Aviation Needs a New Direction — Driven by Vision and Leadership

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Most incorrectly believe airline delays and congestion are an impossible task that can't be fixed because:

- It's an Air Traffic Control (ATC) problem
- There are too many variables
- There are too many things airlines can't control
- It's too expensive
- We need new technology
- Airports are full
- There is nothing you can do when a thunderstorm pops up
- Airlines are doing everything possible to fix delays
- NextGen/SESAR (ATC proposals) will fix airline delays
- Fill in the blank ___________________________

WHILE THIS IS what many believe, it is 100 percent false. Of course, many of these things impact delays, but they aren't a constraint to eliminating most delays.

GOING ONE STEP further, a big part of the airline refusal to move to "*day of*" ***OPERATIONAL EXCELLENCE*** (85 percent A0[i], <3 percent Standard Deviation of day to day on time zero arrival (A0), eight to 10 minute scheduled block/gate time reduction per flight), which requires delays to be drastically reduced — can be found in a quote attributed to Mark Twain:

> *"It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so. "*

For example, in spite of independent evidence to the contrary, airlines know for certain that:

- Airline ***OPERATIONAL EXCELLENCE*** can't be achieved — citing weather, ATC, too many variables, too many things out of airline control (*false*)
- Airline ***OPERATIONAL EXCELLENCE*** is too expensive — not profitable (*false*)
- ATC prevents airlines from reaching ***OPERATIONAL EXCELLENCE*** — ATC is going to fix airline delays/cancelations (*false*)

Additionally, airlines fear dramatically increasing hub efficiency will open up landing slots. While this is true, airlines miss the point that more efficient hub operations, while opening up possible landing slots, would put the hub airline in an elevated competitive position (like Toyota in the 1990s) — they would crush any competitor.

While the cost of airline delays and congestion are huge — the good news is there's an independently validated (FAA, Embry-Riddle University, etc.) system solution available today that dramatically improves on-time performance, recapturing 50 percent of an airline's annual delay losses starting within months — and taking the pressure off ATC. Unfortunately, the bad news is airlines aren't interested.

Airline Delays Can't Be Fixed Because ________________?

OK, let's go straight at the false reasons why delays and congestion can't be fixed:

1 Delays and congestion are an ATC problem: During my 40+ years as a pilot, I worked on airline operations, ATC, and logistics issues. During that time, ATC literally spent 100s of billions of tax dollars during decades of efforts chasing technology to fix delays — and didn't come close to reaching the stated goal of significantly increasing airspace/airport efficiency.

This alone should convince everyone ATC will never fix delays/congestion. But there's an even bigger reason ATC can't efficiently fix delays — it's not ATC's job to make business decisions. For example, in a queue of 10 tightly packed aircraft from the same airline approaching the hub, which aircraft should go first?

Factors to consider include schedule, connections, gate availability, ramp assets, fuel, weather, diversion possibility, crew legality, maintenance, etc. Only the airline has the data to determine which is the "*right*" aircraft to move forward in the queue and which is the "*right*" aircraft to move backward, especially when balancing the goals of 10 to 20 other aircraft trying to land around the same time.

In fact, with the exact same data, two different airlines will probably make different business decisions, so how can ATC ever make an informed, efficient decision? The answer is — ATC cannot.

2 There are too many variables: Yes, there are too many variables days or weeks prior to a flight, but "*day of*," two to five hours prior to landing, the situation changes dramatically. What most see as "*day of*" variables are available — but unacted upon data.

Many times, shortly after takeoff from Hong Kong to San Francisco — with limited access to data — I could determine my landing runway, the weather, and have a good guess about the landing queue given my landing time.

Add in the information the airline has readily available: FAA and EUROCONTROL data showing aircraft position/altitude/speed/intent, aircraft position/weather data from the aircraft, Automatic Dependent Surveillance (ADS-B/C), ramp data from the airline, aircraft to ground digital data link (CPDLC), local radar data, accurate weather, etc.

Hours prior to landing, the variables dwindle close to zero. In fact, the next time you fly, consider the variables of your flight and you'll find very few. Of course, we can't know everything — like a blown tire closing a runway — but events like these are few.

3 There are too many things airlines can't control: This is simply not true. Airlines can't control weather, other airlines, an emergency, etc., but these impact maybe 10 to 15 percent of an airline's operation, leaving upwards of 85 percent of airline operations an airline *can* control — yet does *not*.

