6-2013

Market Analysis for Small and Mid-Size Commercial Turboprop Aircraft

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ABSTRACT

Recent fuel price volatility and growing concerns about the efficiency of regional jets have led to a revival of large turboprop aircraft as efficient passenger carriers on short-haul regional routes. However, the overall market for smaller turboprops is much less defined as it is characterized by a plethora of small commuter and niche operators in addition to regional carriers. Since most small and mid-size turboprop manufacturers have gone bankrupt or discontinued production due to some other reasons, current operators of this aircraft class are left with aging fleets that would need to be replaced by 2020-2030. This paper assesses the feasibility of developing a new generation small turboprop aircraft for regional and commuter airline markets through a survey of industry participants. A mail-in questionnaire asked the respondents to evaluate the potential market and their companies' needs for new small turboprops. In addition, the respondents outlined desired characteristics and design features for a new generation small turboprop. The survey respondents' fleets represent approximately 9% of the global commercial turboprop market in the 20-50 seat class. The results indicate that a market for 20-50 seat turboprops exists, and current operators are looking for performance and design characteristics that their aging fleets cannot provide. The survey data and analysis presented in this paper challenge the forecasts for small turboprop deliveries published by Bombardier and Embraer and estimate that about 8,000 of such aircraft will be needed by 2030.

KEYWORDS: turboprop, market analysis, industry questionnaire, aircraft manufacturing

CLASSIFICATIONS: Airline Economics, Airline Strategy, Management and Operations, Air Transport Demand

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INTRODUCTION

According to Boeing's current market outlook, the world economy is expected to grow by 3.2% annually between 2011 and 2031, with the number of passengers increasing by 4% and the revenue passenger-kilometers increasing by 5% per year (Boeing, 2012). As a consequence, the demand for aircraft will nearly double from around 19,890 commercial jets currently in service to more than 39,780 airplanes in 2031, totaling to approximately US $4,470 billion (Boeing, 2012). Forty percent of the projected new airplane orders will come from the need to replace older and less efficient aircraft to meet rising fuel costs and new regulatory requirements.

Recent fuel price volatility and growing concerns about the efficiency of airline fleets have led to a revival of turboprop aircraft as efficient passenger carriers on short-haul regional routes. Many regional airlines around the world are demanding turboprops in the 60+ seat category as they shift away from more costly regional jets of similar size. The most notable successes in the 60+ seat turboprop market have been the Bombardier Dash 8 and the ATR-72. However, many turboprop manufacturers have stopped or significantly reduced the production of smaller (up to 50 seats) turboprops in favor of larger models. Moreover, ATR announced and began development of an even larger turboprop aircraft with 90-seat capacity.

It seems the major players in the turboprop market are creating a void in an entire category of commercial airplane – small turboprops in the 20-50 seat range. Currently, smaller US domestic regional and feeder routers are served by older EMB-120s, Saab-240s and other similar aircraft that are out of production. For example, both manufacturers (Embraer of Brazil and Saab of Sweden) have announced that they have no plans to create a successor for these smaller aircraft. Meanwhile approximately 4,000 of these smaller turboprops play a crucial role in both developed countries, as part of the regional networks, as well as less developed countries, as a substitute for a rail or highway system.

The purpose of this paper is to explore current trends in the turboprop segment of the aviation market and to identify future needs by surveying a global group of regional airlines that utilize turboprops. The survey respondents' fleets represent approximately 9% of the global commercial turboprop market in the 20-50 seat class. The results indicate that a market for 20-50 seat turboprops exists, and current operators are looking for performance and design characteristics that their aging fleets cannot provide. The survey data and analysis presented in this paper challenge the forecasts for small turboprop deliveries published by Bombardier and Embraer and estimate that about 8,000 of such aircraft will be needed by 2030.

CURRENT MARKET

Turboprops play an integral part in the regional aircraft market. Many airlines utilize turboprops as the most cost-efficient aircraft on short-haul routes as a part of airline network optimization. Typically, turboprop aircraft have a shorter range (less than 1,000 miles) and lower cruising speed (350 mph) than regional jets. Fuel makes up a significant portion of an airline's total costs and is considered to be one of an airline's largest expenses. With the increase of crude oil prices from US $19 per barrel in the 1990s to US $96 per barrel in May 2013 and the corresponding increase in jet fuel prices, turboprops' low operating costs are becoming even more attractive.

ATR, the European joint venture formed by Aerospatiale (now EADS) and Aeritalia (now Alenia Aermacchi, part of the Finmeccanica group) indicated that in 2001, turboprops comprised only 15% of the global fleet. This percentage has slightly grown to about 17% in 2012, mostly due to cost effectiveness over aging regional jets. Lower fuel burn for turboprops, in comparison to similarly-sized regional jets, allows airlines to reduce fuel cost and decrease the overall environmental footprint while maintaining capacity.

High oil prices and stricter requirements for noise and emission pollution support the demand for a newer type of turboprop, mainly in the short-haul markets (Embraer, 2012). Due to their higher cruising speeds, jets have remained the primary choice of airlines in the long-haul and medium-haul markets. Additionally, many operators may have to overcome a negative stigma as older types of turboprops provide less comfort to passengers mainly because of higher noise and vibration levels (Brueckner and Pai, 2009). To this effect, turboprop manufacturers, such as ATR, have continuously made improvements to passenger comfort including installation of Dynamic Vibration Absorbers on the upper side of the frames and on the floor beams, thus greatly reducing vibrations generated by the propeller blades. ATR has also begun using skin damping treatment through viscomaterial strips on the panels that reduce noise propagation by the skin (ATR, 2012). Bombardier Aerospace also made noise reduction a priority by installing Active Noise and Vibration Suppression (ANVS) systems on its new Q400 aircraft (Bombardier, 2012).

In addition to low operating costs, turboprops demand less strict requirements of the airport infrastructure than jet aircraft. In many small communities around the world, poor airport/airstrip infrastructure prohibits the use of jets. In addition, regional airports are often the only choice for turboprop operators, as many major airports suffering from delays and congestion have prohibited turboprop operations in favor of larger jet aircraft. Also, while the United States and continental Europe have well-developed train and highway connections that provide attractive transportation choices for short-haul travel, many island communities or communities located in less developed regions of the world (e.g., Africa, northern territories of Canada and Russia) have no alternatives to short-haul air transportation.

The Federal Aviation Administration (FAA) reported that in 2011 the US commercial aircraft fleet consisted of 7,185 aircraft including 3,739 mainline large passenger aircraft with over 90 seats, 2,567 regional carriers (jets, turboprop and pistons), and 879 cargo aircraft (FAA, 2012). Regional carriers represent more than 36% of the total US commercial air carriers and 41% of the passenger fleet.

