whose value is expected to rise under like-weather conditions.

Much like an investor holding a futures contract for a traded commodity, the operator of a scheduled flight anticipates consuming the utility, or value, of a particular 4D trajectory of RE capacity and SSA capacity at some point in the future. However, very often the anticipated utility of this capacity will be consumed by weather, which occupies the planned trajectory at the same time and place the air vehicle is destined to occupy it (4D). In a commodities market, the investor would simply accept the weather-related forfeit of this utility, or value, and be satisfied that he or she hedged through the value of another commodity. Of course, there is no such market for hedging the utility consumption of aviation capacity. The status quo which has persisted throughout the existence of aviation has simply been to change course, if airborne, or wait on the ground to consume a different trajectory at a different time. This mindset has worked for the better part of a century. However, with the increase in aviation traffic which has prevailed over the past several decades, this status quo has become problematic in several market areas. When the standard stream of daily air traffic must be squeezed into diminished RE capacity and SSA capacity as the result of weather consumption, increasingly complex and lengthy 4D trajectory conflicts must be mitigated. The result is congestion, delays, and lost economic productivity.

Of course, no market exists for the trade of aviation resource futures because these primary resources remain under the control of representative government. However, there is a more simple and elemental reason. Passengers and freight must still be transported in a timely manner. A commodity investor is prepared to accept the loss on a futures contract due to the utility (value) of the commodity having been consumed by weather conditions. In contrast, customers of air transportation providers cannot accept allowing the provider to abandon its contracted transport duties simply because weather has consumed the utility (capacity) of the anticipated 4D trajectory. The economic viability of air transportation and its importance as a critical enabler of commerce dictates that flight operations must continue despite prevailing weather conditions. Accordingly, a general strategy in air traffic control has been to retain a scheduled flight's relative position in the stream of throughput as weather consumes the flight's anticipated 4D trajectory. As in the preceding paragraph, the result can be a long queue of delayed traffic even after weather has cleared. An alternative, which is also employed by air transportation providers and the FAA, is to pare particular flights out of the delayed queue of traffic. This practice reduces the imminent and overwhelming backlog of seat & freight production for the purpose of re-introducing these units in more controllable quantities at a later time. (Most often within 12 to 24 hours.) This results in even greater lost productivity, but is an accepted cost for 'resetting' the system.

But what if a market existed which allowed air transportation providers to hedge losses incurred by the weather-related consumption or impairment of an intended 4D trajectory? Or to purchase contingency options in the form of alternate 4D trajectories? Conceivably, this would allow providers to plan for and accept forfeiting the planned consumption of a particular segment of capacity by hedging all costs from irregular operations associated with displacement of a flight. They would no longer feel the financial press to retain a time-relative place in line. This would allow the delays caused by such queuing to be naturally mitigated through market forces. The passengers and freight on delayed flights would still be transported, but through alternate, market-determined 4D trajectories, which would preclude the consumption of already contracted resources.

Investigating the establishment of such a market for primary aviation resources would be a major focus of the research being proposed by *The V1 Concept of Air Transportation Management*.

Other Issues Requiring Research

The intent of this concept paper is to begin a conversation about the advantages the commoditization of RE capacity and SSA capacity will hold for accommodating market-sustainable air transportation. In this pursuit, there will be many aspects of commoditization which would require deep analysis and consideration. Following are a few of the topical questions which would be targets of the research being proposed:

1. It is proposed that the commoditization of safe-separation airspace could augment the security of national airspace. Accounting for the consumption of granular units could add another layer of surveillance and tracking to already-existing security measures. Would this be useful? How would it be integrated?

2. Open skies treaties between nations will most likely become more prevalent as the air transportation industry becomes more globalized in the 21st century.

How will the consumption of commoditized airspace be accounted for across the borders of disparately controlled airspace?

3. How will the consumption of RE capacity and SSA capacity be accounted for, or levied on, the operations of international flag carriers at U.S. airports-of-entry? What would be the effect on international code sharing alliances that carry contracted U.S. seat & freight capacity onboard foreign-flagged air vehicles?

4. This concept paper has focused on the idea that the commoditization of RE capacity and SSA capacity should be regarded as a necessary augmentation to NextGen. But it must be recognized that NextGen will not remain as a stand-alone system in the world. As NextGen becomes integrated with the European SESAR system, how would the prospect of commoditization also become integrated?

