Emerging E-propulsion Inter-Urban Air Mobility (UAM) Addressable Market, Financial and Development Challenges

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The UAM market is filled with grand expectations. It is too early to say with any certainty how large the inter-urban air mobility (UAM) and Advanced Air Management, AAM, markers will be—but it is possible to understand from a historical perspective the evolving progress, financial needs and hopefully, when will paying customers arrive.

Like earlier Aerospace systems, electric-propulsion systems will tend to converge on dominant specific systems competing for market acceptance with design options encompassing speeds and ranges for urban, suburban, and rural service for regional cargo and separately for Urban Air Mobility. This has yet to happen. It is an indication of an industry in its infancy.

A better understanding of the history of past programs is useful for minimizing a repeat of our historical history. The behavior of large system development and management, involving significant technology enhancements, experienced different but similar challenges. They are amenable to analysis as are most physical and software engineering systems. This note examines *certification and production readiness from a historical perspective* relative to the emerging UAM systems.

An industry with a history and revived prospects: During the last 60 years the airline industry has varied from reasonably prosperity, to depressed business conditions. Let's look at the Utility class market.

In the 1960s there has been a robust discussion for a new short-haul system and aircraft. The challenging questions in this earlier period were *"what this system would be responsive to, the requirements of the transportation system within which it will operate and an assessment of the market which it seeks to influence" (see Appendix)*. We are today responding to the same challenges, reinvigorated by a growing acceptance of environmental risks/needs and emerging electrified propulsion options.

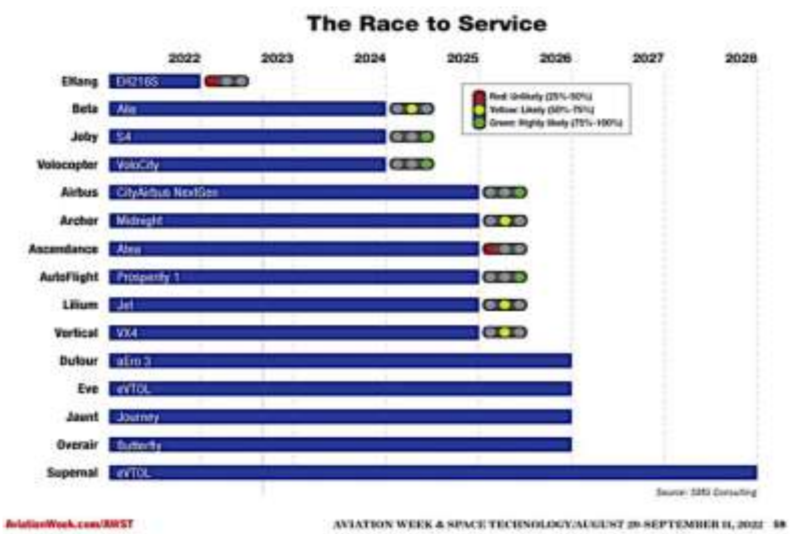
Consider the current Norwegian STOLport network (see Appendix). It is a result of 1960s and early 1970s political decisions. The goal was to meet the requirement for better STOL infrastructure in their countryside. The network was officially opened June 1968. Based on this example, several short runway airports (800–900 m [2,600–3,000 ft]) were then built in Greenland, replacing heliports. Some of the airports in Iceland have become STOLports. The availability of STOL aircraft enabled Icelandair to extend its network to Greenland. Denmark and Sweden have also evolved along a similar path. During the first years, airlines such as Widerøe mostly used the STOL Utility DHC-6 Twin Otter with 13 seats. Today the Norwegian airport authority is concerned about the future availability of aircraft for 800 m (2,600 ft) runways, as the older aircraft retires. They found that after 2010, no new aircraft can be bought that has more than 20 seats and is able to use such short runways. *This is typical of addressable markets for the first generation of battery e-powered aircraft. This will provide a useful insight to the current addressable Utility market given that today's challenges are similar-to the 1960-2020 experiences*

Renewed Prospects for a Market. Has enough attention has been paid to the industry's business plans?

SMG Consulting has launched the Advanced Air Mobility (AAM) Reality Index (ARI), a project rating tool using public information to assess the progress of industry entrants toward the delivery of a certified product at mass-production scale. The UAM/AAM markets have many commercial projects jostling for investor attention, mostly at the concept, technology demonstration stages. While all kinds of vehicles, from cargo planes to surveillance drones, are being planned, almost 75 per cent of the money has gone to AAM companies developing manned electric vertical take-off and landing (eVTOL) craft.

SMG Consulting has launched a Reality Index, a rating tool that uses public information and expert knowledge to assess the progress of industry entrants toward the delivery of a certified product at mass-production scale. The rating is based on five factors: funding, team, technology readiness, certification progress and readiness for full-scale production.

