The Network Airline Production Problem

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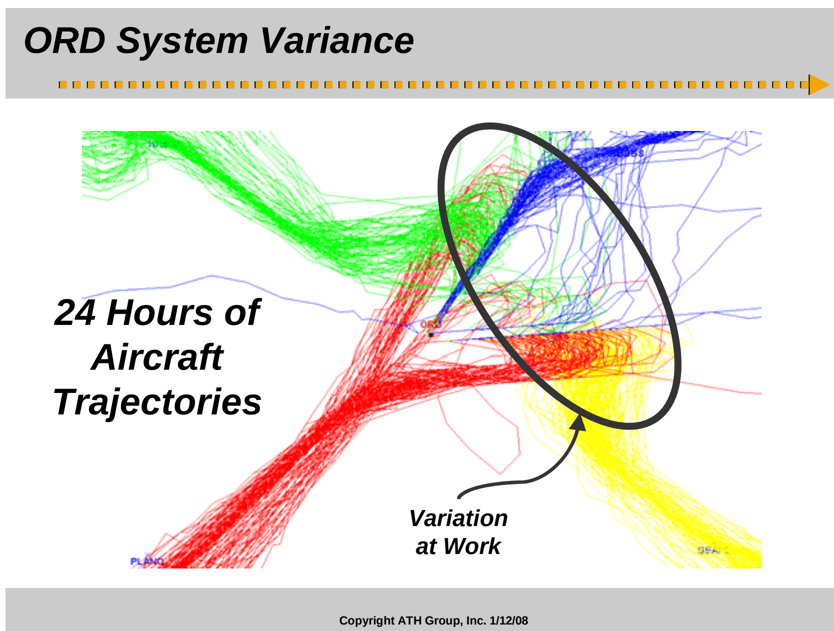
The real problem, **the core issue strangling the hub and spoke model is operational production variance** created by "randomness and chaos" driven by independent action and local optimization. The negative effect of the variance inherent within today's hub and spoke operation impacts the airline's bottom line annually by **upwards of 10% to 20% of total costs** or more.

The first question most will ask is, "What is production variance"? Well, variance is many things. For example, variance is the extra wide bell curve of actual arrival time around the scheduled arrival time, or the different temperature of the meals, or the time the agent shuts the door, or the speed the pilot flies, or waiting for a gate and then waiting for a marshaller to guide the aircraft in, or agent to open the aircraft door, or a pax getting off a B777 in business class and then getting on an RJ. All of these and hundreds more are variance, the single thing that is killing the network airlines and something the airlines have yet to fully understand or measure.

The next obvious question, "What has variance got to do with the airline financial problem"? The short answer is money. In a article discussing variance, Dr. Henry R. Neave (W. Edwards Deming Professor of Management, Nottingham Business School) wrote, "Well, let us consider when you buy a product, or a service, or you are engaged in a service operation, or a manufacturing process, or administrative process, etc. Does it always work smoothly, the same way, take the same amount of time - so that you can either do, or experience, a perfect job? That would be very rare. Or does it work fine one day, but have nasty surprises for you the next? That's variation, or variability. Variation is nasty: it makes things difficult, unpredictable, untrustworthy: bad quality. Good quality is very much related to reliability, trustworthiness, and no nasty surprises. In a big way, bad quality means too much variation, good quality means little variation."



As queuing theory predicts and an in depth analysis of actual aircraft flows at numerous congested airports shows, the time in queue and the associated variance increases where network airlines need capacity most. And unfortunately, the amount of variance in the airline production process is large and growing. Left unchecked, variance will continue to decimate airline after airline.

And the worst enemy the network airlines face is time. Given the fragile financial condition of the network airlines, they either rapidly mitigate the variance eating away at their bottom lines or they follow Pan Am, Eastern and Braniff into aviation history. As for downsizing or linearizing their networks, above and beyond the fact that a properly operated network model is the most profitable, time prevents network airlines from reorienting their business models to compete in Southwest's playground.