4 It's too expensive: Airline delays cost individual airlines billions annually. Add in the costs to passengers and the economy — and costs soar upwards to $100 billion annually[ii]. The cost of fixing airline delays and congestion pales in comparison to not fixing this decades old, very fixable problem.

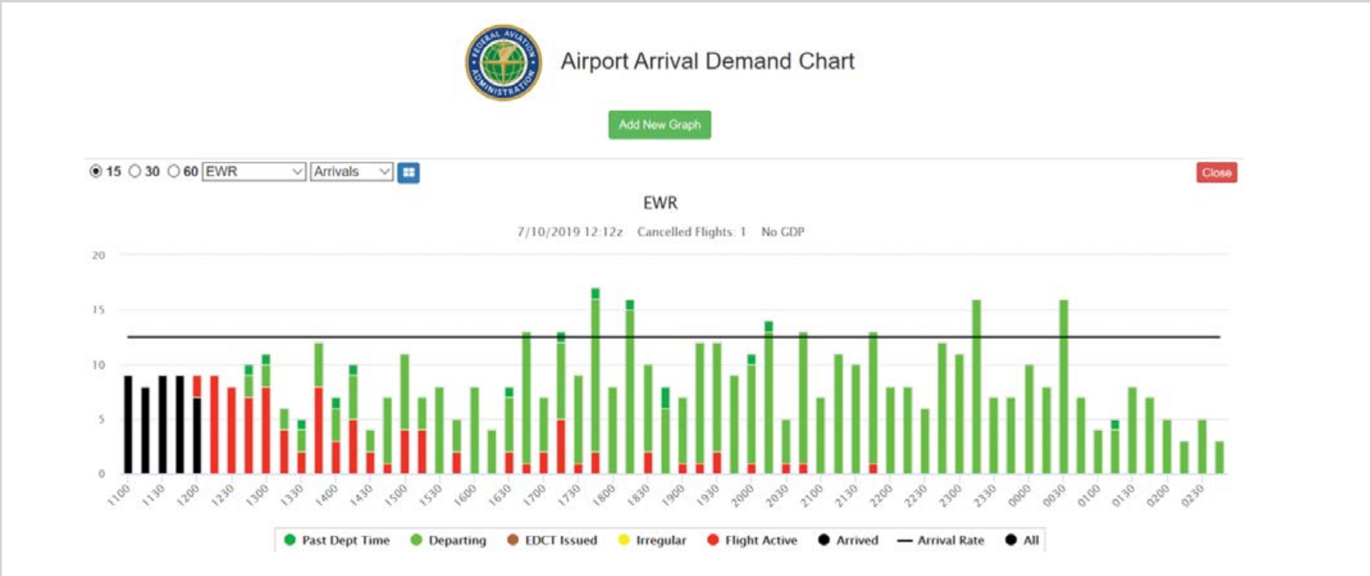
5 We need new technology to fix anything: This is simply not accurate. For example, ATC has been working on the "*next great technological breakthrough*" for decades going through a host of alphabet soup programs like the 1970s Microwave Landing System (MLS, cancelled); FAA's 1980s Advanced Automation System to rebuild the ATC system (AAS, cancelled); FAA's early 1990s downsized AAS rebuild proposal Initial Sector Suite System (ISSS, canceled); onboard navigation (RNAV); Global Positioning System (GPS); aircraft Traffic Alert and Collision Avoidance System (TCAS); Future Air Navigation System (FANS); Controller–Pilot Data Link Communications (CPDLC); Automatic Dependent Surveillance-Contract (ADS-B/C); and now NextGen and SESAR — with little to no improvement.

All the required technology already is in place in aircraft and on the ground to dramatically reduce delays and congestion. Let's use the toys we've already installed and paid for to develop new processes before spending billions on new, untested and yet-to-be-developed technology.

We need a solution now — we can't keep waiting for highly complex programs such as Artificial Intelligence, complex airspace structure, new technology, etc. to solve delays. This doesn't mean stopping research, but it does mean building new, more efficient processes with the tools already in place — currently not a focus for anyone.