PART V: 'The Future Inherent in the Present System' [7]

NEXTGEN IS A GREAT START…

The Next Generation Air Traffic Control System is being developed by a collection of federal agencies and private industries within the congressionally mandated Joint Planning and Development Office (JPDO). The impetus for development and implementation of NextGen can be found in the economic burden which current air traffic control measures have manifested on consumers of air transportation resources. Recall that congestion-caused delays in 2007 alone resulted in an estimated $41 billion drain on U.S. economic productivity. These delays also accounted for 320 million passenger-delay hours.

As NextGen progresses, it is seemingly responding to the symptom of congestion in the same manner as most previous efforts. The persistent answer has remained to simply increase capacity to accommodate current congestion, and hopefully forestall any anticipated or unanticipated congestion which may occur in the future. NextGen seeks to do this by fabricating expandable slack in aviation resources through the advanced application of real-time, satellite-based telemetric data, using net-centric communication procedures. This expansive undertaking will facilitate digitized cockpit to cockpit and cockpit to ground communications in an organic web, which will add greater autonomy for air vehicles to navigate FAA controlled airspace.

NextGen takes advantage of the positional accuracy inherent in the satellite-based global positioning systems (GPS) and the wealth of airspace information which will be provided through the Automated Dependant Surveillance – Broadcast system (ADS-B). The augmentation of GPS information with ADS-B information will allow air vehicle operators to navigate with greater autonomy, flying direct routes off congested standard airways, while consuming a smaller volume of airspace due to reduced separation requirements. In this manner, NextGen will conceivably provide air transportation operators with the break-through capability of flying 4D trajectories which will perfectly match the maximum propulsion and airfoil efficiencies of their air vehicles.

Other advantages of the GPS/ADS-B network within NextGen will include real-time, autonomous, cockpit-to-cockpit traffic de-confliction, and circumnavigation of developing weather systems. Another advantage will be avoidance of time-dependant restricted airspace. Ground traffic de-confliction of moving air vehicles on airport surfaces will be processed through the Airport Surface Detection Equipment – Model X system (ASDE-X), currently being developed.

[7] *Systems Thinking. Managing Chaos and Complexity*. Second Edition. Jamshid Gharajedaghi. Copyright 2006, Elsevier Inc.

…BUT NEXTGEN MAY ONLY BE PART OF THE SOLUTION

A Few Points to Consider
As described, the NextGen system will be a complete redesign of control technologies and accompanying procedures. The application of these technologies will increase aviation resource capacity by increasing both the volume (3D) and the throughput (T) of SSA, as well as the throughput in the airspace portion of runway environments. These technologies will also provide a new and powerful network of organic traffic de-confliction, which will also be a welcome improvement in air transportation. However, it is important to note the following points:

1. NextGen is not a solution for the hard constraints of runway capacity; the most constricting determinant of air transportation throughput.

2. In certain markets, multiple operators will desire consumption of the same 4D trajectory, or portions of it. This seems particularly so in crowded terminal airspace. Yet within NextGen, there is currently no market-based mechanism for reconciling this demand, or an accompanying system of accounting for transient consumption.

3. Taxpayer expense. As of 2006, the expected short-term cost of NextGen through 2012 was estimated at $4.6 billion. Mid- and long-term cost estimates were also developed based on a five-year picture which existed at that time. Total federal spending was estimated to range from $8-$10 billion through 2017, and $15-$22 billion through 2025. [8]

4. Industry expense. Cost estimates for equipping aircraft with NextGen technologies range between $14 billion and $20 billion through 2025. [9] Given the current state of the industry, the flow and ultimate outlay of this cost seems in doubt.

Capacity Expansion – The Tried and True (and Temporary) Solution
It seems apparent that, as the DOT and the FAA have done in the past, the JPDO also perceives air transportation congestion to be a problem solvable mainly through capacity expansion. Hence, for all of the superior and expansive technological advances NextGen will introduce, these technologies are seemingly being focused on solving the same old problem the same old way.

