# The Perfect Air-taxi

### *Background*

There's been a lot of debate within the industry about whether an air-taxi model can thrive as a viable transportation alternative. "Why not?", most asked in beginning as newly efficient jets hit the market, NASA gave its blessing to the burgeoning movement, and technology promised to solve the complicated logistics of this model. The debate reached a fever pitch in '06-'07 when the Very Light Jet (VLJ) race saw the debut of Cessna's Citation Mustang and Eclipse's E500. A 'revolution in air travel' was heralded by manufacturers, investors, and media alike – all in hopes of a rapid expansion of the industry as thousands of new travelers flocked to their local FBO's to hop aboard a jet.

Unfortunately, we find ourselves in 2011 with scant real-world evidence that the air-taxi, per seat charter model can profitably operate. There was Indigo in the late 1990's and early 2000's which utilized a fleet of Falcon 20's to offer regularly scheduled, public charter flights between Chicago's Midway and Teterboro airports. Then came DayJet in the fall of 2007 with its gleaming Eclipse 500's and on-demand service between 5 cities in Florida. Grand predications were touted about 300 jets ferrying 2,700 people daily among 70 cities in the Southeast two years after their launch. LinearAir attempted a Northeast corridor on demand, per-seat service with Cessna Caravans and Eclipse jets but returned to the familiar ground of full plane, pay-by-the-hour, charter flights a short time later.

A couple of years ago, the shared jet services were launched by companies including BlueStarJet's ShareAJet Exchange, Jet-It-Together, and CoGoJets. They all touted the revolutionary ability of the web, Facebook, and other social media to efficiently aggregate individual traveler plans onto shared charter flights. Based on the size of the party, these charter brokers promised to find the best aircraft to efficiently accommodate their trip. Currently, Greenjets appears to be the only surviving per-seat charter product on the market. But their per-seat fare comes with strings attached: one must agree to depart within a 5 hour window from an airport within 40 miles of an origin city. Once you agree to the fine print, Greenjets will honor your quoted fare assuming they can find the right-sized aircraft and profitably broker a shared plane load.

There have been many thoughts as to why these various companies have missed expectations for the predicted revolution in travel. Some blame the strict Part 135 regulatory environment in which "on-demand" travel comes with too many restrictions to efficiently price per-seat fares competitive with 1$^{st}$ or business class commercial fares. Others blame a lack of interest in sharing jets or being bound to other passenger's schedules, something that traditional charter models avoid…at a cost. Or that the investor appetite isn't there to properly fund operations and promotion of a risky, new travel service.

But let's just assume for a minute that all of these challenges could be overcome and that there is a market of travelers who are willing to pay a price between typical commercial and charter prices for shared, on-demand air travel. What type of aircraft would make the most economic sense for such an air-taxi service? For example, does a relatively inexpensive Turbo Prop make more sense on a shorter route due to the small difference in flight time performance compared with a jet? Is it more economical to launch an air-taxi service with a 4 or 6 seat jet?

### *Methodology*

These are among the questions that we attempt to answer in this analysis. Certainly, there must be an ideal aircraft amongst the many dozens (perhaps hundreds) of turbo-prop and turbine aircraft types in service today. But how would one go about identifying the right-sized aircraft for an air-taxi business? When it comes right down to it, there are 4 primary factors in selecting (or designing) an aircraft for any particular mission or business, including an air-taxi service: (1) operating cost ($/hour), (2) seating capacity (# seats), (3) speed (avg. cruise) and (4) range (nm). Assuming we only choose aircraft whose NBAA IFR range can accommodate our analyzed city pairs, we're down to the first 3 factors. These are all intricately linked factors, a change to one of which invariably affects the other three.

Choosing the right aircraft for air travel alternatives is a familiar exercise by now. Charter companies generally find the most efficient aircraft that can fly the requested mission within a satisfactory duration and which can fit the traveling party's size. Of course, larger or specific aircraft types may be chosen to accommodate desired creature comforts and personal preferences. Commercial carriers have a more complicated task in selecting aircraft. Not to simplify this gargantuan effort but they generally must forecast travel demand during certain scheduled flight times, factoring in connecting flight constraints, and similarly select the most efficient aircraft whose seating capacity can accommodate peak expected loads. The task in selecting the right aircraft for scheduled public charter (or scheduled prop service within the permitted limit of 5 per week) is a roughly similar exercise without the complication of a hub and spoke system.