6 Airports are full: Simply because you're on a 25-mile final doesn't not mean the airport is full. All a 25-mile final means is the airport is overloaded at that time. Consider that even Boise — which no one would call full — is overloaded when two aircraft want to land at the same time.

As you can see in the Newark diagram[iii], efficient, on-time capacity exists, but it's forward in time. And this *is*



Newark — arguably, one of the most delay-ridden airports in the US. No weather[iv], no capacity problem, but Newark's on time zero arrival (A0) is 71 percent[v]. There is a systemic delay bias (variance) in arrivals not attributable to weather, schedule, or capacity (variance).

Other "*so called*" congested airports (Atlanta, Los Angeles, San Francisco, Chicago, etc.) show even more capacity forward in time. In fact, most congestion around airports is a *symptom* of unmanaged, highly random aircraft arrival flow — obvious hours prior to landing when it can be prevented (defect prevention).

Currently, by the time the delay symptom is manifest (200 miles from landing), the only answer available to ATC is delay. ATC takes the first aircraft and leaves it alone; the second is moved back a little, the third back a little more, and so on (defect correction).

What Can Be Done To Prevent Overload In the First Place?

Consider two aircraft at the front of a tightly packed arrival queue of 30 aircraft. By identifying/speeding up the first two aircraft — moving them forward two minutes hours prior to landing — the entire arrival queue moves forward.

In other words, moving two aircraft forward at the front end of a large arrival queue doesn't just save two minutes — it saves two minutes for every aircraft in the queue behind the first two flights — as the entire queue moves forward. This creates what Dr. Clark of Georgia Tech labeled the "*draft effect*," dropping 60 minutes of flight time and delay from this one arrival queue.

We often hear the airline delay and congestion problem expressed in terms of the printed schedule, i.e., "*You can't schedule 10 aircraft to land at 8 AM and expect everyone to be on time*." The answer to this riddle is twofold. First, airlines deliver upwards of 80 percent of their aircraft off schedule (early/late), so the potential for actually having all 10 aircraft arrive at 8 AM is very low.

But the real answer of how to schedule 10 aircraft to land at 8 AM and assure all 10 are on schedule is for the airline to tactically manage the aircraft in real time so the first aircraft lands at 7:51 AM (assuming a 60/hr. arrival rate), the second at 7:52, the third at 7:53, etc. To do this requires a level of tactical, real time control airlines currently have the tools and data necessary to accomplish — but ignore.

A There is nothing you can do when a thunderstorm pops up at the airport: First, thunderstorms don't just "*pop up*" out of nowhere. Thunderstorms need three ingredients — moisture, unstable air, and lift — and many times are associated with fronts.

If a front is 60 miles northwest of an airport moving southeast at 20 mph, it will impact the airport arrival fix (30 to 40 miles from landing) and the aircraft departure path in one hour — and the airport in two to three hours. Even with this predictability, little to nothing is done until a thunderstorm directly impacts the operation (defect correction).

So, the question remains — what can be done to mitigate this outcome? We all know weather is coming, so airlines could reroute aircraft to another arrival fix before ATC does it, speed up inbounds to get them on the ground early, or slow down aircraft to save fuel and avoid a divert.

What about departure weather reroutes? What business person in their right mind — knowing west departures will be closed in 30 minutes — would taxi their $100 million capital asset (aircraft) from the gate and allow the government to manage it once in line for takeoff (ATC weather reroute) — yet that is exactly what airlines do (defect correction).

Data exists to accurately predict arrival or departure constraint hours prior to departure when airlines could easily act to prevent or lower the negative impact (defect prevention).

B Airlines are doing everything possible to fix this: If this were accurate, airlines would not have a 30 percent daily defect rate (A0 around 70 percent or less). Sadly, for passengers, shareholders, and employees, airlines are way too comfortable with their current 1950s, "*day of*" production process, even when a more efficient, independently validated (in operation for years), 21st century solution exists.