Historically speaking, the U.S. Department of Transportation, through the Federal Aviation Administration, has worked for decades to keep pace with the incessantly growing demand for the consumption of RE capacity and SSA capacity. We believe it is

[8] *Next Generation air Transportation System in Brief.* Joint Planning and Development Office, Washington, D.C.
[9] Ibid.

fair to state that this effort to provide ever-greater quantities of aviation resource capacity has been driven by a mindset of *capacity expansion and centralized air traffic control*, at the expense of *holistic, decentralized air transportation management*. As an example of this convention in a strategic context, the FAA National Command Center in Herndon, Virginia, perceives a need to conduct bi-hourly teleconferences with hundreds of representatives of the air transportation industry throughout each day in order to keep the entire system in check. This seems a true definition of centralized control. At the tactical level, air traffic controllers have been equipped and trained to use all manner of modern traffic control technologies and tools to mitigate congestion in their sectors, centers, and across regions. Scientifically-thorough human factors analysis has been conducted to determine the maximum error-free throughput of controllers using the most ergonomically efficient designs for their equipment and work stations. Without a doubt, all of these measures have been necessary and have successfully provided an elevated level of capacity throughout the national airspace system. And despite this continuous pursuit of expansion and control, the congestion continues.

The JPDO projects that NextGen will facilitate greater air transportation throughput capacity by a factor of 2-3 times over current measures by the time it is fully implemented in 2025. Yet, despite efforts to make NextGen scalable and expandable for the future, it is still important to ask: How long before these capacity improvements become over-burdened? Or worse: How long before the finite natural resources of atmospheric airspace and runway land area are themselves consumed by the expansiveness of NextGen?

The expanded consumption which the capacity-generating capability of NextGen may invite, coupled with the *finite* nature of the two primary aviation resources which NextGen will increasingly consume, are seemingly not being fully considered. Recall that virgin timber resources in North America were once perceived to be endless. Only after the original resource was consumed to its maximum utility was the timber industry forced to engage in *economically* sustainable practices. And this says nothing about the self-preserving necessity for the timber industry to adopt *ecologically* sustainable practices. There is a lesson here for the air transportation industry.

Aviation Resource Consumption Will Grow to the Limits of Fabricated Capacity…

The statement that NextGen will increase SSA capacity by a factor of 2 to 3 times by 2025 is and should be greeted as a welcome improvement. However, the delivery of this point, with the added indication that NextGen is being designed to be scalable and expandable, is seemingly used as a closing statement to portray the system as the end-game in air transportation congestion.

For context in examining this assertion, we'd like to introduce a parallel to highway infrastructure. What happens when a toll-free two-lane highway is replaced by a six-lane highway, thereby increasing capacity 2-3 times? It is fair to point out that in most cases this increased capacity leads to exhaustive consumption. Consider vehicular traffic on the toll-free I-495 beltway surrounding Washington D.C. when it was completed in 1964. Now, picture that traffic on any recent weekday at 4PM. Do you see a parking lot?

Recall the supposition expressed earlier that taxation on fuel is a poor inhibitor of specific consumer choice in deciding how, where, and when to consume what has been taxed; in this case, highway capacity. Also recall that when a resource is perceived to be 'free', as can be the case with a taxed resource, demand for its consumption becomes theoretically infinite and causes resource exhaustion. In the case of a toll-free highway, greater consumption is invited to the point of congestion (exhaustion of capacity or utility).

Now consider that in 2007 a new 14-mile length of variably priced high-occupancy toll lanes needed to be added ('scalable and expandable') to the I-495 beltway to ease chronic congestion. The total cost of this expansion was $1.9 billion.[10] Our conclusion in this example is that 'free' consumption led to over-consumption, which led to expansion of capacity, which led to the need to impose a direct cost on consumption. We propose that air transportation has arrived at the same point in its economic life.

Several more useful parallels to the future inherent in the pending 'Next Generation' design of air transportation infrastructure can be found in examples of highway infrastructure.

- Consider that in July 2008, U.S. Secretary of Transportation Mary Peters announced a "clean break" from the policy of using gasoline taxes to fund highway transportation costs. Instead, shifting the burden to road pricing and private-sector investment.[11]

- Recall that tax revenues on gasoline for the provision of highway infrastructure suffered a large decline throughout the summer of 2008. As the retail price for a gallon of gasoline topped $4 in many markets, consumers of highway transportation sought alternate solutions, or elected not to travel. While the retail price for gasoline was a natural inhibitor of highway congestion, the unexpected shortfall in tax revenue necessitated an $8 billion infusion from the government's general fund to keep critical highway maintenance projects from lapsing. We see a parallel in how will this might relate to the taxation of fuel for consumption of aviation infrastructure as air vehicles become more fuel efficient or ridership declines in a cyclical market.[12]

[10] *U.S. Department of Transportation Approves Nearly $1.2 Billion in Credit Assistance to Relieve Congestion on I-495 Capital Beltway.* U.S. DOT Press Release, FHWA 21-07. December 20, 2007.