But before we go further in discussing the air-taxi planning methodology we used, it's worth clarifying the air-taxi model assumed for this analysis.  Adhering to the FAA and DOT's strict definition of "on-demand" service, we assumed a per-seat service whereby travelers independently select travel itineraries, i.e. the origin, destination, date & time of travel.  However, we permit as part of this itinerary selection the choosing of either a departure or arrival window of time between 1 and 4 hours in half hour increments. So, Traveler A may want to specify a tight arrival window between 9AM and 10AM in order to make a 10:30AM appointment while accommodating a busy morning in the home office.  While Traveler B specifies a more flexible return departure window between 5:30PM and 8:30PM since his final meeting of the day ends at 5PM and he seeks a lower fare return (the larger the chosen window, the lower the fare).

With these basic air-taxi model assumptions (along with others pertaining to specific booking patterns*), we then repeatedly simulate a single day's worth of randomly generated reservations to forecast average costs and statistics for the day's worth of flight operations. With a statistically significant number of iterations, we can draw conclusions about the costs of accommodating various volumes of booking passengers on certain city-pairs with such an air-taxi service.

In order to provide a comprehensive comparison between standard chartered aircraft, we chose the following 4 types along with these cost and performance metrics:

| Aircraft Type | Seating Capacity | Hourly Cost | Average Cruise Speed (knots) 300nm | 600nm | 900nm | 1,200nm | Examples |
|---|---|---|---|---|---|---|---|
| Turbo-Prop [TP] | 8 | $1,200 | 220 | 235 | 250 | 250 | Hawker Beechcraft King Air, Cessna Caravan |
| Entry Level Jet [EJ] | 4 | $1,500 | 240 | 270 | 300 | 325 | Embraer Phenom 100, Cessna Mustang |
| Light Jet [LJ] | 6 | $2,500 | 265 | 320 | 360 | 380 | Hawker 400XP, Embraer Phenom 300, Cessna CJ3 |
| Midsize Jet [MJ] | 8 | $3,500 | 280 | 325 | 375 | 400 | Cessna Citation Excel, Bombardier Learjet 45 |

Table 1 - Air-taxi Aircraft Types

We then simulated air-taxi service with each of these aircraft types on 4 popular city-pairs for business aircraft: Van Nuys, CA (KVNY) <–> Las Vegas, NV (KLAS); Bedford, MA (KBED) <–> Washington, DC (KIAD); Teterboro, NJ (KTEB) <–> Chicago, IL (KPWK); and Teterboro, NJ (KTEB) <–> Fort Lauderdale, FL (KFLL). Given the above average cruise speeds, the chart below lists the assumed flight times between each city pair for each aircraft:

| Aircraft Type | Flight Time Performance (hh:mm) | | | |
|---|---|---|---|---|
| Route | VNY-LAS | BED-IAD | TEB-PWK | TEB-FLL |
| Distance | 199nm<br>229sm | 352nm<br>405sm | 627nm<br>721sm | 940nm<br>1,081sm |
| Turbo-Prop [TP] | 0:54 | 1:29 | 2:30 | 3:45 |
| Entry Level Jet [EJ] | 0:49 | 1:18 | 2:05 | 2:53 |
| Light Jet [LJ] | 0:45 | 1:06 | 1:44 | 2:28 |
| Midsize Jet [MJ] | 0:42 | 1:04 | 1:40 | 2:21 |

Table 2 - Air-taxi Route Flight Times by Aircraft Type

 

***Findings***

*Which route is best?*

First, let's assume that Charter Operator X has an existing fleet of a single type of aircraft and wants to determine which route makes the most sense to launch an air-taxi service. From our analysis, the recommendation would be launch on the longest city-pair which their aircraft type can serve. In general, longer routes are more profitable, require a lower # of booked segments to break-even, and utilize aircraft more effectively (i.e. higher % of occupied flight hours vs. empty leg flight hours).