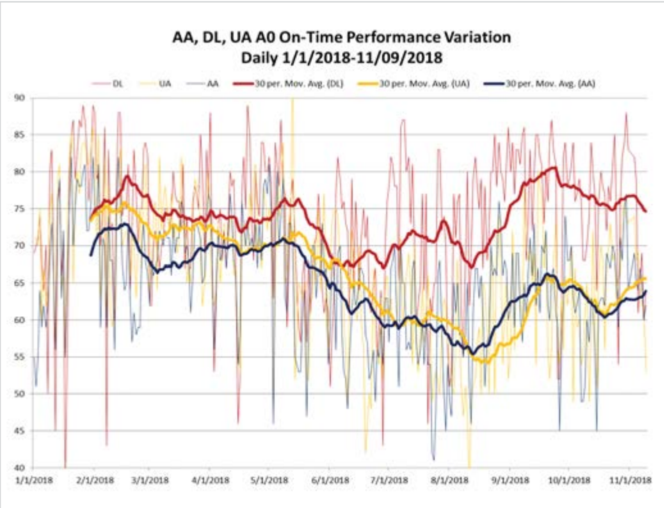
C **NextGen/SESAR will fix airline delays:** Like numerous other ATC-centric programs from the past that tried to fix delays, NextGen and SESAR are more of the same — high cost, extremely complex, technology-driven programs, with benefits always a decade and billions of tax dollars away.

What if they did succeed? The ultimate NextGen/SESAR goal is full ATC tactical control over the movement of aircraft and customers — a very inefficient outcome. For example, consider a Nor'easter slamming the northeast US under NextGen, with ATC managing departure time, EnRoute speed, and most likely altitude and path of every east-bound flight.

This alone is a non-starter given the amount of communication and workload required by individual controllers, who — along with separating aircraft (their primary job) — would be forced to sequence each aircraft from takeoff to landing.

Variance: Root Cause of Most Delays and Congestion

Variance — not a word we hear much in aviation — is the root cause of most delays and congestion in our airspace and at our airports.



As the graph shows, the airlines "*day of*" product quality is hugely variant. One day, the flight is 20 minutes early; the next, that same flight is 20 minutes late — but all we hear are averages (still not that great). If 10 flights are 20 minutes early, and 10 are 20 minutes late, the average delay is zero.

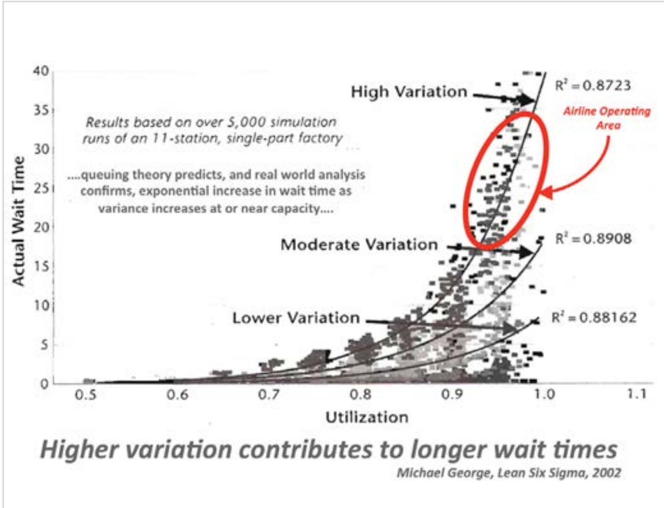
As described at ***Shmula.com***: "*It's important to always remember it is variation people feel, not the average. Managing the variability in your process takes work and some knowledge of tools that are pragmatic and helpful. The average is an inadequate measure and is not descriptive of what the customer is feeling. If the customer is to benefit, we must take action against variation through reducing it or eliminating it and then managing it.*"[vi]

The end result is that the ATC system has little information on airport demand hour-to-hour, nor does the passenger know which level of quality they will receive. Of course, the airline is quick to blame ________ (fill in the blank).

Airlines Could. Airlines Should. Airlines Don't.

To better understand variance and its impact on arrival queuing, and thus delays, we need to look at logistics and queueing — not typical aviation discussions.

As described by Wikipedia, "*Queueing theory is the mathematical study of waiting lines, or queues. A queueing model is constructed so that queue lengths and waiting time can be predicted. Queueing theory is generally considered a branch of operations research because the results are often used when making business decisions about the resources needed to provide a service.*"



As well understood in manufacturing — and shown in the graph — when variation increases, time in queue grows exponentially.

Therefore, airlines must drive variation out of their entire curb-to-curb production process — especially in arrival flow. Only individual airlines can efficiently achieve this since they own the business data to understand "*day of*" variance in the first place (schedule, fuel, connections, gate availability, crew legality, maintenance requirements, deicing, ramp assets, etc.). Airlines could. Airlines should. Airlines don't.