In 2011, turbine aircraft shipments by US manufacturers fell an estimated 7%, echoing the slow recovery of the US economy. This compared favorably to the 24.9% decline in 2010 and 39.2% decline posted in 2009 (FAA, 2012). The turboprop and piston fleet is expected to shrink in the US from 860 units in 2011 to 564 units in 2032. Turboprop and piston aircraft are expected to account for only 18.9% of the regional carrier passenger fleet in 2032, which is down from a 33.5% share in 2011 (FAA, 2012).

Despite the declining overall trend in turboprop fleets, they remain popular with regional carriers involved in the Essential Air Service (EAS) in the United States. The EAS is a federal subsidy enacted by the US Congress as a means to maintain scheduled commercial air service for communities that otherwise would not offer profitable markets for air carriers (Black, 2011). Since its inception in 1978, the program has been through a renewal cycle several times with each continued authorization bringing slight adjustments to subsidy availability, restrictions, and budget amounts. Principally, the Department of Transportation (DOT) reimburses the operating carriers for each flight at a predetermined rate based off the annual subsidy for the EAS community.

As of October 2012, 163 communities within the US were served through the EAS program at a total subsidy cost of $239 million, which comes to an average of $1.467 million per community (DOT, 2012b). Out of these 163 communities, 133 are served by turboprop and piston aircraft, while only 30 are served by regional jets or Boeing 737s. Table 1 demonstrates the majority of the communities in the EAS program are served by turboprop aircraft with less than 50 seats.

Table 1: The Essential Air Service Program in the United States.

Aircraft Type	Number of Communities Served	Annual Subsidy
Piston	56	$41,140,723
Turboprop	77	$142,294,419
Turbofan	30	$55,687,017
Total	163	$239,122,159

Source: DOT, 2012b

Additionally, many of the regional carriers that receive EAS subsidies also contract with mainline carriers to serve communities that are too large to receive EAS benefits, but not large enough for mainline operation. Also, many of these small markets are not large enough to be served by regional jets or large turboprops and can be economically serviced only by sub-50 seat aircraft.

In addition to serving small communities, turboprops play an important role as cargo transport, as hundreds of these planes fill in as cargo feeders to national and international logistics companies.

GLOBAL MANUFACTURERS

Historically, commercial turboprop aircraft have been produced by dozens of manufacturers in counties all over the world (e.g., Saab, de Havilland, Embraer, British Aerospace, Fokker and ATR). Filling the niche of regional, commuter, utility and small cargo markets enabled these manufacturers to build and deliver thousands of turboprops that constituted a major branch of the global aviation infrastructure. However, these manufacturers arguably flooded the market in the 1970s-1990s, oversupplying a declining demand as many potential customers shifted focus to regional jets or 50+ seat turboprops. As a result, the majority of these manufacturers were either restructured to aeronautics support and/or defense contracting, acquired by other aeronautical firms or ceased operations altogether. Table 2 presents the remaining manufacturers that produce commercial turboprops.

Table 2: Current manufacturers of commercial turboprops.

Manufacturer	Country
ATR	France and Italy
Bombardier Aerospace	Canada
Embraer	Brazil
Xi'an Aircraft Industrial Corporation	China
RUAG Aerospace Services and Hindustan Aeronautics	Germany and India
CASA and Indonesian Aerospace	Spain and Indonesia
GECI Sky Aircraft	France
Antonov	Ukraine

Appendix A presents the aircraft types that comprise the total active commercial turboprop fleet. While some manufacturers left the turboprop market to concentrate on other areas, new entrants have emerged. For example, China continues to develop and produce several regional turboprop aircraft such as the MA60 and a larger improved MA700, which is scheduled to arrive in 2014. South Korea is considering a proposal to fund a 90-seat turboprop aircraft, while Indian NAl is working on its Saras 19-seat turboprop, which had a first test flight in 2004. Indonesian Aerospace (IAe) launched a three-year program to create another 19-seat turboprop aircraft. The aircraft list price is approximately $3.5 million, and is being marketed mostly to small charter operators (Francis, 2010).

In 2002, a major part of the insolvent company Fairchild Dornier was acquired by RUAG, a Swiss group with divisions encompassing aviation, defense, space, munitions and technology. The result was a German commercial entity - RUAG Deutschland – which was subdivided into RUAG Aerospace Structures - primarily supplying large airframe parts to Airbus - and RUAG Aerospace Services, covering German government military support as well as existing Dornier 228 civilian customer care support. Some 230 Do 228s are still flying, with 58 different customers worldwide, and RUAG holds the type certificate for the Do 228-212 (Collins, 2012).

Based on this -212 type certificate, RUAG launched the Do 228 New Generation (NG) in 2007. It was certificated in 2010, under a European Aviation Safety Agency major-change approval. First delivery of the Do 228NG was in 2011, and eight have been sold to date (Collins, 2012). Features of the newer aircraft include a new five-blade propeller, a Rockwell Collins and Universal glass cockpit and an uprated -10 version of the Honeywell TPE331 engine (Morrison, 2011). Likely markets for the aircraft include cargo, medevac, Caribbean island hopping and, thanks to its short take-off performance, "specialized commuter", such as transporting personnel to mines and other remote operations. The company is also discussing the non-pressurized aircraft's potential for sensor-equipped reconnaissance and homeland security missions (Morrison, 2011).

RUAG targets a production rate of eight to twelve Do 228NG aircraft per year to meet a forecast of 300-plus aircraft over 20 years. The complete airframe of the Do 228NG is built by India's Hindustan Aeronautics and then shipped to Germany, where RUAG carries out final assembly and fits ancillary systems, engines and avionics (Collins, 2012).

In May 2012, Saab announced it was considering a return to the civil aircraft manufacturing market. It is still currently manufacturing its Grippen aircraft for the military, but its 37-seat Saab 340 and 50-seat Saab 2000 have not been produced since 1997 (Trimble, 2012). There are still several hundred of their aircraft being owned and leased around the world, and the past success of the program warranted a new study. However, it seems that after a discussion with suppliers and engine manufacturers, Saab has decided that its focus should be placed elsewhere (Kaminski-Morrow, 2012).