However, these higher margins come at a higher risk in that more aircraft capacity is needed to reliably accommodate all booked single seat itineraries. In other words the investment in lift or flight time costs to reliably provide service on a particular route will be higher. For example, let's say Operator X has a fleet of light jets and concludes that with the right sales and marketing effort, they can attract 20 passenger segments per day on any of these 4 routes at an average fare of $3/seat mile. Which city-pair will be best to target their marketing dollars to first? The below example shows how key statistics for these routes compare:

| **Aircraft Type: Light Jet (Hawker 400XP, Embraer Phenom 300, Cessna CJ3)** | | | | |
|---|---|---|---|---|
| **Daily Booked Seat-Segments (Passenger One-Ways): 20** | | | | |
| **Price (Fare): $3/seat-mile; Cost: $2,500/hour** | | | | |
| | **Route/City Pair** | | | |
| **Daily Statistics** | **VNY-LAS** | **BED-IAD** | **TEB-PWK** | **TEB-FLL** |
| Average One-Way Fare | $690 | $1,220 | $2,170 | $3,250 |
| Average Round-Trip Fare | $1,370 | $2,430 | $4,330 | $6,490 |
| Revenues | $13,700 | $24,000 | $41,600 | $62,700 |
| Costs | $18,800 | $26,600 | $37,800 | $55,800 |
| Profit/(Loss) | ($5,100) | ($2,600) | $3,800 | $6,900 |
| Profit Margin | (37%) | (11%) | 9% | 11% |
| # Aircraft Needed | 2 | 2 | 3 | 3 |
| Total Avg. # Flight Hours | 7.5 Hrs. | 10.7 Hrs. | 16.6 Hrs. | 22.4 Hrs. |
| Total Avg. # Flight Legs | 10.1 Legs | 9.7 Legs | 9.5 Legs | 9.1 Legs |
| Average Load Factor | 1.9 Pax | 2.0 Pax | 2.1 Pax | 2.1 Pax |

Table 3 - Light Jet Performance Statistics by Route

One can see that launching service between Teterboro and Fort Lauderdale (longest route analyzed) will be more profitable (profit margin of 11%) at 20 booked segments per day but will require a higher investment in lift (3 light jets at an average daily operating cost of $55,800) in order to satisfy demand. This may seem counterintuitive given that longer routes are more expensive to fly but the simple fact is that longer routes enable operators to ensure that passengers are physically in their seats for more hours. On shorter routes, there's more time spent turning aircraft around and waiting for passengers versus flying passengers. Therefore, a longer route will be more profitable at a forecasted demand level for air-taxi service as long as an operator has adequate capacity and financial wherewithal to support higher lift requirements.

*Worth using faster aircraft?*

On the other hand, let's say that Operator X is about to purchase/manage aircraft or has several different aircraft in their fleet from which to choose in launching an air-taxi service. Which aircraft makes the most sense on a given route? Let's take a look at the VNY - LAS route and contrast the various aircraft types, again assuming an expected demand of 20 one-way segments per day:

**Route/City Pair: Van Nuys, CA (VNY) <-> Las Vegas, NV (LAS); Distance: 199nm (229sm)**
**Daily Booked Seat-Segments (Passenger One-Ways): 20**
**Price (Fare): $4/seat-mile; Average One-way Fare: $920; Average Round-Trip Fare: $1,830**

| | Aircraft Types | | | |
|---|---|---|---|---|
| **Daily Statistics** | **Turbo Prop** | **Entry Level Jet** | **Light Jet** | **Midsize Jet** |
| Hourly Cost | $1,200/Hr. | $1,500/Hr. | $2,500/Hr. | $3,500/Hr. |
| Seating Capacity | 8 | 4 | 6 | 8 |
| Revenues | $18,300 | $18,300 | $18,300 | $18,300 |
| Costs | $10,700 | $12,700 | $18,800 | $25,000 |
| Profit/(Loss) | $7,600 | $5,600 | ($500) | ($6,700) |
| Profit Margin | 42% | 31% | (3%) | (37%) |
| # Aircraft Needed | 2 | 2 | 2 | 2 |
| Total Avg. # Flight Hours | 8.9 Hrs. | 8.5 Hrs. | 7.5 Hrs. | 7.1 Hrs. |
| Total Avg. # Flight Legs | 9.9 Legs | 10.2 Legs | 10.1 Legs | 10.1 Legs |
| Average Load Factor | 1.9 Pax | 1.9 Pax | 1.9 Pax | 2.0 Pax |