[11] *Shocks Fail to Break Up US Car Love Affair.* Financial Times. July 31, 2008. Page 4.

[12] *Bush Ends Opposition to Highway-Fund Boost.* The Wall Street Journal, September 6-7, 2008, Page A7.

- Consider that the governor of the State of Pennsylvania is pursuing leasing the entire 537-mile length of the Pennsylvania Turnpike to private investors for almost $13 billion. This has been proposed as a solution for over-coming the highway's crumbling infrastructure, the ballooning pension obligations of the state's Turnpike Commission, as well as the state's reduced tax base. We see a parallel in how this might relate to federal funding of air transportation infrastructure. [13]

Getting back to air transportation once again, it is important to point out that in its annual market review for 2008, The Boeing Aircraft Company forecasted that 35,800 commercial aircraft will be in operation by 2027. This figure includes an additional 12,500 commercial aircraft over today's level of 23,300. This indicates a 53 percent increase in commercial air vehicles alone and is based on a $110 to $120 price per barrel of oil. (This price recently dropped below $80.) Depending on the average stage cycles each of these additional aircraft will impose on aviation resources, the impact on resource consumption could be greater. Add in other forms of air vehicles, such as the increased use of business jets, as well as the need to simply overcome *current* capacity shortfalls, and it becomes apparent that much of the 200-300 percent capacity which will be introduced by NextGen by 2025 has already been consumed.[14]

…And Fabricated Capacity will be Constrained by Natural Limitations.
Just as consumption of highway space grows to the concrete limits of its capacity within the constraints of available land, so does the consumption of RE capacity and SSA capacity grow within the constraints of land and atmospheric airspace.

Overlooking the obvious constraint to runway capacity which is imposed by land, some may erroneously perceive that the ambiguous vastness of airspace makes consideration of natural constraints unnecessary. In this case we need only recall that as shortly ago as January 2005, the entire upper route structure of the U.S. domestic airspace system, from FL290 to FL410 (29,000 feet to 41,000 feet above mean sea level), underwent the implementation of reduced vertical separation minimums (RVSM). This domestic operation was only one phase of a global implementation plan carried out by the International Civil Aviation Organization (ICAO) over the years between 2000 and 2008. For decades, the previous vertical separation minimum in U.S. domestic airspace had been specified by F.A.R.'s to be no less than 2,000 feet. This was due to the limitations of barometric altimetry technology. However, RVSM technology and accompanying procedures have allowed this separation minimum to be reduced to 1,000 feet. As a result, aircraft now routinely pass within this vertical distance of each other at closure speeds in excess of 1,000 miles per hour. Technology makes this a common and safe proposition and has served to increase controlled airspace capacity by making room for

---

[13] *Leasing of Major Toll Roads Puts States at Policy Crossroads.* The Wall Street Journal, August 22, 2008. Page A1.
[14] *Global Wealth*. Aviation Week & Space Technology, July 14, 2008. Page 78.

the addition of six new flight levels in the upper route structure. Yet despite this new capacity, the sky remains crowded. We are also compelled to ask two questions:

1. Are passengers truly paying for this level of development?
2. Is *500 foot* vertical separation with a lateral offset for wake turbulence next? If so, how much will the technology for ensuring the safe consumption of that capacity cost? And, how will it show up in the price for air transportation?

The V1 Concept of Air Transportation Management recognizes that the outward natural limits of atmospheric airspace and its division into ever smaller units are not its only limitations. Throughout the world, there will be limitations to the consumption of airspace imposed by other natural, political and social barriers. Some of these may include: carbon emission caps, engine noise, super-sonic pressure waves, national security and sovereignty issues, radiation in high altitude polar airspace, volcanic ash, and as always, weather systems. All of these elements, and no doubt several unforeseen, will detract from the vastness of natural atmospheric airspace to accommodate the volume and throughput which may be required of SSA.

There Will Be Many More Forms of Air Vehicles

The previous section briefly pondered some constraints to aviation resources as the consumption of these resources is *currently* perceived. However, several new forms of air vehicles, now being conceived or developed, may change the manner in which the primary aviation resources will be consumed in the future. As the development of these new forms of air vehicles continues to evolve, it seems prudent to consider the various forms of resource consumption which will occur. Like a growing number of pedestrians on *Segway* cruisers attempting to navigate six-lane highways, or highly specialized racing vehicles attempting to transit crowded suburban boulevards; in addition to merely consuming *greater quantities* of RE capacity and SSA capacity, evolving air vehicles will place a *greater variety* of complex demands on safe-separation services.