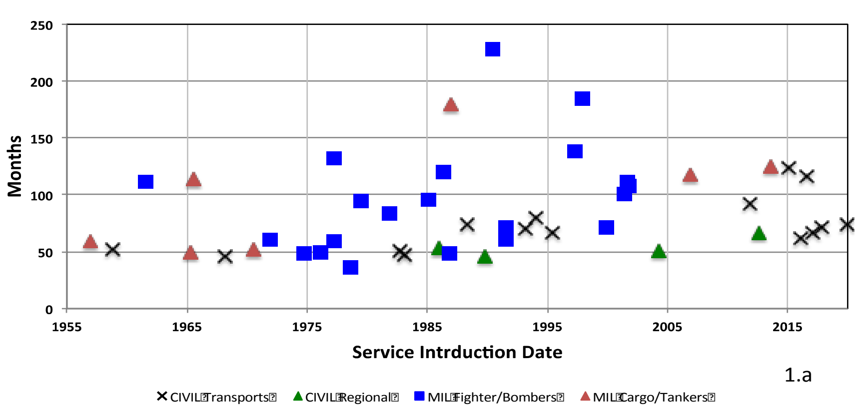
SMG Consulting's Advanced Air Mobility (AAM) Reality Index (ARI) scores each market entrant on a scale of 0 to 10: **0** is a company considering entering the market with little or no financing. A **10** rating is company with a commercial product in high-volume production, of which there are none–so far.



SMG's results are in the attached chart. They suggestion for those likely to succeed are the 4 companies with a "green" rating.

Certification progress and production readiness are key but separate metrics, recognizing that a company could arrive at certification, yet fail to produce the aircraft in the units needed. This makes sense. A company can arrive at certification yet fail to produce the aircraft in the units needed, develop supply chain capabilities to support production and provide support for Continuing Airworthines spares, operational repairs and maintenance for their customers and operators.

These are the essential elements in an Aerospace Industrial Ecosystem Partnership.

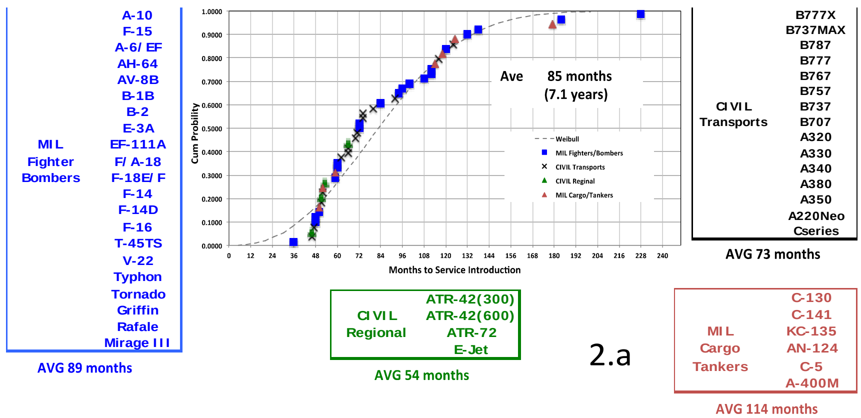


1.a

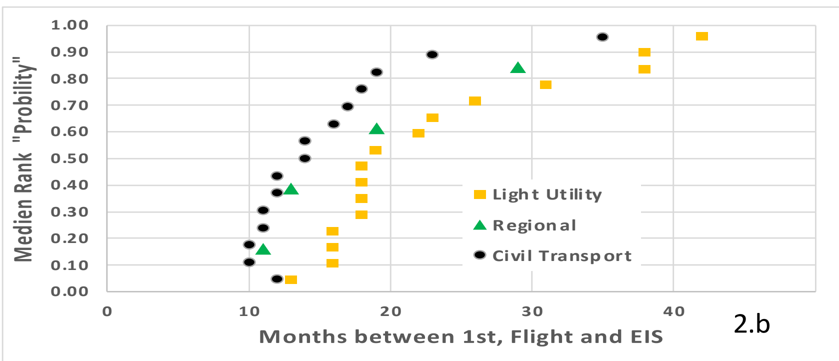
HISTORICAL PERSPECTIVE: some data,

The time to EIS from start of approval for product development, certification and delivers has been similar. Over the past 60 years, for a variety of development programs

The combined statistical variability, months to EIS from the formal start of "Full Scale Development" also appears similar when the data for all programs are merged. However, each class of vehicles have different values for the average months.