In 2001, GECI Aviation announced its intentions to develop the Skylander SK-105, a new generation 19-seat, twin-engine turboprop aircraft that was marketed as an interchangeable passenger, cargo, and utility aircraft with Short Takeoff and Landing (STOL) capability. Although the firm acquired 46 orders in 2011, and 40 more in 2012 with options for an additional 260, the company has encountered financial difficulties and failed to complete a prototype to continue testing (Sarsfield, 2011; Zaitsev, 2012). The GECI Aviation branch has since gone into receivership as the company attempts to procure sufficient financing to continue the project. GECI continues to produce the Reims-Cessna F-406 Caravan II, surpassing 100 airframes in 2011 with modest orders over the next few years (Sarsfield, 2011).

In addition to these mainly commercial turboprop manufacturers, several other companies have continued or began production of business and 'utility' marketed aircraft. Business turboprop aircraft that currently are in production include: Cessna Caravan, United States; Beechcraft King Air 350, United States; Piaggio P.108 Avanti, Italy; Piper Meridian, United States; Socata TBM 850, France; Pilatus PC-12, Switzerland; GECI Aviation (Reims-Cessna), F-406 Caravan II, France. Currently produced 'utility' aircraft are: Britten Norman Islander BN-2, United Kingdom; Bombardier CL-415, Canada; Pilatus PC-6, Switzerland; Quest Kodiak 100, United States; Viking Air DHC-6 Twin Otter, Canada; CASA/IAe 212/235/295, Spain/Indonesia.

INDUSTRY FORECASTS

In 2011, the US Energy Information Administration forecasted the price of crude oil will average US $103 per barrel for the next 20 years (Aerospace Global Report, 2011). However, in the first half of 2012, the US Energy Administration upped their oil price prediction by $20 per barrel, increasing the expected 20 year average to $126.

Interestingly, before this prediction was revised, Bombardier had estimated that approximately 40% of the 20-99 seat market deliveries will be turboprops up until 2030 (Bombardier Market Forecast, 2011). After the announcement of the revised oil prediction, Bombardier also revised their turboprop estimates by stating that 48% of 20-99 seat aircraft delivered will be turboprops (Bombardier Market Forecast, 2012). As presented in Table 3, this percentage equates to an estimated 2,850 20-99 seat turboprop aircraft to be delivered by 2031. Additionally, Bombardier believes that the overwhelming majority of all deliveries (95%) will be in the 60-99 seat category, leaving only 150 new turboprops delivered with 59 seats or less. The figure of only 150 aircraft over twenty years seems very unlikely, especially considering that only RUAG is planning to sell 300 19-seat Do-228NG over the same timeframe.

The turboprop market can be divided into several segments. Different manufacturers identify those segments differently. For example, Embraer has 30-60, 60+ seat categories; Bombardier 20-59, 60-99; ATR mixes with turboprops with regional jets in 30-50, 30-60, 61-90, and 91-120 seat categories.

According to the Embraer Market Outlook (2012), approximately 2,070 turboprops in the 30+ seat category were in service in 2011 with an average age of 15 years. By 2031, the total turboprop fleet is forecasted to increase to 3,235 with 2,515 new turboprops (with a capacity of 30+ seats) to be delivered (see Table 3). Out of the 2,515 new turboprops to be delivered, 46% will support market growth and 54% will replace aging aircraft. Approximately 83% of turboprop demand will be in the capacity of 60 seats or greater.

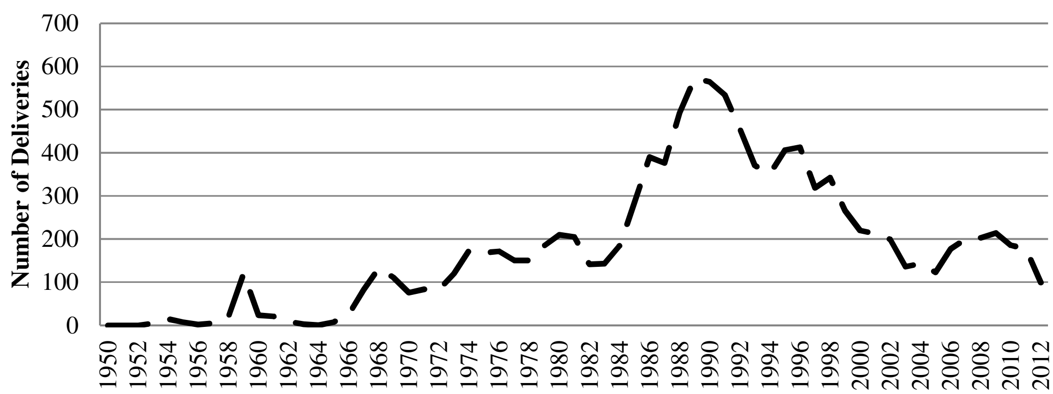
Table 3: Turboprop delivery forecast, 2012-2031.

Bombardier Forecast		**Embraer Forecast**	
20-60 seat segment	150	30-60 seat segment	440
60-99 seat segment	2,700	60+ seat segment	2,075
Total New Delivery (20-99)	2,850	Total New Delivery (30+)	2,515

Source: Bombardier Market Forecast 2012-2031;Embraer Market Outlook, 2012-2031

CURRENT FLEET AND HISTORY OF DELIVERIES

Turboprop and Regional Jet delivery data were compiled by the authors using Flightglobal's Ascend database, and OAG Aviation's FleetNet database. Figure 1 demonstrates the global commercial turboprop deliveries between 1955 and 2012. A total of 16,175 turboprop aircraft were delivered in this timeframe with a peak of almost 600 deliveries in 1989. Since 1989, the delivery numbers exhibit a declining trend line with the lowest number of deliveries since 1973 occuring in 2012 with 100 aircraft.



Source: Flightglobal's Ascend database and OAG Aviation's FleetNet, December 2012

Figure 1: Commercial turboprop deliveries.