A list of vehicles with new designs on airspace consumption which have already begun to appear includes:

- Very Light Jets (VLJ's) and personal jets.
- 'On-demand' air carrier operations and air taxi operations.
- A 'super-heavy' class of airliners (Airbus A-380's) requiring *10 nautical mile* in-trail spacing by following air vehicles in terminal areas for wake turbulence avoidance.
- Autonomously-controlled Unmanned Aerial Vehicles (UAV's). The U.S. Air Force has recently increased its projected purchase of these vehicles to 78 units.
- Remotely Piloted Aerial Vehicles (RPAV's)

A list of vehicles which are likely to appear in the near future includes:

- Space tourism vehicles. Five of these are already being fabricated by famed air vehicle designer and 'X Prize' winner Burt Rutan, for Richard Branson's *Virgin Galactic* operation.

- Supersonic bizjets. Aerion Corporation currently holds 40 commitments for its developmental eight-passenger, mach 1.6 business jet.
- Large tilt rotor vehicles**.** The Karem Aircraft Company is actively pursuing concept development of a 120-passenger commercial tilt rotor capable of cruising at 0.6 mach in the upper route structure.
- Lighter-than-air vehicles. During the summer of 2008, the U.S. Coast Guard conducted trials in the Straits of Florida evaluating the re-emergence of blimps for coastal patrol. Also, a European enterprise is developing a LTA vehicle for industrial heavy-lift operations in the U.S.
- Autonomous UAV in-flight refueling tankers. The Northrop Grumman KQ-X project and the U.S. Air Force Research Lab's automated aerial refueling program are making this a reality.

And farther out on the time line:

- The Defense Advanced Research Projects Agency (DARPA) is currently engaged in developing a high-endurance autonomous air vehicle, (the 'Vulture') with the capability of loitering in flight for *five years*.
- Until October, 2008, DARPA was also engaged in developing a hypersonic air breathing vehicle as part of its 'Blackswift' program. Air vehicles in this class cruise in access of 5.0 mach. Although this program has been cancelled due to funding decisions, the joint French-Russian 'LEA' program has continued to develop this technology.
- The National Aeronautics and Space Administration (NASA), is currently engaged in the study of blended wing-body air vehicles for commercial short take off and landing application. NASA is also engaged in the study of low-sonic-boom technology which could enable development of a small commercial air vehicle capable of cruising at a speed ranging between 1.6 to 1.8 mach.
- All of these programs provide a hint of some of the radical changes in aviation resource consumption which may occur in the future.

There Will be Many More Passengers

As the world population grows, and as a greater portion of it obtains the means and the necessity to travel by air, it seems quite logical to assume that U.S. domestic air traffic will also grow. Secretary of Transportation Mary Peters stated in 2007 that U.S. domestic passenger load was expected to increase 33% between 2006 and 2015, topping 1 billion passengers.

PART VI: CONCLUSION

Looking Back at (Partial) Deregulation
Throughout this document, *The V1 Concept of Air Transportation Management* has made the following assertion:

Since the implementation of *The Air Line Deregulation Act of 1978*, the low cost of air transportation has been artificially sustained in three ways:
1. Over-consumption of nationalized primary aviation resources.
2. Cyclic infusions of private capital from non-sustainable and destined-to-be-bankrupt air transportation providers.
3. Federal subsidies for underserved and under-patronized markets.

This cycle is as follows:

1. *The Air Line Deregulation Act of 1978* made the low cost of air transportation non-sustainable by deregulating only part of the industry. The *free-market* provision of seat & freight capacity was detached from the *regulated* provision of nationalized primary aviation resources. We have identified these resources as runway environment (RE) capacity and safe-separation airspace (SSA) capacity. Taxation has been a poor governor of demand for both of these resources because it is displaced from the actual point of consumption chosen by the consumer. It has also been an inefficient enabler of supply. The end result has been that prices for seat & freight capacity have remained artificially low because they have not included the full cost for consumption of primary aviation resources. This has invited over-consumption of these resources.