2.a



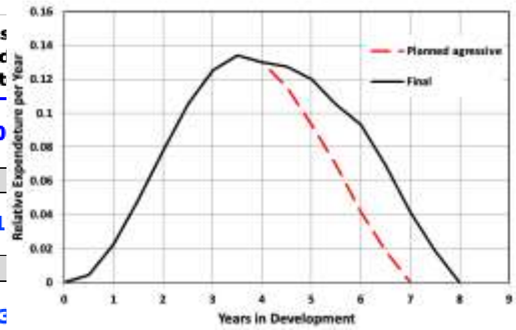
2.b

1st. flight for certification is a key program marker beginning the qualification of a potential production representative vehicle for the Type and Production Certificates required for EIS.

Chart 2.b is a comparison for the 3 classes of vehicles based on the numerically summed data points. On careful inspecting of the 2.b curves, it becomes that there are 2 distinctively different distributions. Between **1/2** to **2/3**-rds of all programs are late to initial plan. Comparing schedules, the Utility class development appears to have significantly more variability than the other 2 classes. Too understand why this is not unusual let's examine the causes of program slippage and cost overruns. This table illustrates a typical program slippage of 1 year, sometimes 2 or more years. These slippages were due to several causes including a shortage of funding, an "optimistic "program schedule and technology immaturity. The 50% plotting values are shown here, however the numerical averages for EIS are significantly higher.

	Months from 1st Flight to Entry Into Service		
	Light Utility	Regional	Civil Transports
Averages	18	18	16
Total Average		19 months	

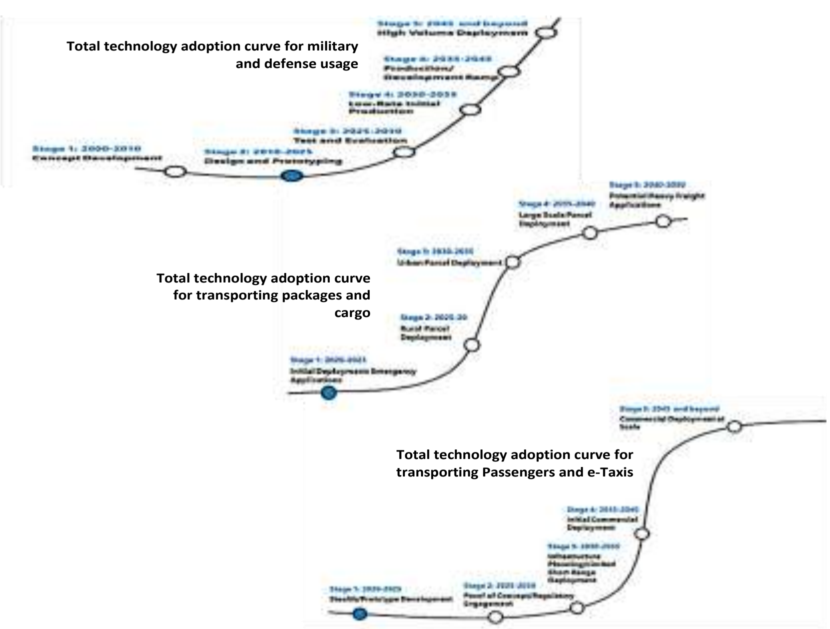
	CDR	First Flight	FF Schedual Factor	EIS	EIS Schedual Factor	Cos Sched Fact
Yrs Mnt's	3.5Y's. 42M's	4.5Y's. 54M's	1.00	5.5Y's 66M's	1.00	1.0
	1's program slip 1 year at year 4 (48 months)					
1st Schedule Slip		5.5Y's 66M's	1.22	6.5Y's 78M's	1.18	1.1
	2nd program slip 1 year at year 5 (60 months)					
2nd Schedual Slip		6.5Y's 78M's	1.44	7.5Y's 66M's	1.36	1.23



Many programs are late to initial plan by a factor of 1.29 for Full-Scale Development. Development programs typically experience cost growth by a factor of 1.2 to 1.5. Development program Cost Growth due to financial or technical challenges. Illustrated in adjacent charts is typically experienced program slippage. The red dashed line is a typical optimistic estimate, the black line is the usual expenditure rate for Product Development. The difference between the two curves is the additional funding required to do the engineering development for certification. This growth competes with the funding needed for transition from a technology focus to an industrial enterprise with deliveries that generate revenue. Realisticaly, it it takea about 8 to 10 years after full scale development initation to a functional industrial capability. The maximun expendurate rate is at the CDR timeframe - discussed belowed.