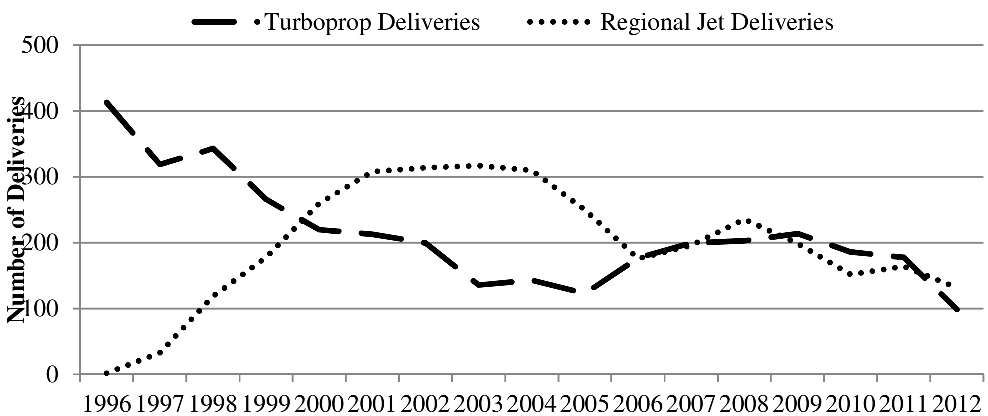
As presented in Table 4, delivery data shows that out of 16,175 produced aircraft 5,463 are still in active commercial use, and approximately 4,690 are owned privately, by government agencies, or are currently in storage. Weighted average aircraft age by seat class indicates that currently 40-50 seat category has the oldest average aircraft age of 28.6 years, fewer than the 20 seat category has the second oldest age of 23 years, following by 18.7 years for 20-30 and 30-40 categories. Aircraft with more than 50 seats that are still in production had an average age of 14.8 years.

Table 4: Turboprop fleet by seat category.

Fleet by Seat Category	<20	20-30	30-40	40-50	>50	Total
Aircraft Delivered	8,226	677	1,257	3,669	2,346	16,175
Current Turboprop Fleet	2,305	269	648	496	1,745	5,463
Percent Still in Service	28%	40%	52%	14%	74%	34%
Average Age (years)	23	18.7	18.7	28.6	14.8	-

Source: Flightglobal's Ascend database and OAG Aviation's FleetNet, December 2012

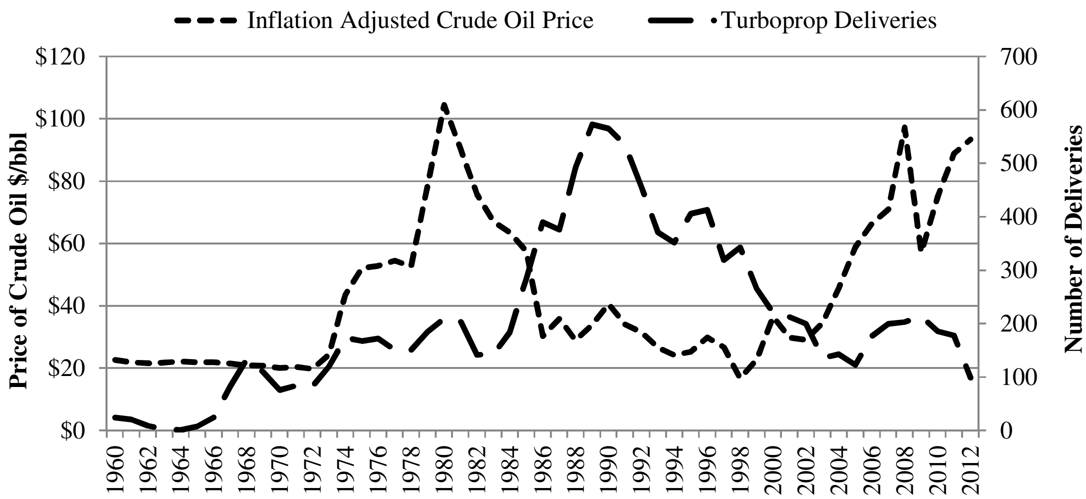
Figure 2 presents the turboprop deliveries versus regional jet deliveries in 1996-2012. Between 1996 and 2006, the two lines seem to suggest a negative correlation (when turboprop deliveries were decreasing, regional jet deliveries were increasing, and vice versa); after 2006, they are both moderately declining.



Source: Fleet iNet database 2013

Figure 2: Turboprop and regional jet deliveries in 1996 – 2012.

Figure 3 illustrates the relations between turboprop and regional jet deliveries and the inflation adjusted price of crude oil. There appears to be a lag of 7-9 years between crude oil price and deliveries of turboprop that is especially obvious in 1980 – 1998 period. Inflation adjusted crude oil price peaked in 1980 and steadily declined until 1998; whereas, Turboprop deliveries peaked in 1989 and then declined until 2005 – almost exactly mirroring the crude oil price pattern with 7-9 year delay. If this historical relationship holds, we are about to witness an increase in deliveries of turboprops.



Source: Fleet iNet database 2013

Figure 3: Crude Oil Price vs. Turboprop and Regional Jet Deliveries in 1960 – 2012.

GLOBAL REGIONAL OPERATORS SURVEY

To assess an opinion of the current regional operators toward potential markets for a new generation of 20-50 seat turboprops and identify their desired characteristics and features, a mail-in survey was conducted by Embry-Riddle Aeronautical University and InfoJets, Inc. research team. The questionnaire consisted of more than 20 questions concerning both specifics about fleet data and aircraft requirements, as well as open ended questions to collect participant opinions on the market and industry. Airline representatives were contacted through the Regional Airline Associations of Europe and North American and others. In an attempt to increase the response rate, the questionnaire was prepared in English, French, Spanish, Russian, Portuguese, and Chinese. Out of 300 airlines surveyed globally, 31 responses were received, generating a response rate of 10%. Appendix B presents a list of the respondents including countries where they operate and years when they established their operations. While only 31 regional flight operators responded to the survey, their fleets represent about 9% of the global commercial turboprop market in the 20-50 seat category. Figure 4 illustrates the survey respondents' fleets as percentage of global turboprop fleets by category. As presented in the figure, the 30-40 seat category was well-represented in the survey with respondents' fleets comprising 12.19% of the global fleet in the corresponding aircraft category. According to the responses, 52% of the carriers operate a mixed fleet of regional jet aircraft and turboprop, and 84% believe that a market for smaller 20-50 seat turboprops exists.

Collected data was analyzed both qualitatively and quantitatively to assess respondent's opinion about the potential market for a new generation small turboprop and desired features and characteristics of such an aircraft if it is developed.

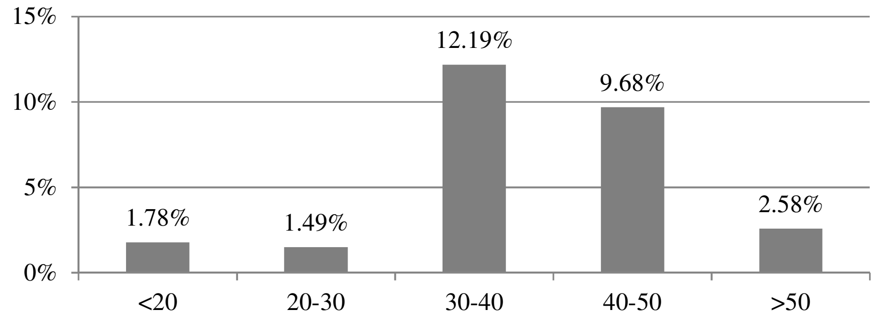


Figure 4: Survey respondent fleet as percentage of global turboprop fleet per seat category.