Unless something is done, and done quickly, the network model will continue its downward spiral. While some free market advocates believe that this is a good thing, it is not. The hub and spoke model is not only the best airline business and transportation model (passengers and cargo), it is also the best model for both the economy and the traveling public.

Unfortunately, as currently operated, the hub and spoke model is unsustainable. Further, the following list of problems, most of which stem from those "nasty surprises" mentioned by Dr. Neave, are actually the visible symptoms of the huge amount of variance within the network airline operation. Therefore, these problems can only be corrected by removing the underlying problem creating these symptoms - variance.

- Underutilization of assets, overutilization of consumables, i.e., higher fuel burn
- Customer's view of the airline seat as a commodity
- Low employee success, low employee morale
- Decreased product quality, no product differentiation
- Less satisfied customers, lower customer expectations
- Lack of pricing power, price driven costing
- Ever increasing block time
- Less system throughput/productivity
- Increased cost of production, higher labor costs
- Increased production of green house gasses (CO_2/NOX emissions)
- Randomness and chaos, collapse of the static processes
- Just in case operation, numerous last minute changes required

Too Much Noise

In today's Six Sigma, Just-in-Time, Supply Chain managed world built through order, predictability and consistency of process, the way the hub and spoke model is operated today generates the opposite – randomness and chaos. In effect, although the hub operation is not designed to fail, given the local, independent optimization of each element of the hub system, it is guaranteed to fail all too often. As W. Edwards Deming taught, "Trying to optimize within the noise not only doesn't help, it hurts". (*Necessary, but Not Sufficient,* Dr. Eliyahu Goldratt). Sadly, the network operational model generates far too much "noise".

And while all airlines, including Southwest, face this problem, it is the large network airlines that are affected most - effectively a reverse economics of scale. As an airline increases in size and complexity (i.e., large, interdependent hub and spoke operations), the negative effects of variance within the system expand dramatically. And while the costs associated with the high levels of variance are considered by most to be inherent within the hub and spoke model, they are not. Not only can much of the variance be removed from the network model, it is required for survival.

Yet, instead of processes to prevent randomness and chaos, the current hub and spoke schedules, by funneling all arriving and departing aircraft into a very small time frame, assure that randomness and chaos will reign. Further, the more hubs an airline has, and the greater the congestion it must navigate around and through, the greater the variance generated, exponentially driving cost higher and quality lower.

The end result is that the variance created by local optimization and independent action greatly increases the network airline's cost of production, destroys morale and forces product quality down to the lowest common denominator, such that the customer is no longer willing to pay a premium for what should be a superior product.

To understand why this is true, one must first realize that an airline is nothing more than a relatively simple, interdependent, geographically dispersed manufacturing process. Airlines take in raw materials (people, bags, cargo, fuel, etc.). Apply numerous processes to these materials (work in process inventory). Then deliver the finished product (passenger/cargo) to the destination curb. Like all manufacturing processes, managing all of these interdependent flows of materials such that the right part is at the right place at the right time is critical for profitability.

Why Hub and Spoke?

The most obvious next question is if the hub and spoke is so inefficient, why not abandon it for a linear system like the Southwest's original route system? Why not just depeak airline schedules?

The first and most important answer is revenue. The network model generates more revenue than a linear airline model. Mr. Crandall (former AMR CEO) has stated that American's network schedule generated 20% more revenue than Southwest. While this number is decreasing given the reduction in the quality of the network product, the economic leverage of the hub and spoke model to provide transportation with a single flight to 50 to 60 destinations is very large.

In fact, given the revenue positive aspects of the hub model, **airlines should increase their scheduled arrival peaks**, not flatten their arrival peaks as is being done today. Unfortunately, the associated cost of increasing scheduled arrival peaks, although entirely solvable, is driving the hub airlines to the wrong action - decreasing arrival peaks and therefore, revenue.

The next factor is customer demand. There are simply not enough customers to support a nonstop flight from Des Moines to Fresno, or many other small communities. Only a hub network can offer reasonably priced service between many of these small cities, as well as international destinations.