Unforced Errors Should Never Happen

How many times has an aircraft pulled up to the gate and waited (and waited) for a ramp person to guide the aircraft to parking or a jetway driver? How many times has an aircraft sat at the gate for 10 minutes waiting on the "*final paperwork*?" How many times did the flight land without a gate, but there are gates open — just not yours?

These internal airline process errors should simply never, ever happen. Not once — not ever.

Given the linear nature of airline operations (cleaning must be done before boarding, repairs must be done before paperwork is completed, departing aircraft must leave the gate before the next aircraft can park, etc.), each of these errors, while small by itself, has a huge negative impact on overall efficiency of the operation.

For example, moving an airplane from gate to gate requires about 15 processes — all required to get the aircraft from the first gate to the next gate. If all average a 97 percent success rate (complete and on time), it sounds pretty good.

Production Math

- Approx 15 Processes Gate to Gate
- 97.0% to the 15th power = 63.3%
- 99.0% to the 15th power = 86%

....

Internal airline's silo over system processes generate most airline delays

But given the compounding nature of a linear process, 15 processes at a 97 percent success rate only achieve a 63.3 percent success rate for the overall process (.97 to the 15th power). To achieve an 86 percent success rate, the same 15-step linear process requires a 99 percent success rate.

Even the failure of an individual process can be harmful. For example, in what operational model does it make sense to shut down (park) a $100 million production facility (aircraft) 50 feet from the gate for want of a $30 per hour, fully loaded employee?

Consider an airline cancelling two flights, deadheading two sets of crews, and ferrying the aircraft to the next airport — all done to train a mechanic to change brakes on an aircraft (true story).

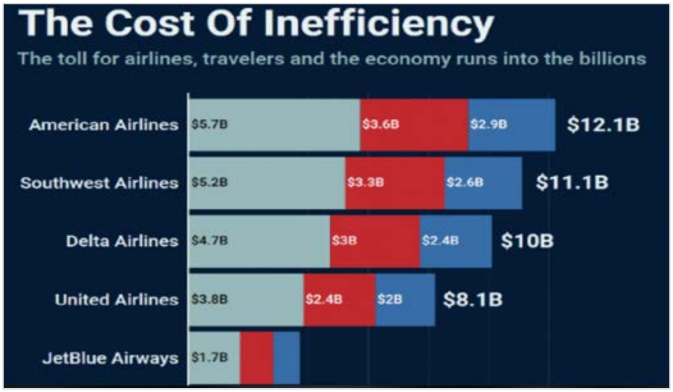
The Cost of Delays and Inefficiency is Huge

Analysis is quite clear — the airline industry's poor "*day of*" operational quality (30 percent daily A0 defect rate) costs large individual airlines billions — yes billions — annually while ATC, airports, and weather *incorrectly* gets the lion share of blame and governments spend $100s of billions of tax dollars on unsuccessful efforts to find a fix.

Look at a 2019 analysis of airline delay costs in a recent Forbes.com article, *The Fastest Airlines in the US*[vii]. This article looked at every US city pair and compared delay performance of individual flights (8.1 million). Total cost of these delays to airlines, travelers, and the economy was $88 Billion in 2018.

Single Airline Cost of Poor Quality Analysis
Crew/Defects/Fuel/Lost Productivity Costs and Lost Revenue

Annual Crew Buffer Cost	$	109,500,000
Annual Defect Rework Cost	$	36,792,000
Annual Overnight Rework Cost	$	76,650,000
Annual Fuel Buffer Cost	$	448,735,294
Annual Aircraft Lost Productivity Cost	$	2,238,666,667
Annual Additional Ticket Revenue with A0 Quality	$	306,600,000
Total Single Airline Annual Buffer/Rework Cost	$	3,216,943,961



Airline Operating Costs	Value of Passenger Time	Spillover Costs to the Economy	Total
$19.1 Billion	$12.0 Billion	$9.6 Billion	$40.7 Billion

Also, consider a 2008 Senate study prepared by the U.S. Senate Joint Economic Committee that estimated airline operating costs, value of passenger time, spillover costs to the economy, and total costs of airline delays as of 2007[viii].