Survey Results

In this section we present the survey results in the order the questions were included in the questionnaire, which was organized into several sections:

- General section (questions about perceived market for such aircraft, when the respondent's company may need them, needed passenger capacity, exact number of seats, and if dedicated cargo version is needed);
- Performance characteristics section (questions about payload range, maximum cruise speed, take-off distance, soft-field operation capabilities, and desired maintenance performance characteristics);
- Interior arrangement and comfort features section (questions about desired interior arrangements; time for passenger to cargo conversion; business class seats options; and desired comfort features);
- Economic characteristics section (questions about list price vs. economic performance, and desired level of commonality among different aircraft in the family);
- Comments section (open-ended questions about future of regional air travel, features and characteristics not mentioned in the questionnaire, and other comments);
- Company information section.

When the questions were intended to ask for the respondent's opinion, a scale of 1 to 5 was used. The selected value of 1 indicated "No market at all" or "Does not need at all", while the selected value of 5 indicated "Very substantial market" or "Needs very much". The value of 3 indicated a neutral opinion of the respondents.

General Section

1. *In your opinion, is there a market for new generation turboprop aircraft in 20-50 seats category? (Yes, No, N/A)*

Overwhelming majority of respondents (89.6%) indicated that yes, there is a market for such aircraft, while 10.4% of respondents believe that there is no market.

2. *If "YES", when do you think your company will need such an aircraft? (Number of years for each category of aircraft)*

As presented in Figure 5, perceived need for such aircraft is between 3 and 6 years. It seems that the need for 20-30 and 30-40 seat categories is more immediate that for 40-50 seat category aircraft.

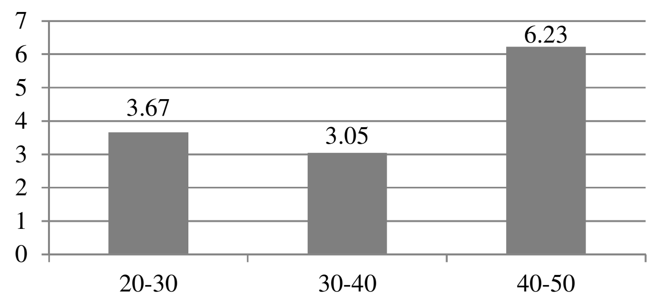


Figure 5: When will your company need such aircraft?

3. *Considering existing and future route network, what aircraft passenger capacity does your company need? (Scale from 1 to 5 for each seat category, or N/A)*

Figure 6 presents the average response for each category of aircraft. The most positive response was for 40-50 seat category, while 30-40 and 20-30 seat category needs were perceived slightly above and slightly below neutral.

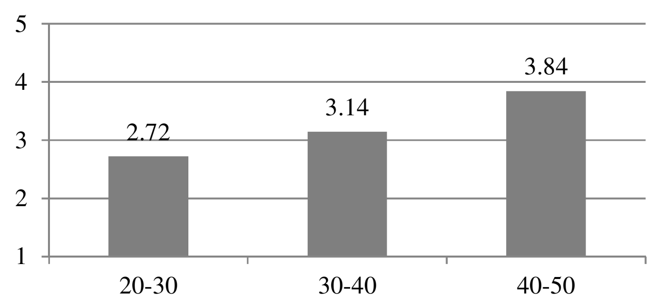


Figure 6: What aircraft capacity does your company need?

4. *Please, specify the exact number of seats that would be optimal for your company in each category of aircraft (Number of seats for each category of aircraft, or N/A).*

Figure 7 illustrates the average number of seats selected by the respondents. While for 20-30 and 30-40 seat categories the response was very close to the middle of category range (25.1 and 36.4 seats respectively), the optimal number of seats for the 40-50 seat category was almost maximum – 49.8 seats.

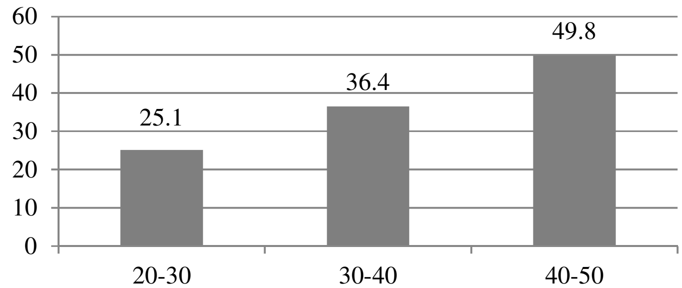


Figure 7: Optimal number of seats for each category of aircraft.

5. *In your opinion, is there a market for a dedicated cargo version of such an aircraft? (Scale from 1 to 5, or N/A)*

As illustrated in Figure 8, the respondents believe that there is no need for a dedicated cargo version for either category of aircraft (all averages less than 3).

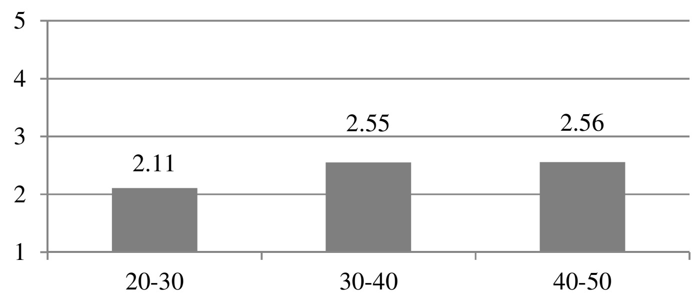


Figure 8: Need for a dedicated cargo version.

Performance Characteristics

1. *In your opinion, what should be the full passenger and maximum payload range for each category of aircraft? (Specify full passenger and maximum payload range (nm), N/A)*

As shown in Figure 9, the full passenger and maximum payload range increases with the number of seats of the aircraft. The respondents believe the 20-30 seat category aircraft should have a 600-650 nm range, while the 40-50 seat category aircraft will require up to 900 nm of the maximum payload range

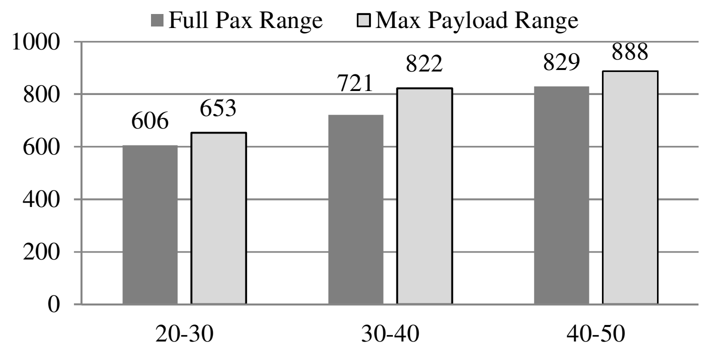


Figure 9: Full passenger and maximum payload range.