Table 4 - VNY <-> LAS Route Performance Statistics by Aircraft Type

One can see from the above chart that the efficiency of the turbo-prop ($1,200/hour) on this route overcomes any advantages the other aircraft have in speed (lower Flight Hours) and seating capacity. So, assuming Operator X's passengers accept a flight time of 54 minutes (vs. midsize jet travel time of 42 minutes), Turbo Props are the way to go (Profit Margin = 42%). But let's say their passengers demand a jet due to its faster and quieter travel advantages, the Entry Level Jet again beats out its larger jet brethren at this demand level (Profit Margin = 31% vs. -3% and -37%, respectively) due to its relatively low operating costs.

However, it does appear that the speedier aircraft do make up some cost ground with fewer hours despite their higher operating costs. Could it make a difference on a longer route where larger jets have more significant travel time advantages over turbo-props?

**Route/City Pair: Teterboro, NJ (TEB) <-> Fort Lauderdale, FL (FLL); Distance: 940nm (1,081sm)**
**Daily Booked Seat-Segments (Passenger One-Ways): 20**
**Price (Fare): $2.50/seat-mile; Average One-way Fare: $2,710; Average Round-Trip Fare: $5,410**

| | Aircraft Types | | | |
|---|---|---|---|---|
| **Daily Statistics** | **Turbo Prop** | **Entry Level Jet** | **Light Jet** | **Midsize Jet** |
| Flight Time (hh:mm) | 3:45 | 2:53 | 2:28 | 2:21 |
| Hourly Cost | $1,200/Hr. | $1,500/Hr. | $2,500/Hr. | $3,500/Hr. |
| Seating Capacity | 8 | 4 | 6 | 8 |
| Revenues | $54,000 | $54,000 | $54,000 | $54,000 |
| Costs | $36,000 | $41,200 | $55,800 | $76,800 |
| Profit/(Loss) | $18,000 | $12,800 | ($1,800) | ($22,800) |
| Profit Margin | 33% | 24% | (3%) | (42%) |
| # Aircraft Needed | 4 | 4 | 3 | 3 |
| Total Avg. # Flight Hours | 30.0 Hrs. | 27.5 Hrs. | 22.4 Hrs. | 22.1 Hrs. |
| Total Avg. # Flight Legs | 8.0 Legs | 9.5 Legs | 9.1 Legs | 9.4 Legs |
| Average Load Factor | 2.4 Pax | 2.1 Pax | 2.1 Pax | 2.1 Pax |

Table 5 - TEB <-> FLL Route Performance Statistics by Aircraft Type

Unfortunately, the same results apply even though the fastest jet in our analysis travels this route in almost 1 ½ fewer hours than a Turbo Prop. There's not much to be gained by deploying faster aircraft. Sure, your passengers might enjoy getting to their destinations faster but your bottom-line won't be happier.

So, it appears that speed can make up for higher operating costs but to what extent? In other words, if we could take a 4 seat jet and speed it up without increasing operating costs, how much more profitable could Operator X be? Put another way, how many more hourly operating costs could a manufacturer design into the aircraft in order to increase its travel time performance without sacrificing operating profits? We analyzed a four seat configured jet at various average cruise speeds with these results:

| Route/City Pair: Teterboro, NJ (TEB) <-> Fort Lauderdale, FL (FLL); Distance: 940nm (1,081sm) | | | | | |
|---|---|---|---|---|---|
| Daily Booked Seat-Segments (Passenger One-Ways): 20 | | | | | |
| Hourly Cost: $1,500/Hour; Avg. Price (Fare): $2.00/seat-mile; Seating Capacity: 4 Passengers | | | | | |
| | Average Cruise Speeds (knots) | | | | |
| Daily Statistics | 325 | 350 | 375 | 400 | 425 |
| Flight Time (hh:mm) | 2:53 | 2:41 | 2:30 | 2:21 | 2:12 |
| Revenues | $43,300 | $43,300 | $43,300 | $43,300 | $43,300 |
| Costs | $41,200 | $36,800 | $35,100 | $34,100 | $32,900 |
| Profit/(Loss) | $2,100 | $6,500 | $8,200 | $9,200 | $10,400 |
| Profit Margin | 5% | 15% | 19% | 21% | 24% |
| # Aircraft Needed | 4 | 3 | 3 | 3 | 3 |
| Total Avg. # Flight Hours | 27.5 Hrs. | 24.5 Hrs. | 23.4 Hrs. | 22.7 Hrs. | 21.9 Hrs. |
| Total Avg. # Flight Legs | 9.5 Legs | 9.2 Legs | 9.4 Legs | 9.7 Legs | 9.9 Legs |
| Average Load Factor | 2.1 Pax | 2.1 Pax | 2.1 Pax | 2.0 Pax | 2.0 Pax |

Table 6 - TEB <-> FLL Route Performance Statistics for 4 Seat Jet by Cruise Speed

While our 4 seat jet can generate 5% margin at its baseline average cruise speed of 325 knots, there are economic advantages to building a faster jet. An operator can utilize less aircraft at fewer overall hours while being able to satisfy the same demand. Keeping operating costs constant, the profit margin increases from 5% to 24% at an average trip cruise speed of 425 knots, an almost five-fold increase in profits. Or another conclusion that can be drawn from this data is that if one could build a 4 seat jet that can travel this route at an average cruise of 425 knots,, one could accommodate an increase in operating costs of $1,900/hour vs. $1,500/hour and maintain the same 5% average profit.

*How much is an extra seat worth?*

Another decision Operator X might have is how to select an ideal seating capacity or seating configuration in order to maximize profits with their air-taxi service. Many assume that a larger aircraft, whose per-seat operating costs at full capacity are lower, will always make more sense to deploy within an air-taxi service. In other words, if your Citation Excel boasts a full load (8 passengers) per person operating cost of $0.93/seat-mile vs. your Phenom 100 full load (4 passengers) cost of $1.00/seat-mile, you ought to utilize Citation Excels to launch an air-taxi service, right? To get our answer, we contrast each jet's economic performance with their standard seating capacity on the Teterboro - Chicago city pair at a demand level of 20 one-way segments per day.

| Route/City Pair: Teterboro, NJ (TEB) <-> Chicago, IL (PWK); Distance: 627nm (721sm) | | | |
|---|---|---|---|
| Daily Booked Seat-Segments (Passenger One-Ways): 20 | | | |
| Avg. Price (Fare): $3.00/seat-mile; Average One-way Fare: $2,170; Average Round-Trip Fare: $4,330 | | | |
| | | Aircraft Types | |
| Daily Statistics | Entry Level Jet | Light Jet | Midsize Jet |
| Flight Time (hh:mm) | 2:05 | 1:44 | 1:40 |
| Hourly Cost | $1,500/Hr. | $2,500/Hr. | $3,500/Hr. |
| Seating Capacity | 4 | 6 | 8 |
| Revenues | $43,300 | $43,300 | $43,300 |
| Costs | $30,600 | $37,800 | $51,000 |
| Profit/(Loss) | $12,700 | $5,500 | ($7,700) |
| Profit Margin | 29% | 13% | (18%) |
| # Aircraft Needed | 3 | 2 | 2 |
| Total Avg. # Flight Hours | 20.5 Hrs. | 15.2 Hrs. | 14.7 Hrs. |
| Total Avg. # Flight Legs | 9.8 Legs | 8.7 Legs | 8.8 Legs |
| Average Load Factor | 2.0 Pax | 2.2 Pax | 2.2 Pax |

Table 7 - TEB <-> PWK Route Performance Statistics by Aircraft Type

If we look at key performance and cost data for each aircraft type, we can see that the higher seating capacities of the larger aircraft can't overcome their higher hourly operating costs at this demand level.