The third factor is the economy. The air transportation system is part of the lifeblood of the world's economy. For example, current estimates put the air transportation system at upwards of 6% of the total US Gross Domestic Product. As the world has adopted more time critical processes, having the right part at the right place at the right time is essential for profitably. An ongoing failure of the network airline business model will have a significant negative economic impact in every industry throughout the world economy.

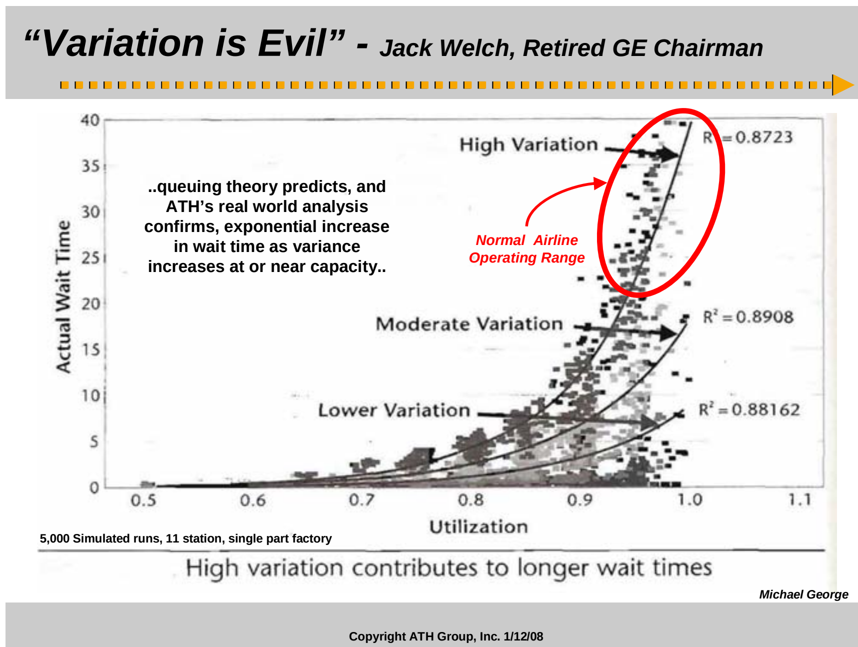
And, finally, as discussed above, the hub and spoke airlines do not have the time to alter their basic business model. The network airline asset base is built around the network business model, such that they have far too many assets for a depeaked or linear system. And even if the network airlines could shed their large network driven asset base quickly, too many of these assets have little retained value in today's environment.

The major problem with system variance is that almost all of the company's operational processes are negativity impacted. Of course this is also a good thing, since when most of the production variance is eliminated, which can be accomplished much more rapidly than most believe, all of those operational processes automatically become more efficient.

The following are some of the larger cost and revenue areas affected by the variance so prevalent within the current hub and spoke operation.

Cost of Production

First, as any flow of materials becomes more and more random and chaotic, additional production buffers must be added to accommodate the resultant variance. Unfortunately, the easiest way to buffer the airline production process within the current hub and spoke operation has been to add block/gate time. This creates a significant time and inventory problem, well understood by the Supply Chain community, but not on the radar within the airline community.



In some cases in the northeast United States, to improve operational performance, block time is 1.5 to 2 times higher than needed. As is obvious, adding 15, 20, 30 or more minutes of block time to what should be a 1 hour flight is a very expensive method to mitigate the effects of variance, driving the hub airline's cost of production skyward. This alone accounts for the larger portion of the hub airline's cost problem. For example, if a medium size airline (1,500 flights/day) adds 10 minutes of buffer time to the scheduled block time, this increases crew costs by over $30 million annually, and this is just the tip of the buffer/defect cost iceberg.

Next, a random flow of materials always requires more "stuff" (assets and labor) to operate. An aircraft lands and waits for a gate, while gates assigned to aircraft that have yet to arrive stand empty. Cleaners wait for an aircraft that is 12 minutes late, while another aircraft that is 8 minutes early waits for cleaners. Cargo is left at the gate because a weight problem, that although resolved, was not relayed to the proper personnel. An early aircraft sits and waits for a marshaller to aid with final parking, and then waits for someone to position the jet way and open the door. Because flight attendants are delayed inbound, the boarding process for the next aircraft is delayed and the aircraft departs late. One only need look around an airline hub to see the large amount of assets sitting idle. All of this "stuff" standing around "just in case" is expensive to purchase, requires additional labor, fuel and material to operate and repair, all of which adds significantly to the airlines cost of production.