2. *In your opinion, what the maximum cruise speed of the aircraft should be? (Specify maximum cruise speed (kt), N/A)*

As with maximum payload range, respondents also indicated the maximum cruise speed of the aircraft increases with the number of seats, as shown in Figure 10.

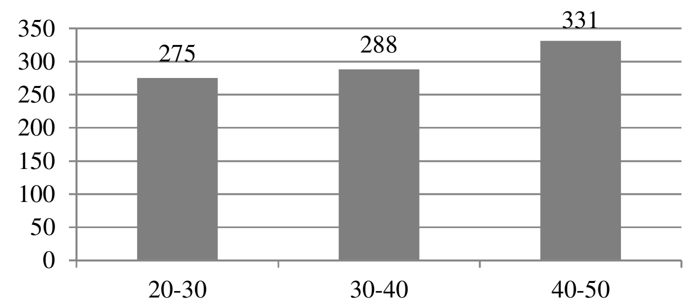


Figure 10: Maximum cruise speed (kt).

3. *In your opinion, what take-off distance is required at sea level (ISA, MTOW)? (Specify take-off distance (ft), N/A)*

Figure 11 illustrates the respondents indicated the required take-off distance for the 20-30 seat category aircraft can actually be higher than the typical take-off distance for current models of the same category of aircraft (1800-1900 ft). As for the categories for 30-40 seat and 40-50 seat categories, respondents believe the required take-off distance should be within the current models' ranges (3200-5100 ft and 3800-5400 ft, respectively).

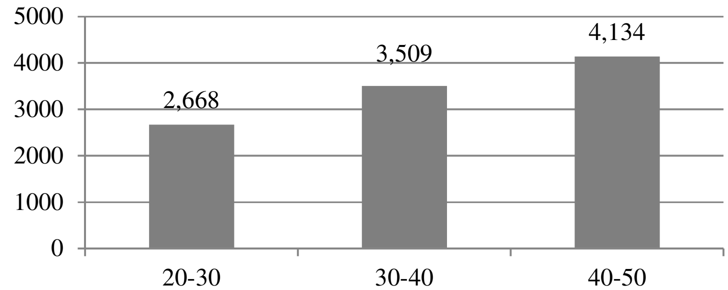


Figure 11: Required take-off distance (ft).

4. *In your opinion, is it important for the aircraft to have soft-field operation capabilities? (Scale from 1 to 5, N/A)*

As demonstrated in Figure 12, respondents felt that soft-field operation capabilities were somewhat important for the 20-30 seat and 30-40 seat categories, but not important for the 40-50 seat category.

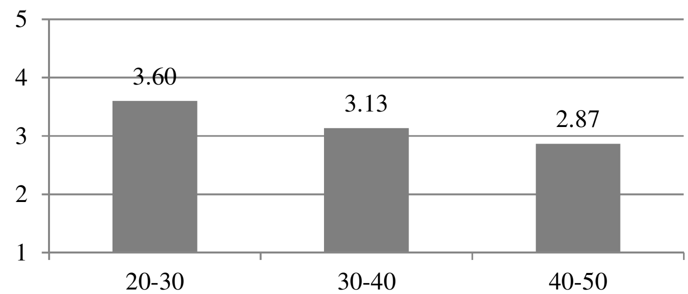


Figure 12: Importance of soft-field operation capabilities.

5. *Please, specify the following desired maintenance performance characteristics for each category of aircraft. (Specify turnaround time (min), daily maintenance check (Yes/No), Line check, A-Check, C-Check (flight hours), and Design life (flight hours/cycles))*

As shown in Figure 13, respondents indicated that the desired turnaround time for the 20-30 seat category is the longest with 31 minutes, while the shortest desired turnaround time is for the 30-40 seat category. While this result seems counterintuitive, all recommended turnaround times are quite similar (about 30 minutes).

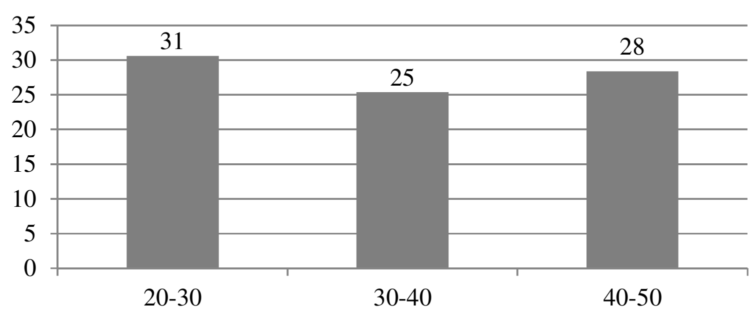


Figure 13: Turnaround time (min).

Figure 14 shows the desired time between Line Checks and A-Checks increase with the number of seats; however this pattern does not hold for C-Checks. The 30-40 seat category had the fewest number of flight hours between C-Checks with 3,860 hours, with the 40-50 seat category being the longest between C-Checks with 6,250 flight hours.

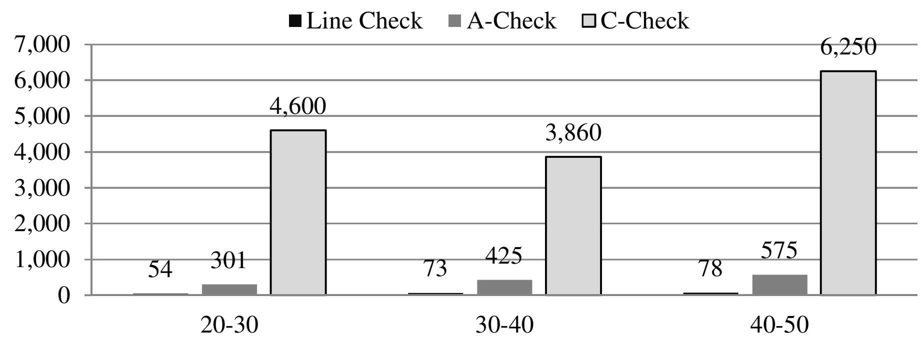


Figure 14: Maintenance intervals (flight hours).