Or, look at United Airline's 1995 analysis showing a $2 billion annual inefficiency cost. Or ..., but you get the idea. In fact, direct and especially indirect costs (lost productivity) of airline delays are *huge* for everyone — airlines, passengers, shareholders, ATC, airports, governments, taxpayers, crews, employees, the economy, and the environment.

Bottom line: current locally-based, ATC-centric aircraft sequencing solutions never — and will never — make airspace, airports, and/or airlines efficient. Costs will continue to rise.

The Solution: Drastically Reduce Variance and Unforced Errors

To move to a solution, we first must understand the answer is not more complexity. Aviation can no longer accept multi-decade, $100 billion programs that just don't attack the core problem — variance.

If ATC and governments can't fix this, what can? The answer — drastically reduce the variance and unforced errors. Airlines could. Airlines should. Airlines don't.

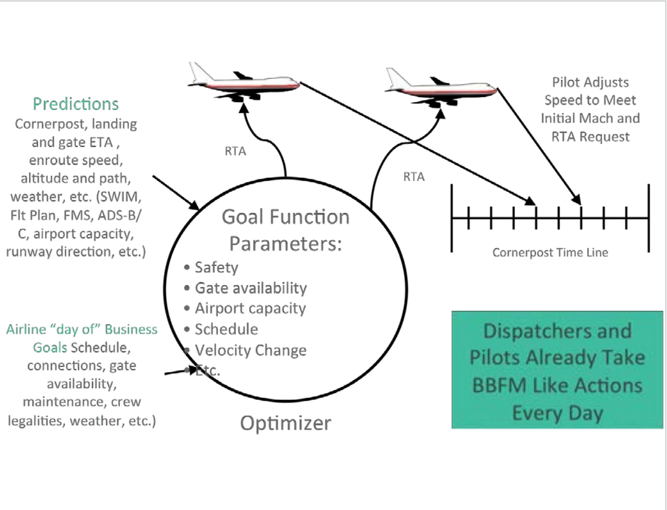
Specifically, as a first step, airlines must manage their aircraft in real time — hours prior to landing —

to precondition aircraft arrival flow before it reaches the airport, i.e., don't overload the box (defect prevention).

Airlines could easily (within months) tactically control their aircraft to deliver a more rational, efficient, stable flow to ATC near the airport, eliminating many of the problems we accept as normal (delays, congestion, ATC structure, etc.).

Instead of forcing ATC to play 52 pickup with highly variant arrival flows, airlines could reduce delays and congestion, making ATC's job much simpler by tactically managing the arrival queue.

For example, consider a single airport with four arrival fixes. If this airport can handle 60 arrivals per hour, one per minute, and the airlines randomly throw 45 arrivals at the airport in 30 minutes, the airport is overloaded. ATC very predictably sequences and queues up the arrivals backwards in time — first come, first served — on a 20 to 30 mile final (defect correction).



Conversely, with the data available today, the airline can easily predict this negative outcome and act to prevent it hours prior to landing (defect prevention). And the readily available, low cost solution to make this happen is Business Based Flow Management (BBFM[ix]).

A Proven Airline-Centric Solution — *Business Based Flow Management (BBFM)*

BBFM is the only proven real time, independently validated, system optimized, "*day-of*", flight arrival queue management solution — based on the airline's defined business rules and airport demand/capacity — which can be coordinated with ATC and the airport in real time. BBFM has been independently validated to improve on-time performance, product quality, lower costs/CO2, and generate highly accurate Estimated Times of Arrival (ETAs) worldwide.

Further, BBFM uses stepped implementation and current equipage (no new technology required), starting at a single airline/airport, for a single airline, available *within months*, thus simplifying the path forward, which can be expanded rapidly system wide.

BBFM identifies every airport arrival; tracking position, speed, and altitude in real time — as well as the flight plan path and real time winds — accurately predicting arrival fix, runway, and gate ETA of each aircraft.

BBFM then evaluates the "*goodness*" of the outcome of the predicted gate arrival time for each aircraft from a system perspective (schedule, gate availability, ramp, fuel, capacity, demand, maintenance, crew legality, etc., for all arrivals). Within seconds, BBFM literally evaluates thousands of iterations — speeding up some aircraft, slowing down others — to find a better "*system*" outcome.