The principal **Total Addressable UAM Markets and Schedules** are separated by the functions they provide for potential commercial business operations and government interest. Potential market penetrations for Cargo, Transporting Passengers and Military- Government are illustrated below. The prefix, **intra**- means "within" a combined urban and suburban area while the prefix **inter-** means "interaction between" two or more Urban-suburban-rural areas. The differences:

1. **Advanced Air Mobility**, AAM, what are the functional requirements between inter and intra-Urban-Air mobility? These are illustrated in typical technology adoption "s-curves" as a fraction of the market penetration in calendar time.



a. **intra-Urban Air mobility,** a subset of Advanced Air Mobility, focuses on lower-altitude operations within urban environments. The aircraft systems are envisioned to be composed of uncrewed eVTOL vehicles and the complementary ground facilities that will be tightly integrated into the vehicle operation. The ground facilities will provide not only the usual airline fleet operations management and flight dispatch functions, but also some essential functions currently performed by onboard pilots that will be allocated by design to automation and personnel on the ground.

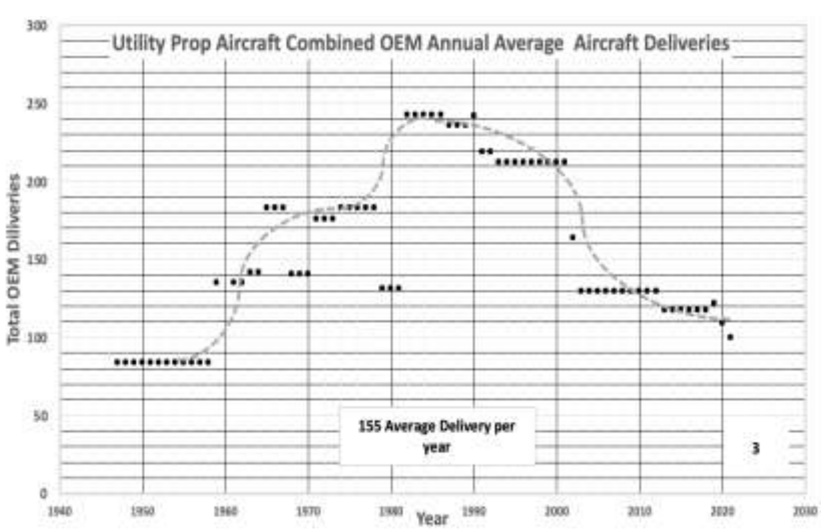
b. **Inter**-UAM aircraft systems are not all VTOL as envisioned for intra-UAM. It is composed of eSTOL and larger eVTOL systems. There was a blend of both operational characteristics was known as V/STOL in the 1960,70, and 80 timeframes. V/STOL aircraft used a rolling takeoff reducing the amount of thrust required to lift an aircraft from the ground (compared with vertical takeoff), and hence increases the payload and range that can be achieved for a given power consumption that is typically greater than the capability of helicopters. Today's developers of electric short – takeoff – and landing (eSTOL) aircraft believe the limitation of battery technology are best overcome by using short runways rather than staying within the confines of a vertipad. Some of the history for V/STOL and lessoned learned was included in the discussion as a reminder.

Type of Order	Number	Percent
Firm Orders	644	5.9%
Flight Hours	265	2.4%
Options	1870	17.2%
Non-firm	8082	74.4%
Total	10,861	

2. **Quantifying the Potential Addressable Market** is an ongoing challenge for any firm estimating demand and funding for new products. This is especially true when the product has new technology replacing an existing product and/or has a potential to create a new market.

   a. **Is a potential for 6,000 to 10,000 deliveries sensible?** Let's review our historical experience with **Light Utility Aircraft** – there have been **12,098** deliveries over the past 6 decades. The average total deliveries per year were **155** aircraft; each firm's average rate was about **25** deliverers per year. The average time in production for a variant is also displayed in the table.

   b. The history of deliveries for regional Utility cargo/passenger prop-aircraft indicates two technology adoption cycles and a decline as the jet propulsion technology emerged. That changed the regional business cases. While the regional aircraft market appears quiet now, the expectations for the Utility sector is to serve as a launching ground for new technologies ranging from eSTOL and eVTOL vehicles boosting the currently stagnant market segment. Many of the proposed eVTOLs under development are intended to serve a substitute for ground transportation in inner-city communities not the short haul routes that provide a few hundred nautical miles of goods, supplies, passengers services that small communities feeding legacy cargo and airline hubs.



3. **Potential Product Expression of Interest.** Developers are booking orders for cargo, passenger, and medical aircraft sectors. Most are conditional based on the aircraft meeting performance targets and business objectives. Little money has changed hands so far. **92%** of the orders are Letters of Intent, LOIs. For manufacturers and investors alike, they serve as an indicator of interest. And for customers, they represent an option for access to the potential transformation of aviation <u>if-and-when demonstrated to be viable.</u>
4. **When can profitable deliveries start – Low-Rate Initial Production, LRIP, Operational Capability Demonstrations and Transition into Full Rate Product Delivery?** As a program moves toward 1st flight, its focus is on producing "*production representative*" test articles for Type Certificate. This effort also provides essential data for the "Production Certificate" to assure that each delivered article is consistent to what was tested and certified by the Type Certificate. This Low-Rate Initial Production (LRIP) phase produce a small-quantity of articles for qualification and hopefully early deliveries supporting the EIS.