Finally, the ATC system's response to random flows also has a negative effect on airlines costs. Given that the ATC system is a 2 dimensional, locally managed, manually operated process, the only response to more and more traffic is **more and more structure**. As structure is added, the aircraft flow is linearized farther and farther from the end of the runway. While this mitigates part of the ATC controller's problem, it forces airlines into longer and longer queues that further increase the randomness of the arrival flow. This structure and the resultant queuing forces airlines to add even more block time to fly from A to B. And again, adding block time drives up costs.

"Just In Case" Production

As the manufacturing world has turned to "Just in time" and "Build to order" production processes to reduce costs, airlines have been forced to build costly "Just in case" processes. Unfortunately for the network airlines, the unpredictability of their operation forces each manager at each stage of the airline production process to add buffers to protect their part of the process "Just in case".

Since airline schedulers don't know exactly when the aircraft will arrive, they add extra block and gate time "Just in case" the aircraft is a few minutes late. Since pilots don't know the arrival congestion, they add fuel to the flight "Just in case" they have to hold at the destination. Since reservations agents don't know how many passengers will show up, they overbook "Just in case". And on, and on, and on…..

This "Just in case" mentality permeates throughout the entire network operation such that it drives an already high cost of production higher.

Defects

One of the most serious side effects of the variance airlines accept as normal is the cost of the staggering number of defects created, defects that must be corrected. The "hidden factory" of defect correction adds a huge amount of cost to the airline production process.

As an example of the costs associated with defects, if we use the medium size airline again (1,500 flights/day, $10 to $12 Billion in revenues)), passenger flow per day averages around 140,000. Based on DOT statistics, airlines deliver 20% of the passengers 15 minutes late or later. Of these it is reasonable to assume that 10% of the passengers, or 14,000 per day, they must be rebooked, redirected to a new gate, overnighted, their bag must be found and sent after the fact or in some way retouched by the airline customer service agent.

Conservatively, if we assume 10 minutes of rework time per passenger, $15 per hour labor cost, overnight costs, etc, again, the annual bill for correcting these defects is over $30 million. Over $30 million for addition crew costs (for buffers), over $30 million for misconnects (defects); in other words, over $60 million per year to correct what should have been prevented in the first place. And this is a conservative estimate, with the actual cost a minimum of 3 to 4 times greater once all of the costs are calculated. For example, In Philip Crosby's book, "Quality is Still Free", he states that, "In those industries (service industries) the price of nonconformance is 40% of operation costs". Surely, no one would argue that airlines conform.

In other words, airlines are drowning in a sea of defects that is eating them out of house and home. And while it might be expedient to blame the weather, the Air Traffic Control system, or a host of other causes, these don't prevent the defects, nor does it get the passenger to the destination curb, on time faster better and more profitably.

Sadly, the airline's focus is correcting defects, not preventing defects. Correcting defects adds costs, preventing defects adds profit.

Revenue

The first problem on the revenue side with system variance is lower product quality. As variance increases, the passenger and/or cargo is less likely to be delivered to the destination curb on time, and, therefore, the less the customer is willing to pay for the product. Lower perceived value is directly related to pricing power, or more accurately, the lack thereof. As described by George Eckes (*Making Six Sigma Last*), "Customers feel variation, not averages".

The "new pricing paradigm" so often mentioned by airlines today is not that the airline customer is unwilling to pay higher prices for an airline seat, but that they are unwilling to pay higher prices for an airline seat that is unpredictable, with ever decreasing quality. To see the level of product quality now prevalent within the airline industry, one only need watch CNN or the Weather Channel for hourly reports on airline defects (i.e., airport delays). Any industry that delivers 40% of its product late (on time zero), has a serious quality problem. This is the primary reason airlines are unable to raise fares.