Once BBFM has determined a "*better*" system outcome for each controlled aircraft, BBFM automatically sends each pilot a Required Time of Arrival (RTA) via ACARS[x], two to three hours prior to landing to be at the airport arrival fix at a specified time. Usually, the time change required is around two to four minutes. The pilot adjusts speed to be at the arrival fix at the specified RTA — the speed change is typically 10 to 20 mph, well under a speed change that necessitates notifying ATC (10 mph or five percent of filed True Airspeed, whichever is higher).

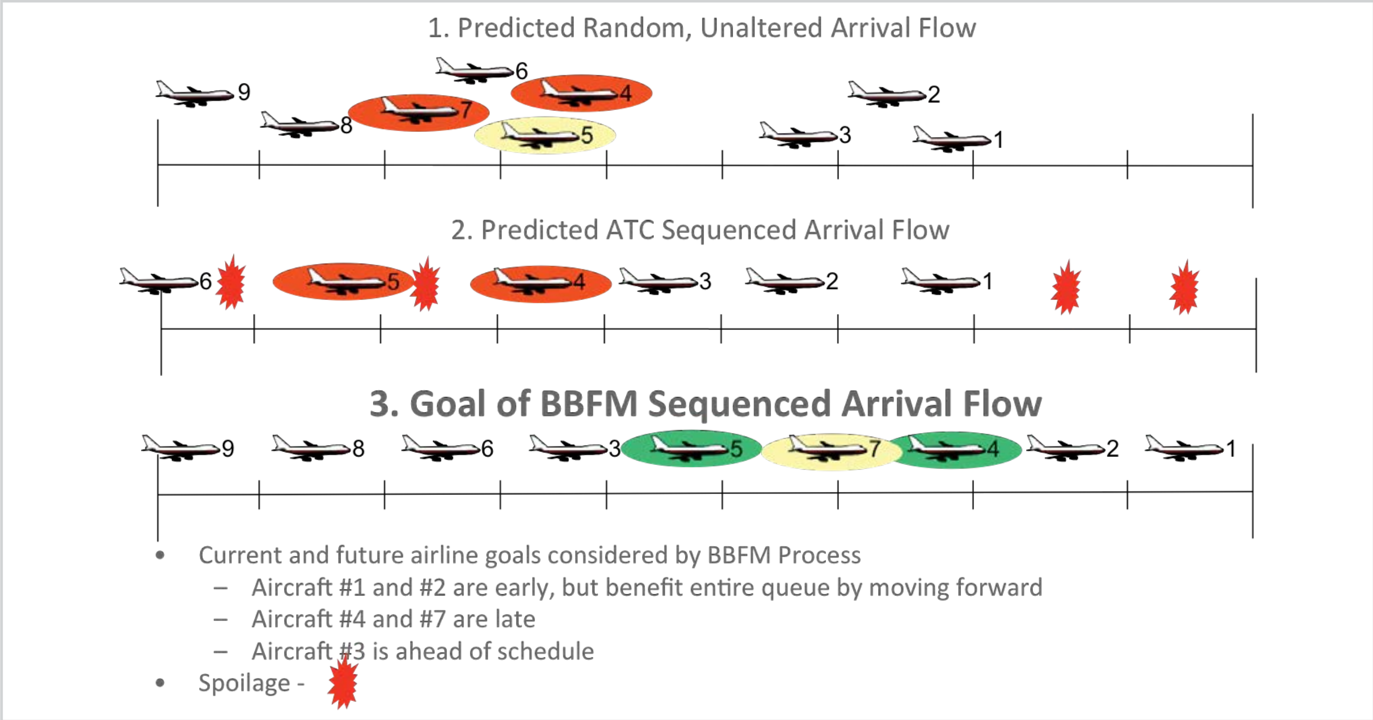
Another unique benefit of an airline centric BBFM solution is that it easily crosses sovereign airspace (FIR) and ATC sector boundaries. This is an absolute necessity for any successful "*day of*" queue management solution — and a huge political and technical limitation inherent in current ATC-centric programs.

While great for hub airlines — doesn't this disenfranchise other airlines? The answer is no. "*Pulling*" the entire queue forward benefits everyone.

Independent analysis of actual Business Based Flow Management (BBFM) operations (not simulations) shows a system-based, airline/aircraft-centric sequencing solution — coordinated with ATC in real time — can and does work, with a Return on Investment (ROI) measured in months.