   LRIP establishes an initial production base and sets the stage for a gradual increase in **Full-Rate Production (FRP)** upon completion of **Operational Capability Evaluations**. Operational Capability Evaluations may be a part of purchase conditions within the LOI's and firm contracts.

Program Phase	Duration		Estamated Investments		Deliveries
	Months	Years	€(m)	$(m)	
Start To EIS	54	4.5	400 - 500	----	
1st Flt to EIS	19	1.6			
Start to 1st Flt	35	2.9			
Total expected Deliveries					756
		1st Flt to FRP			
LRIP to FRP (~10%) Deliveries					76
LIRP Duration	90	7.5			~10/yr
1st Flt to FRP	71				
Ratio months (1st Flt to FRP)/(Start to 1st Flt) ≅ 71/54 ≅1.3					
(similar Fincial Burn Rate in Full Scall Developemnt = $500(m)			500 - 650	----	
Total Investment is sum of Development to EIS + FRP investment ≅					
			900 - 1,150		

Light Utility Aircraft	Total OEM Deliveries	Duration	Years in Production	Av. Deliveries per year by OEM	Role
Basler BT-67	68	1990 - 2021	11	6	Utility
[illegible]ir	930	1960-1978	18	51.7	Transport
Beechcraft 1900	695	1982–2002	20	34.7	Transport/cargo
Britten-Norman BN-2 Islander	1,280	1965-2021	56	22.9	STOL Utility
CASA C-212 Aviocar	483	1971–2012	41	11.7	STOL Utility
[illegible]	2,600	1982- 2021	39	66.6	Transport/cargo
de Havilland Canada DHC-2 Beaver	1,657	1947–1967	20	83.4	STOL Utility
de Havilland Canada DHC-6 Twin Otter	985	1965-2019	54	18.2	STOL Utility
Dornier 228	370	1982 - 2020	38	9.7	STOL Utility
Embraer EMB 110 Bandeirante	501	1968–1990	22	22.7	STOL Utility
Fairchild Swearingen Metroliner	600	1968–2001	33	18.2	Transport/cargo
LET 410	1,200	1971–2021	50	24	STOL Utility
Shorts 330	125	1974-1992	18	6.9	Utility
Short Skyvan	149	1963-1986	23	6.5	STOL Utility
Tecnam P2012 Traveller	24	2019-2022	2.5	9.6	Utility Transport
Volcanair Partenavia P.68	431	1972 -2021	49	8.8	Utility
Average OEM Deliveries	756	1960-2021	31	25	
Total Deliveries	12,098				
STOL Utility	6,124			51%	STOL AIRCRAFT

   Operational Capability Evaluations are usually performed by an operator in their expected usage operations and environments. Usually, the <u>OEM shares the costs of the equipment for the testing</u>. Operational Test *verifies capability and suitability* for the concept of operations, CONOPS, and business case, regular full-rate delivery. FRP begins. From a business perspective, this should be a change from a <u>financial expenditure flow</u> to <u>positive earnings</u>.

Typically, the transition between LRIP and FRP occurs at about 10 percent of the expected total production quantities. This depends on complexity, level of technology and Operational Capability Evaluations data. <u>The transition between LRIP and FRP consumes additional financial resources similar in amount to those expended in development.</u> Using the SMG data for current funding needed for EIS of about $(€)400-500M. A total investment could be about $(€)900-1,150 constant year currency over an 8 to 10-year period. This table illustrates a programmatic estimate of funding and schedule

4. Industrialization of the Aeronautical "Start-Up" Companies.

Over the past decades the focus for new aircraft projects has been technological advancements in aerodynamics, structures, engines, and avionics. Gains in classical technical areas for new airliner projects have flattened. The performance improvements in the Boeing 787 and Airbus A350 projects may have been a transition point for aeronautical industrial projects. Technology enhancements have offered 15% efficiency gains for the new airliners over the aircraft they replace. While still important, the next airliner projects have an additional focus that has moved to the top of the list.

Performance for environmental considerations will not offer 15% to 20% performance efficiency gains for the new airliners over the aircraft they replace. Our challenge is how to satisfy our environmental objectives at an affordable cost relative to the aircraft that will be replaced.

Technology start-up's experiencing financial challenge to bring an environmental, electrical propulsion, Utility class vehicles to market.