Another very visible symptom of low airline quality stemming from the variance inherent within the current operating model is double booking. While some of this is based on the passenger's inability to predict their airport arrival time (i.e., the length of a business meeting), much also has to do with the poor performance of the airline. Given that 40% of the airline customers are delivered to their destination late (on time zero), customers, especially business customers, book seats on 2 or more flights. Since the customer can only use one seat, to prevent the other seat from going empty, the airline over books the flight. Unfortunately, many times the airline overbooks too much (customers are left behind) or too little (the fight departs with empty seats) further lowering revenues (free tickets), while decreasing quality (unhappy customers).

Finally, the biggest revenue problem with system variance is the reduction of system throughput. As block time is increased to combat variance, it increases the scheduled production time of the aircraft asset. Using the manufacturing analogy, while the manufacturing industry is working flat out to increase system throughput by increasing inventory turns, lowering production run times and improving quality with Six Sigma initiatives, the airline industry continues to fall further behind in these important profit initiatives. According to Andy Chatha (ARC Advisory Group Inc., a manufacturing consultant), "the inventory turn ratio is particularly critical in industries that face significant pricing and competitive pressures, low margins and fast obsolescence rates". Sound familiar?

Therefore, when an airline adds 10 minutes extra block time to fly from A to B, not only is the segment cost increased and the product quality lowered because the work in process inventory (i.e., passengers/cargo) is sitting idle too long, but the additional scheduled block time (i.e., buffer time) is aircraft production time that can not be used for producing additional products from B to C (lost opportunity cost).

In manufacturing terms, if Factory A produces 5 widgets per machine per hour and Factory B produces 10 widgets per machine per hour, all other things being equal (quality, labor, marketing, etc.), Factory B wins every time. Or more to the point, if a Southwest's B737 generates 40,000 ASMs/hour and a network airline's B737 generates less than 30,000 ASMs/hour, all other things being equal (perceived value, etc.), given the customer's perception that the value proposition of all airlines is identical, Southwest wins every time.

This airline throughput problem is further compounded within the hub and spoke schedule because of the need to connect to the hub. For example, if an airline adds 10 minutes to the outbound leg (hub to spoke) and 10 minutes to the inbound leg (spoke to hub) to accommodate system variance, the flight may not have enough time to make it back to connect to the arrival bank at hub. The result is that the aircraft is scheduled to sit longer at the spoke waiting to takeoff at the correct time to reconnect at the hub. And as is obvious, parked aircraft make no money.

Further, as airlines chase up-market margins and profits, they abandon the low/entry markets to new entrants. This allows the new entrants a foothold in the market, from which they eventually must grow up-market. This up-market mentality, although completely rational and a sound business practice, meant to increase revenues actually decreases revenues by allowing and enabling the deadly low cost attacks from below. As proof, one only needs to look at Southwest march from it's roots as a low cost Texas airlines to it's expansion into BWI, PHL, etc.

In Closing

Since the 1980s, increased production time has been the network airline's only answer to the ever-increasing variance within their operations. Unfortunately, this only masks the problem and does nothing to solve the problem.

Yet, until the early 2000s, airlines could easily pass on the higher production costs associated with increased block time to their customers with little resistance. This was true, even in the face of decreasing product quality (delays and congestion), especially in the late 1990s.

Then, after 9/11, with the resultant drop in demand and therefore revenues, airlines reacted by cutting services, further lowering the perceived value and quality of the airline product. In turn, customers reacted rationally and refused to pay a premium for what they viewed as equally low quality for any airline seat. The end result is that the network airlines find themselves in the worst possible predicament - high costs and low quality leading to lower revenues.

Variance is the root cause of most of the financial problems facing the network airlines. Variance lowers product quality. Variance requires more block time. Variance requires more aircraft. Variance requires more gates. Variance requires more pilots. Variance requires more fuel. In fact, variance always requires more of everything, while always reducing product quality.

Finally, solutions exists that can solve the network airline variance problem such that schedules can be increased and tightened. The network airlines must recognize, define, measure, analyze, improve, control, standardize and integrate system processes to eliminate the variance within their operations, to get off this downward slide.