According to Figure 15, the respondents expect the design life of the 20-30 and 40-50 seat categories to be 72,000 flight cycles and 60,714 and 65,000 flight hours, respectively. This suggests the respondents expect the aircraft to perform short-haul flights. It seems that the respondents believe the 30-40 seat category turboprops will be used on a bit longer flights as they indicated the desired design life of 68,750 flight hours and 61,667 flight cycles.

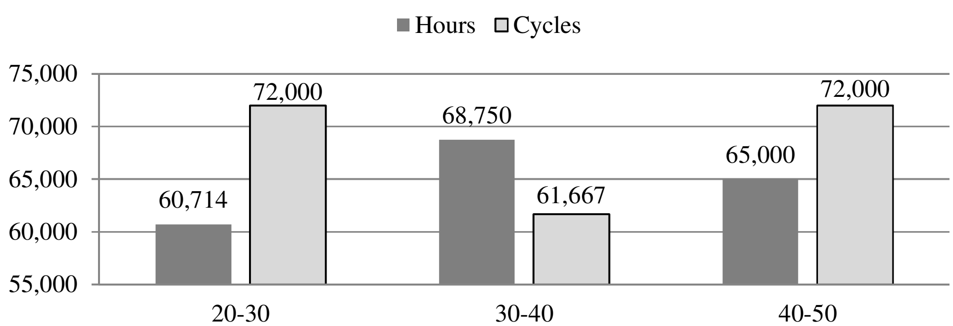


Figure 15: Design life.

Overall, respondents did not feel that daily maintenance checks were needed. For the 20-30 and 40-50 seat categories, 63% felt the checks were unnecessary. For the 30-40 seat category, 67% of respondents felt the daily maintenance checks were not needed.

Interior Arrangement and Comfort Features

1. *Please, specify the following desired interior arrangements for each category of aircraft. (Specify seat width, seat pitch, aisle width, and headroom in inches. Specify overhead bin volume per passenger and baggage compartment per passenger in cubic feet. Specify cargo door height and width in inches.)*

Figure 16 summarizes the desired aisle width, seat width, seat pitch, and headroom specified by the respondents. All of the numbers are fairly consistent throughout the three categories. There was also no significant difference regarding the overhead volume and baggage space per passenger, as shown in Figure 17. Figure 18 reveals the respondents felt the 30-40 seat aircraft should have a larger cargo door than the other two categories of aircraft.

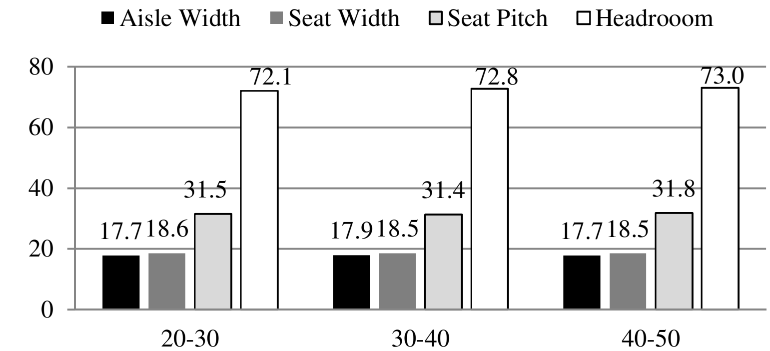


Figure 16: Interior dimensions (inches).

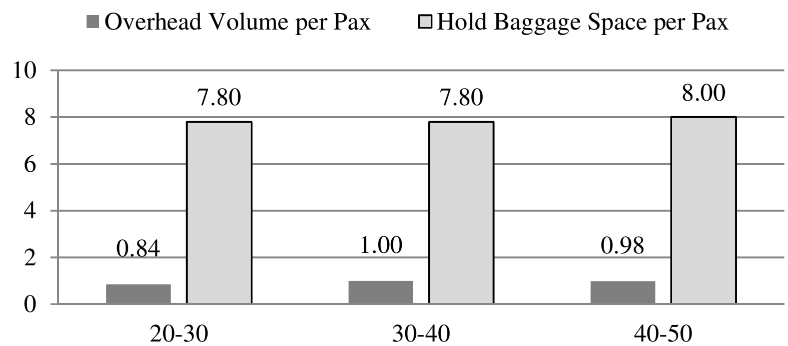


Figure 17: Passenger storage needs (cubic ft).

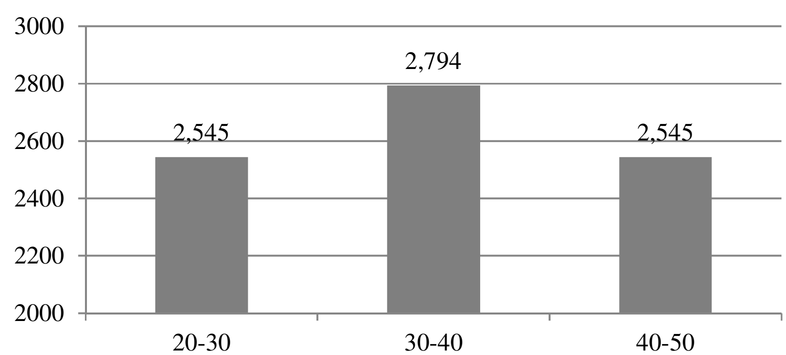


Figure 18: Cargo door dimension (square inches).

2. *In your opinion, what should be the target time for passenger to cargo conversion? (Specify conversion time (min), N/A)*

As demonstrated by Figure 19, the respondents felt that the target time for passenger to cargo conversion should be much shorter for the 20-30 seat category aircrafts (48 minutes), compared to the other two categories of aircraft.

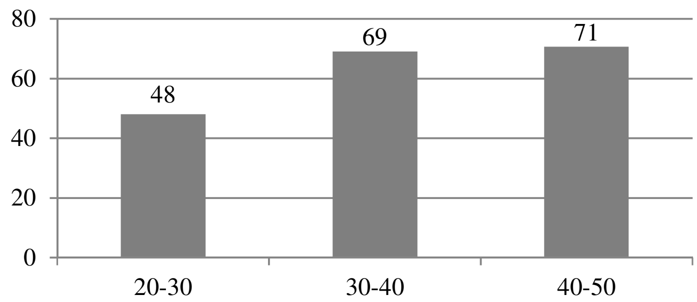


Figure 19: Target time for passenger to cargo conversion (min).