The development cost of a new Utility Class vehicle is generally understood, typically from €1bn to €15bn dependent on the size of the aircraft and the complexity of the project. The next industrialization phases of the vehicle system is less well known. For the last 30 years, aircraft projects have doubled their initial estimated development costs before they reach the Entry into Service, EIS.

Concurrent with the vehicle engineering tasks is the design of a production system which can achieve a shortened time to "break-even" and once there, be produce at affordable cost levels and reliable delivered as scheduled. This phase is the industrialization phase of the aircraft's transition to the market and subsequent air-worthiness needs. There is an extra cost, a funding need, for the design of the industrialized production system. Typically, this added cost is about the same order of magnitude as the engineering development investments to EIS.

After EIS the next major milestone is the cost/revenue break-even point. This is when the revenues from the market price of the delivered aircraft are sufficient to cover development and industrialization expenditures and hopefully generate a profit.

the industrialized production system. Typically, this added cost is about the same order of magnitude as the engineering development investments to EIS.

5. A hypothetical example: Development Budget at start-up approval, ~ € 400 to € 500M, million

At the CDR, Critical Design Review, drawings, and funding is released for initial production. This production phase is the Low-Rate-Initial Production supporting testing, and deliveries as the manufacturing system is matured for an expected Full-Rate-Production need. The added costs will be about another ~ €400 to €500M, million

The total investment costs is now ~ €900M+.

- Funding profile,
  - At the CDR the about 40% of the initially approved Engineering Development (EMD) funds are spent (~ € 200M),
  - Schedule slips 1 to 2 years,

   - Transition to production and product support industrialization is approved (~ € 400M) for a total budget of (~ € 900M),
   - EMD funds are about (~ € 200M)/(~ € 900M) ≅ 22%
- Product delivery rate, starting at about 1/month, to 2/month to 1/week to 1.5 to 2 /week, to 78 to 100/year as a typical Utility class delivery rate.
- Market price ~ € 3M per delivery
- Break-even number of deliveries to recover the investments is sensitive to the "cost Improvement curve reduction factor. 80% is a typical aeronautical cost improvement relation between the cumulated output of a product and its costs. Today the industry is targeting a further 15% improvement in direct manufacturing costs including the supply chain. The combination of manufacturing and supply change management is now known as the Industrialization Phase.

Year from EIS	Deliveries	Cum Deliveries	Residual Unpayed Investment, €M **80%** Improvem	Comparison **68%**	
	1st @ EIS	1	€ 900.00	€ 900.00	
1st year	12	12	€ 880.17	€ 873.02	
2nd year	24	36	€ 857.53	€ 803.83	
3rd year	52	88	€ 842.20	€ 640.78	
4th year	78	166	€ 816.36	€ 334.42	
5th year	78	244	€ 793.98	€ (27.55)	**Break Even**
6th year	100	344	€ 788.20	€ (449.76)	**Positive**
7th year	100	444	€ 777.65	€ (927.40)	**Cash**

The bottom line, a 15% improvement (80% to ~ 68%) Cost Improvement Reduction in the industrial phase is becoming a requirement. A requirement to recover the investment cost in a reasonable amount of time. This example is for a Consolidated Companywide Improvement Process that includes the cost elements (including supply-chain elements) that determine cost and selling price. Achieving these cost reductions in each element will be challenging.

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5. What are the evolving certification challenges, changes?

   a. In the 1960 to the 1970 timeframe there was a distinction between helicopters and fixed wing STOL aircraft. Blended technologies were labeled V/STOL aircraft as they were a combination of Lift and Cruise propulsion as we know it today. Many of the early technology concepts of demonstration vehicles had challenges. Although some did make it into operations, there were some perceived safety concerns due to uncertain handling qualities and the associated training of pilots. These challenges frustrated the adoption of the "V/STOL" vehicles in the 1980-to-2000-time frame.

b. Current Regulations are very specific and distinct for a helicopter and airplane and their pilots. They address the vehicle and pilot using an Integrated "systems" approach that evaluating vehicle design, flying qualities, handling qualities, pilot training and flight-school certification. Flying qualities involves the evaluation of the stability and control characteristics of an aircraft. Handling quality is the combined performance of the pilot and vehicle acting together as a system. This data will also be used for Vertiport guidance. The current FAA vertiport guidance will be used until performance-based vertiport design guidance is developed.

c. This system's performance requirement is to assure a *balance* between the airplane's in-flight stability (or instability) and the pilot's ability, or Automated Flight Management System and software that controls its movements for safe flight. Too extend this performance requirement objective to eVTOL and e-DRONE CARGO a "powered lift operations category" certification is being added supplementing the helicopter and airplane categories.