 

Despite a slower travel time, the Entry Level jet is the most profitable aircraft type to operate for 20 booked passenger segments per day.

However, it does appear that there may a sweet spot of seating capacity assuming a particular demand and price point. So, we analyzed various aircraft seating capacities at a light jet speed profile and 20 booked segments per day at $3/seat-mile to determine a sweet spot for the Teterboro – Chicago route. Here are the results:

| Route/City Pair: Teterboro, NJ (TEB) <-> Chicago, IL (PWK); Distance: 627nm (721sm) | | | | | | |
|---|---|---|---|---|---|---|
| Daily Booked Seat-Segments (Passenger One-Ways): 20 | | | | | | |
| Hourly Cost: $2,000/Hour; Avg. Price (Fare): $3.00/seat-mile; Travel Time = 1:44 (hr:mm) | | | | | | |
| | Seating Capacity (maximum # passengers) | | | | | |
| Daily Statistics | 3 Pax | 4 Pax | 5 Pax | 6 Pax | 7 Pax | 8 Pax |
| Revenues | $43,300 | $43,300 | $43,300 | $43,300 | $43,300 | $43,300 |
| Costs | $37,500 | $34,600 | $33,400 | $33,200 | $32,600 | $32,600 |
| Profit/(Loss) | $5,800 | $8,700 | $9,900 | $10,100 | $10,700 | $10,700 |
| Profit Margin | 13% | 20% | 23% | 23% | 25% | 25% |
| # Aircraft Needed | 3 | 3 | 3 | 3 | 3 | 3 |
| Total Avg. # Flight Hours | 18.7 Hrs. | 17.3 Hrs. | 16.7 Hrs. | 16.6 Hrs. | 16.3 Hrs. | 16.3 Hrs. |
| Total Avg. # Flight Legs | 10.8 Legs | 10.0 Legs | 9.6 Legs | 9.6 Legs | 9.4 Legs | 9.4 Legs |
| Average Load Factor | 1.9 Pax | 2.0 Pax | 2.1 Pax | 2.1 Pax | 2.1 Pax | 2.1 Pax |

Table 8 - TEB <-> PWK Route Performance Statistics by Aircraft Seating Capacity

Given this speed profile (average cruise speed = 360 knots and travel time of 1:44 hours) there is an advantage to increasing capacity up to 5 seats. But relative economic advantages stop after the 5th seat for 20 daily booked passenger segments. In other words, if configuring a light jet for 5 seats is more attractive to travelers for space and comfort reasons, an operator won't sacrifice profits to take away a 6th seat.

Similarly, designing for 4 seats vs. 3 seats (at this speed profile) will yield a profit margin of 20.1% vs. 13.4%, an almost 50% increase in profits at this demand level. This is well worth designing (or choosing) an aircraft with additional seating capacity, everything else being equal.

***Conclusion***

So, is there an ideal air-taxi aircraft? Generally speaking, a lower operating cost aircraft will always outweigh advantages to be gained in selecting faster or higher seating capacity aircraft. Of the 3 basic aircraft selection criteria - (1) operating cost ($/hour), (2) seating capacity (# seats), (3) speed (avg. cruise) – operating cost trumps the other two for any air-taxi strategy given typical performance characteristics of available business aviation aircraft.

However, utilizing more efficient aircraft for an air-taxi service may not always suit an Operator's passengers' wishes for travel comfort and speed. Luckily, Operators can determine quite accurately whether certain aircraft choices make relative economic sense for a chosen air-taxi routing strategy. Plus, one can determine a "sweet spot" choice of aircraft given expected demand level and price point that can maximize an Operator's profit.

So, why haven't we seen a commercially successful air-taxi service? It is certainly not for lack of available aircraft. The answer to that question better lies in the answer to this question. Is there a market for an on-demand, per seat charter service priced between premium commercial fares and per-person business aviation rates (i.e. $2-$3 per seat-mile)?

* For a detailed listing of these assumptions, see appendix.

 