BBFM is a fully-automated, system-based, arrival flow sequencing process providing a real time, "*day of*," aircraft-by-aircraft, business-driven, arrival solution — dramatically improving airline/airspace/airport operation and reducing ATC complexity. Of course, implementing BBFM leads to other questions:

- What if two airlines want the same arrival fix time (BBFM Exchange);
- What about large, non-hub airports (even a single airline can benefit);
- What happens in bad weather (lower capacity means airlines must make real time business decision on the value of each flight);
- What about smaller airports (BBFM helps there as well);
- What about airspace constraints (BBFM can manage any constraint);
- What happens inside the arrival fix (ATC does what it does now — with more consistent, stable, easily-managed arrival flow);



- What if a pilot can't make the RTA or ATC vectors the aircraft — pilots do their best, but follow ATC directions — BBFM will reconfigure the flow in real time), etc.

All of these questions and more, have been asked and answered in full, but space doesn't allow a fuller answer here.

Achieving *OPERATIONAL EXCELLENCE* — BBFM Is the First, Critical Step

Once aircraft flow is stable, predictable, and driven to a higher quality outcome, the airline must manage its gates in real time (three to five hours prior to landing) to increase gate utilization and availability — and limit gate changes. Once an airline has a stable, predictable aircraft/gate package, third level optimization must manage ramp, gate, and other assets.

Business Based Flow Management (BBFM) was independently validated by FAA (Task J); Embry-Riddle Aeronautical University (Dr. Vitaly Guzhva and Dr. Ahmed Abdelghany); Georgia Tech (Dr. John-Paul Clark); GE Aviation; and Veracity Engineering[xi] — proving the airline/aircraft centric flow sequencing solution works and is profitable, with ROI measured in months, and with absolutely zero analysis to the contrary.

A New Direction for Aviation — Driven by Vision and Leadership

Given the billions spent, decades lost, and pain inflicted without reaching the desired result, aviation needs a new direction — driven by vision and leadership:

What aviation is doing, i.e., spending billions and waiting decades for governments to fix airline delays, is not working.

An independently-validated, operationally-proven, low-cost, commercial off-the-shelf (COTS), near-term solution to dramatically reduce airline delays and congestion is available and implementable — BBFM.

The overarching question we should ask about NextGen/SESAR is: "*When do we get to benefits*?" For four decades, I've been working ATC and airline efficiency issues — but benefits remain billions of dollars and always eight to 10 years away.

Unfortunately, airlines and ATC are so invested in their 1950s process (complexity and structure are standard), it's difficult for them to step out of their comfort zone. This needs to change — something BBFM can facilitate quickly.

Aviation can recapture $100s of billions annually around the world, while dramatically reducing noise, ATC complexity/costs, and improving airline quality/profits. Even with a proven solution readily available, the airline "day of" operational model remains rooted firmly in the 1950s.

Now is the time for ***OPERATIONAL EXCELLENCE*** and BBFM to lead airlines worldwide out of their comfort zone!

CITATIONS

i. US Department of Transportation and airlines report A14, which is up to 15 minutes late. A0 is arriving at the gate at or before the scheduled arrival time.

ii. forbes.com/sites/jeremybogaisky/2019/06/17/methodology-for-the-fastest-airlines-list/#2150319c6ffa

iii. fly.faa.gov/aadc/

iv. Newark's Jul 10, 2019 weather was excellent with over with 10 miles visibility, zero precipitation, high clouds, light winds and temperature in the mid-90s.

v. freeflight.com/airopsview/

vi. shmula.com/the-variability-tree/437/

vii. forbes.com/sites/jeremybogaisky/2019/06/17/the-fastest-airlines-in-the-us/#2fd7d932680d

viii. forbes.com/sites/jeremybogaisky/2019/06/17/methodology-for-the-fastest-airlines-list/#2150319c6ffa

ix. For the record, my partner and I developed Business Based Flow Management (BBFM), previously branded as Attila™, and I have a vested interested in its success.

x. Aircraft Communications Addressing and Reporting System - Aircraft to ground data link communication process in place since the 1980s.

xi. athgrp.com/_pdoc/Airline_Business_Based_Flow_Management_White_Paper_2018-02-06.pdf