6. Is the aging utility aircraft a ***realistic target addressable replacement market*** for the evolving technology? Let's look at some typical current Utility aircraft renewal examples.

a. Tecnam's introduction of the P2012 STOL is an example of the accessible utility market serving challenging, remote airports. *Tecnam says the modern piston twin will outperform aging rivals Utility Transport/Cargo competitors like the Britten-Norman BN-2 Islander, Cessna 208B Grand Caravan, and de Havilland Twin Otter.* They consider it a neglected segment of the air transport market where *there is room for growth*. Many short-haul operators serving small, remote airports use aging fleets of aircraft that were designed decades ago and no longer meet modern customers' expectations. Hyannis, Massachusetts-based Cape Air has 100 of the P2012 commuter aircraft on order. Their P-Volt, a battery powered a nine-passenger short-haul aircraft suitable for commuter airline/cargo use, is a derivative, of the 11 passenger P2012 Traveler is in development.

b. ATR 42–600 S (STOL) is a viable option for operators of smaller aircraft had a greater number original airport. the company viewed this measure as expanding the aircraft's potential because of the shorter runway choice and opening new sales possibilities. We're seeing maybe the start of a wave of replacements as *some older aircraft hit their limits, including some regional jets as well*. ATR estimates a market for STOL 20–42 seaters of 800 over 30 years, to serve islands and deliver cargo to short runways.

~~c.~~ FedEx Express' feeder fleet currently uses 238 aging Cessna Caravans—these will be phased out and replaced by the SkyCouriers beginning in 2020. Caravan aircraft was conceived as a rugged STOL utility aircraft with low operating costs. The development focus was on use in rural/remote areas with short runways, extreme weather changes, mountainous terrain, and rough landing conditions. The turboprop is widely use by a variety of customers in global markets, including government agencies, law enforcement and militaries, air ambulance operators, freight haulers, corporations, and humanitarian organizations. Today, 35 years since the first delivery on Feb. 25, 1985, to an air service provider the Cessna Caravan turboprop evolved into four models. The FedEx Express' feeder fleet currently uses 238 aging Cessna Caravans. It was launched on November 28, 2017, made its first flight on May 17, 2020, was type certified on March 11, 2022. ~~FedEx~~

7. Potential operators are ~~also~~ signing Letters of Intent (LOI) for both eSTOL and electrical conventual-takeoff-and-landing (eCTOL). The eCTOL and eSTOL fixed clean wing certification paths, infrastructure, business cases or more straightforward than eVTOL. This may lead to ~~the need~~ an opportunity for less funding and time to arrive at a profitable break-even market position. By 2030, United expects to have electric fixed-wing aircraft (eCTOL) flying regional routes. United and its regional affiliate Mesa Air Group have invested in Swedish startup Heart Aerospace and placed conditional orders for 200 ES-30 30-seat electric regional aircraft, plus an option of another 100. Deliveries are planned to begin in 2028.

8. **Who will Lead?** Experienced judgment is that the STOL cargo and logistics markets will lead the transition. They have an *established, understood, business case and infrastructure*. Today, eSTOL, and clear fixed wing aircraft, eCTOL, have a certification path under the FAA's FAR Part 23 and EASA's CS-23 that can be operated with a standard fixed wing pilot's license and updates to historical “STOLports” and local airports infrastructure. There are significant differences in the CONOPS between air taxis, middle-mile logistics, short-haul cargo, and regional passenger services. The *CONOPS is a mediation between the business cases for the different elements of the ecosystem players and the technical performance of a specific vehicle.* The maturing of a practical CONOPS is a major contributor to the duration of the Technology Induction Phase (time between EIS and FRP) and the transition between LRIP and FRP.

9. Change is in the air. The Utility aircraft market will be the proving ground for future propulsion technologies. It will be key to helping decarbonize aviation, reducing fuel costs and making smaller aircraft economically viable again. Hopefully it will rejuvenate and expand services to smaller communities in the inter and intra-urban air spaces. Expectations are that eSTOL will lead the technology transition due to its established/understood certification, CONOPS and business cases. Autonomous eSTOL and then eVTOL will follow as their technology and certification status matures.

- Over the past 50-60 years the months from development initiation to Entry into Service (EIS) have had “similar variability” across various aircraft systems including less complex Utility Regional Vehicles. This implies that the electrical propulsion technology **development and potential market penetration** will follow a similar course including the time to full-rate production deliveries as production is scaled to demand.
- About 6,000 potential eSTOL deliveries, 60% market penetration, expected
- The military adaptation timeline reflects the combined adoption timescales for the transportation of goods and humans.
- A variety of aircraft concepts are evolving but not all can effectively replace legacy regional flying. A blend of competing propulsion options will be available.