2. By deregulating only seat & freight capacity, The Act set the stage for the sequential injection of capital into the air transportation industry in the form of under-capitalized or poorly conceived start-up enterprises (i.e. competition). This capital ultimately subsidized unsustainably low seat & freight transportation prices, at various times over the past 30 years. The enterprises which introduced this capital were sequentially swallowed by more sustainable competition from more financially robust enterprises.

3. The sequential and transient provision of under-priced and non-sustainable seat & freight capacity induced further pricing subsistence through the competitive cost restructuring it forced upon established providers of air transportation services. This free-market 'leaning out' of balance sheets subsequently caused most established providers of long-haul intercontinental service to take advantage of forgiving bankruptcy laws in order to satisfy creditors. This, in turn, further subsidized low seat & freight transportation costs through the termination of workforce pensions throughout the industry.

While consumers of air transportation have directly benefited from the discontinuance of traditional pension costs, these costs have merely been re-shuffled as a burden to *all* taxpayers in the form of federal collateral to the Pension Benefit Guaranty Corporation, as well as vastly reduced pension values to recipients.

It is also important to note that in addition to facilitating the non-sustainable infusions indicated above, the Act also facilitated the legitimate and game-changing growth of domestic providers of rapid-cycle, point-to-point air transportation. These air carriers became highly successful in applying this strategy to compete in the domestic feeder markets of intercontinental, hub-and-spoke networks. Pricing in these domestic feeder markets had previously helped to subsidize the long-cycle intercontinental operations of these established providers. The competition which was introduced by the rapid-cycle point-to-point domestic providers made this strategy non-sustainable. Intercontinental service providers investigated new low-cost methods with which to feed their hub operations. Some of the strategies adapted included partnerships with regional jet operators and code-sharing agreements with other hub-and-spoke operators. This process served to commoditized international air travel for most consumers through the cost reductions which followed at the intercontinental providers. However, it seems important to ask; What is the end-game in the exploitation of the point-to-point market strategy in a (partially) deregulated industry? As this environment is permitted to prevail, how will providers of intercontinental air transportation fill large transports with profit-facilitating consumers? Perhaps the answer lies in pending open skies treaties, point-to-point domestic service by foreign-flagged air carriers (cabotage), capital infusions through foreign ownership of domestic air carriers, or a combination of all three.

4. In domestic air transportation markets where even the most ill-conceived business models have dared not go, federal subsidies have been made available for the provision of services. This consumption of aviation resources has not normally imposed undue delays at the infrequently traveled outlier airports it targets. However, it does introduce non-sustainable over-consumption of resources in the high-density airspace of the major urban centers at the other end of these city-pair markets.

Are there anymore ‘pots of gold’ left with which to subsidize the artificially low cost of air transportation? Probably not at this time. If there were, the ten-or-so domestic air carriers which have gone bankrupt as a result of the current economic environment and the spike in jet fuel prices in 2008 would probably have found them. And for perhaps the first time since (partial) deregulation, the high cost of fuel has made it impractical for a new-entrant provider to temporarily under-price a market segment, hoping to amass a self-sustaining market share before running out of capital. As a result, there seemingly is no longer the hope of a temporary 'white knight' to cyclically save air transportation consumers from the long-overdue and necessary increase in air transportation prices which have now begun to rise. However, due to all the dynamics which have been discussed, we should be skeptical that prices will rise high enough to efficiently and effectively cover the cost of *all* resources consumed. This is due to at least two reasons. First, seat & freight cost structures remain detached from the cost of nationalized primary aviation resources. Second, in a *highly* taxed industry, air transportation providers will only be able to raise prices so far before hitting the threshold beyond which any further increases would cause a perilously elastic decrease in the quantity demanded for air transportation.

It's Time for a Paradigm Shift in Thinking about How the Two Primary Aviation Resources will be Consumed

The (partial) deregulation of the air transportation industry is non-sustainable. Due to the continued existence of RE capacity and SSA capacity as federally controlled resources, and due to the cost for the consumption of these resources being levied through displaced taxation, air transportation consumers have seemingly developed an unrealistic reliance on artificially low prices. As a result, consumers have shown great resistance to critically necessary price increases as well as the 'unbundling' of fares for the purpose of covering the hard cost of aviation fuel, even as they have witnessed for themselves the increased cost of pumping their own gasoline. It also seems probable that this unrealistic reliance on artificially low air transportation prices is a defective underpinning supporting secondary travel industries such as hosting, tourism, and auto rental.

