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Network Airline Production Problem

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For over 30 years, in spite of their best efforts, the financial health of the network airlines has continued south. Contrary to conventional wisdom, the fundamental problem pushing so many airlines towards the brink is not the hub schedule, weather, fuel costs, ATC/FAA, congestion, delays, nor even unit wage rates. These are just the visible symptoms of the real problem. The underlying cause of 80% of the airline industry's financial problems is production variance. Production variance within the daily operation, especially at the hub airports, represents the fundamental flaw within the current airline production process (over 35% of the customers delivered late) that, over time, will decimate airline after airline. Yet production variance, the inability to consistently deliver a quality product, is not measured, quantified, nor is it clearly understood. To first understand, and subsequently solve this problem, one must first forget it's an "airline" problem. Conversely, think production, think right part, right place, right time (smiling pax, bag/cargo, destination curb, on time). Think of this as a flow of materials problem. Think Henry Ford (current airline production process) versus Toyota (required airline production process). For example, by adopting industrial engineering principles outside the mainstream thought process - concepts promoted by Deming during the post WW II era of the 1950s post-war Japanese reconstruction, Toyota embraced lean production. Based on Deming's principal of "build the process that gives the right answer, first time, every time" (i.e., right part, right place, right time), Toyota leapfrogged Henry Ford's/Detroit's production processes from the 1970s right up to the early 1990s, when the Big Three belatedly woke up and smelled the coffee. Yet, the initial auto industry reaction to such outside the box ideas was quite predictable. Those who approached the big three in the 1970s and suggested "just-in-time" as a manufacturing philosophy, were quickly shown the door. Even now, although close to Toyota, Detroit is still lags behind. Toyota continues to make a higher quality car less expensively. The unfortunate outcome is that in 2007 Toyota is poised to overtake GM's 75 year dominance as the largest automobile manufacture in the world. What would automobile manufacturers give to go back 40 years and say yes to such radical ideas as JIT, Supply Chain, etc.? Will the business press say the same about the airline industry 10 to 20 years from now? It is clear that airlines need a new direction, or actually an old direction. We continue to go back to W. Edwards Deming, whose theory is that the only way to reduce costs is to improve quality. And one of the fastest ways to improve quality is to significantly reduce the large amount of production variance airlines now incorrectly accepted as "normal" within their operations (over 35% of your product delivered late is definitely not normal). In summary, it is not the network peaked schedule that drives up costs, decreases utilization and limits revenues through poor quality, but the network operation, which represents a relatively simple, and solvable logistics problem.

Introduction

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 network 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 large 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 recent 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

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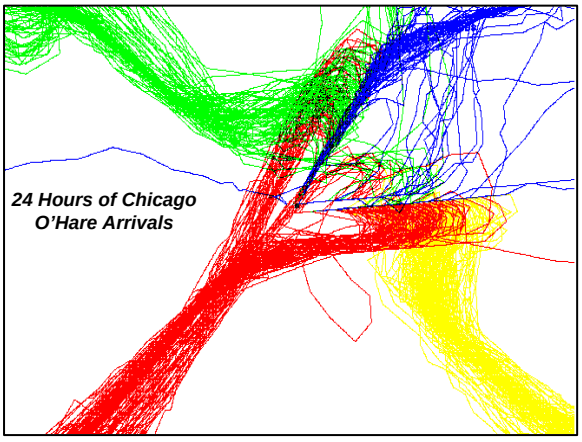
perfect job? That would be very rare. Or does it work fine one day, but have nasty surprises for you the next? That's variation, or variability. Variation is nasty: it makes things difficult, unpredictable, untrustworthy: bad quality. Good quality is very much related to reliability, trustworthiness, 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.



That said, 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, over utilization 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
- 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, i.e., Delta, US Airways, United and American, 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, thus lowering costs and improving quality, 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 (i.e., United), and the greater the congestion it must navigate around and through (i.e., US Airways), 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. One small problem, so many negative results.

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), and then delivers 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 Southwest's? Why not just depeak airline schedules to avoid the problem?

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.

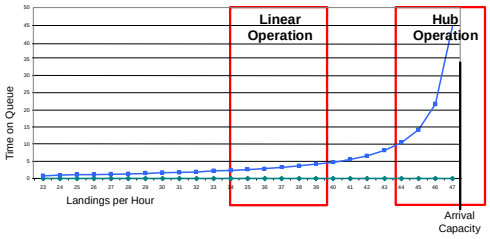
The next factor is customer demand. There are simply not enough customers to support a nonstop flight from Des Moines to Fresno, or many other small communities. Only a hub network can offer reasonably priced service between many of these small cities, as well as international destinations.

The third factor is the economy. The air transportation system is part of the life blood 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

Problem - Variance

..queuing theory predicts and analysis of actual aircraft flows shows that the effects of variance get worse in the range where hub airlines need capacity the most ..



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.

That said, 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.

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 which further increases 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.

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".

That said, 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 which delivers its product late 35% to 40% of the time (on time zero) has a serious quality problem, which 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 passengers 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 35% to 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. And 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 20 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.), Southwest wins every time.

This network 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.

Conclusion

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.

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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 equal 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.

Given the logistical nature of this problem, i.e., right part, right place, right time, solutions exists that can solve the network airline variance problem such that schedule peaks can be increased and tightened, while block time is reduced and operational efficiency can be dramatically improved.

That said, until the network airlines recognize, define, measure, analyze, improve, control, standardize and integrate system processes to eliminate the variance within their operations, they will continue their downward slide.