Summary electrical batter powered propulsion presents 4 challenges:

- **Performance:** Batteries replace traditional fuels and are therefore a fixed weight which impacts payload range for the vehicles. In addition, electrical actuation of the propulsion system is usually performed through prop-technology limiting altitude and speed - interesting parameters for vehicle operators.
- **Fixed Cost:** Battery systems installed in an airplane represent an additional “fix-variable” cost as the batteries are a fixed cost item, costed against the vehicle price, whereas fuels are replenished by the operators of a system. They are not a fixed cost in the price of the airplane. The operators pay separately for the fuel.

- **Operating Cost:** Traditional or electrically powered air vehicles are expected to be similar as are the automobile operating cost today.
- **Funding:** Upfront EMD investments are typically 20 to 30% of the total funding needs to reach a Break-Even Point.
- An investment cost estimate for EIS of about **$400-$500m** is based on the SMG financial assessments of current project planning.
- Demand will expand as the business cases and CONOPS mature during the period between EIS and FRP.
- A potential for **10,000+ deliveries** (replacement and new uses) is sensible for utility-class vehicles.
- The total cost of certification and entering full-rate production will be about **$1-1.5 billion.**

Closing Comments.

Turboprop Utility aircraft evolved in the 1960-70's-time frame. In that era several OEM successfully reached the production and operational phases. Today we are asking, will people that operate these aircraft make money? Can you have an Uber in the sky? Is the cargo market viable?

It will not be easy staying the course to FRP and profitability, it's not clear that enough attention has been paid to their business plans for the industrialization of their programs. Consolidation within specific system classes, competing for market acceptance, will be driven by the financial "headwinds" discussed here.

The 1990+ consolidation time frame the closing of Utility class vehicle OEMs was, in part, due to the capital intensive of aircraft industrial development and a fall in demand. The fall in demand for small turboprop was due to jet propulsion technology, the 1978 US Airline Deregulation Act changing the hub-and-spoke business models, and to the difficult transition from LRIP (Low-Rate Initial Production) and FRP (Full Rate Production) that consumed financial resources necessary needed to complete the transition from technology demonstrations into operations.

Will a rise and fall in demand occur again? Of course, new technology always replaces the legacy at some future date.

Appendix: Some History

The US Civil Aeronautics Board (CAB), formed in 1938 and abolished in 1985, was entrusted with safety rulemaking, accident investigation, and economic regulation of the airlines that included regulated aviation for scheduled passenger and cargo airline service. The CAB strictly controlled all U.S. certificated, scheduled, airlines -- deciding which routes would be serviced by which airlines, *setting minimum limits on passenger fares -- effectively managing competition between airlines and ensuring certain levels of service to communities throughout the United States.*

In parallel the FAA (April 1966) published a study examining the technological and economic feasibility of a V/STOL (vertical/ short takeoff and landing) transport system. This was a part of the FAA's agency's long-range study of interurban air transportation -- V/STOL *aircraft operating from small airports close to downtown city areas could play a major role in meeting increasing needs for short-distance inter-urban transportation.*

The 1978 US Airline Deregulation Act gave airlines almost total freedom to determine which markets to serve domestically and what fares to charge for that service. Before airline deregulation, air carriers' operating certificates required air carriers to schedule and provide two daily round trips at each point on their certificates. The prospect of allowing carriers to terminate scheduled air service without prior Government approval *raised concern that communities with small cities and rural communities that have relatively lower traffic levels, would lose service entirely as carriers shifted their operations to larger, potentially more lucrative markets utilizing larger regional aircraft*. After the Airline Deregulation Act, it was judger necessary to subsidizes short-haul inter urban routes, a financial incentive to (underpin) local and regional short-haul aircraft and operations was needed. The Essential Air Service was established.

V/STOL - STOLport's at close-in locations were expected to alleviate some of the air traffic congestion at large conventional airports. Too encourage STOLport's development the FAA, in 1970, issued an advisory circular providing criteria and specific information for planning, designing, and constructing such facilities. In addition, the FAA established a V/STOL (vertical/short takeoff and landing) Special Projects Office to *stimulate and encourage the private development of economically viable V/STOL system*s and *provide a focal point* for all of FAA's V/STOL development activities. The new office would formulate and maintain a comprehensive agency V/STOL development plan. The FAA also signed an agreement with NASA, for ***aircraft handling qualities*** *research projects and the development of certification criteria for new aircraft, such as the V/STOL aircraft.*

Soon after the FAA retitled the V/STOL (vertical/short takeoff and landing) Special Projects Office to the Quiet Short-Haul Air Transportation System Office to foster a short-haul air transportation system acceptable to the public. An interstate STOL transportation system did not mature at that time reflecting public concerns about noise. Noise created by smaller more numerous STOLport's as opposed to larger airports. In 1974 the Quiet Short-Haul Air Transportation System Office was eliminated.

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