It's time to start over. The V1 Concept of Air Transportation Management proposes that it is time to stop simply increasing capacity, in parallel with a mindset of centralized traffic control. This is seemingly an inadvertent means for accommodating the economic inefficiencies and financially un-reconciled growth of a (partially) deregulated industry. In order to build a sustainable air transportation system, which will serve as a stable foundation for continued economic development, the capacity of primary aviation resources must be released to the free market. In addition, the cost for the consumption of these resources must be directly reflected in the cost of air transportation to the end-consumer in replacement of federal taxation. The technology being developed for NextGen is a step in the right direction, but will only serve to hide the underlying economic flaw in air transportation pricing if it increases capacity without directly charging the end-consumer for the increased demand it will invite.

Moving Forward From Here

Velocity 1 LLC intends to pursue formation of a non-profit research entity for the purpose of conducting federally sponsored research into the effect *The V1 Concept of Air Transportation Management* would have on the air transportation industry, the U.S. economy, and overall GDP. Some specific questions which would be the target of this research would include:

1. What are the true dynamics which define the aggregate supply and demand functions for all three determinants of air transportation throughput? In other

words, what are the true shapes of the supply and demand curves of these three determinants?

2. Precisely how does the market equilibrium quantity for air transportation seat & freight capacity impose on the supply functions representing RE capacity and SSA capacity?

3. What is the actual difference between the *market* equilibrium quantities for RE capacity and SSA capacity and the *imposed* equilibrium from detached seat & freight capacity?

4. By what dollar amount would the unit-adjusted free-market price paid for the consumption of aviation resources by the end-consumer change from the prevailing price for air transportation, including all taxes?

5. What is the difference between the present value of continual losses in economic productivity caused by aviation delays, verses the present value of projected costs of implementation of a market-based design for resource consumption?

6. How would the transition from a tax-based nationalized infrastructure to a free-market-based utility be conducted? How long would the transition take? Would there be any uncovered exit costs from the nationalized infrastructure?

7. What technological capabilities currently exist for use in allowing NextGen to include a function for accounting for the market-based consumption of primary aviation resources? What capabilities would need to be developed? What are the costs? What would be the *specific* benefits to the air transportation industry, end-consumers, and the U.S. economy in general?

8. How would a market for the trading of 4D trajectories be structured? How would it function? What entity would govern it? Who would be permitted to participate in such a market?

9. How would the minute-by-minute re-bidding of 4D trajectories be accomplished in a free-market environment when weather consumes planned trajectories? Is there an existing model in commodities trading which can be adjusted for use?

Albert Einstein has been quoted as having once said “We can't solve problems by using the same kind of thinking we used when we created them.” This seemingly pertains to the chronic problems which face the air transportation industry. Ever-greater ‘free’ capacity continues to lead to ever-greater over-consumption in a repetitive cycle of thinking and economic behavior. This has not succeeded in mitigating air transportation delays in the past. Is it appropriate to have faith that it will succeed in the future?

- End -

List Of Abbreviations

2D	Two dimensional
3D	Three dimensional
4D	Four dimensional (3D plus time)
ATC	Air Traffic Control
DOT	Department of Transportation
FAA	Federal Aviation Administration
F.A.R.'s	Federal Aviation Regulations
ICAO	International Civil Aviation Organization
RE	Runway Environment
SSA	Safe-separation Airspace
T	Throughput

Acknowledgements

Grateful appreciation is extended to the professors of the Villanova University School of Business, Executive MBA Program; for providing the tools for initiating this project.

Special recognition and appreciation is extended to Jamshid Gharajedaghi, Managing Partner and CEO of Interact, The Institute for Interactive Management; for providing the inspiration to conceive of new ideas and the Systems Thinking Methodology for building them.

Sincere gratitude is extended to Russell Rosa and R. Blake Edmonds of Q-Max Technologies, LLC; for their unending support and devoted guidance in transforming ideas into existence.

This effort is dedicated to Laura, Kaitlin, and Grace; for their boundless love and patience.

About the Author

Scott Davies has been a career aviator for 25 years. He is a retired U.S. Navy officer and naval aviator. He is also an FAA licensed Air Transport Pilot. Mr. Davies holds a Bachelor of Science degree in finance from the Rochester Institute of Technology, and is a 2008 graduate of the internationally ranked Executive MBA program at Villanova University. He is the founder of Velocity 1, LLC.