3. *In your opinion, should the aircraft of this family have a business class seats option? (Yes, No, or N/A)*

Figure 20 shows most respondents felt no need for a business class seat option for the 20-30 and 30-40 seat categories. For the 40-50 seat category the opinion was split equally between the respondents that believed that there was a need for business class and those who felt there was no need.

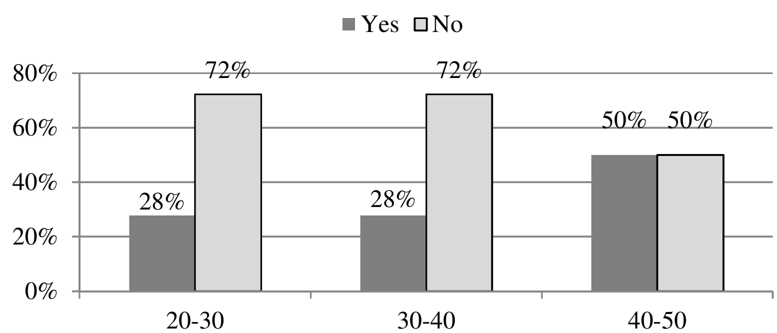


Figure 20: Business class seat option preference.

4. *In your opinion, how important for each category of aircraft to have following comfort features? (Scale from 1 to 5, or N/A for in-flight entertainment system, galley, and mobile phone/internet compatibility)*

The respondents felt that in-flight entertainment (IFE), galley, nor Mobile/WiFi Support were important for turboprops with 20-30 seats, as shown by Figure 21. However, a galley became important for aircraft with 30-40 and 40-50 seats.

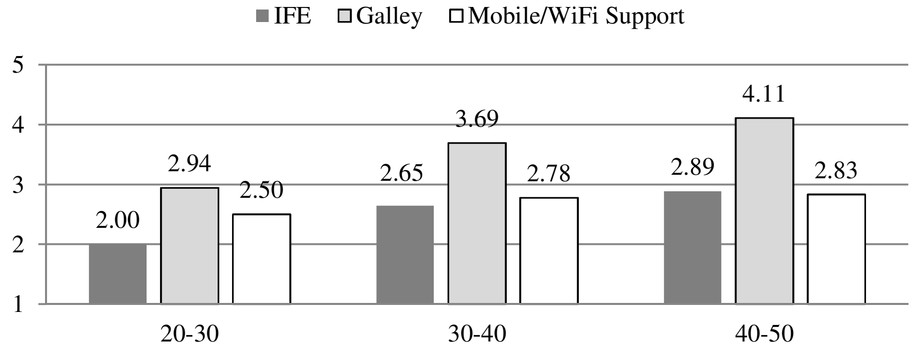


Figure 21: Amenity perceived need.

Economic Characteristics

1. *Improved fuel efficiency usually comes with a higher list price of new aircraft. In your opinion, what is the right balance between the improvements in fuel consumption and the increase in price of the aircraft? (Select one or more cell that represents the best relationship.)*

Figure 22 demonstrates that a large portion of the respondents, 30%, would not be willing to pay extra for any decrease in fuel burn. The majority of remaining respondents would be willing to pay 5-10% premium for 10-20% decrease in fuel consumption. The largest group of the participants (12%) selected 20% decrease in fuel burn versus 10% increase in list price as the most favorable combination.

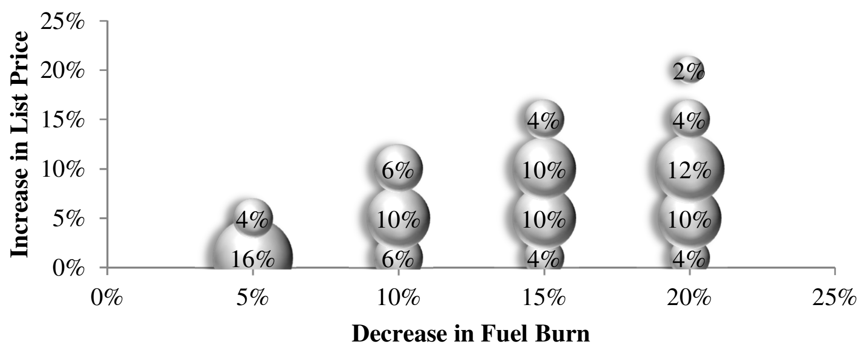


Figure 22: Increase in list price vs. Decrease in fuel burn.

2. *Built in low maintenance expenses usually come with a higher list price of new aircraft. In your opinion, what is the right balance between the reductions in maintenance expenses and the increase in price of the aircraft? (Select one or more cell that represents the best relationship.)*

As with decreased fuel burn, there was a portion of respondents who were not willing to pay extra for any reduction in maintenance expense, as shown in Figure 23. About 26% of the participants would not pay extra for any reduction in maintenance costs. However, 16% of the participants indicated that they would be willing to pay a 10% premium for a 10% reduction in maintenance expense. In general, the majority of the participants (66%) would consider paying 5-10% more for the aircraft with 10-20% reduced maintenance expenses.

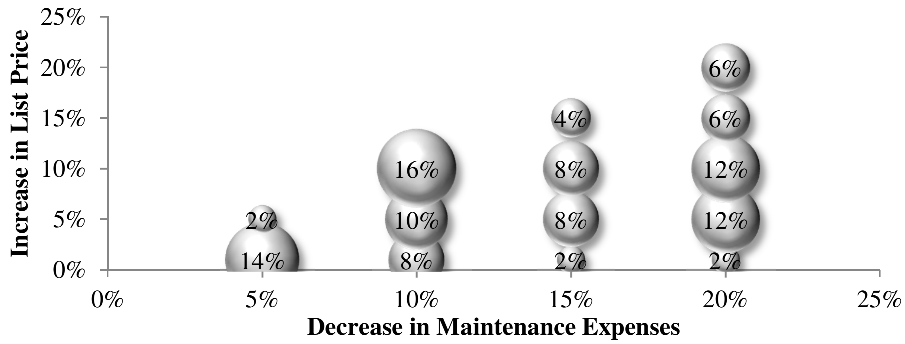


Figure 23: Increase in list price vs. Decrease in maintenance expenses.

3. *Built in low overall operating expenses usually come with a higher list price of new aircraft. In your opinion, what is the right balance between the reductions in operating expenses and the increase in price of the aircraft? (Select one or more cell that represents the best relationship.)*

Figure 25 shows the perceived relationship between list price and reduced operating expenses. In general, the response is similar to the questions about fuel burn and maintenance expenses. While 22% of the respondents would not pay extra for any reduction in overall operating costs, 46% of the respondents would pay a 5-10% premium for a 10-20% reduction in overall operating expenses.

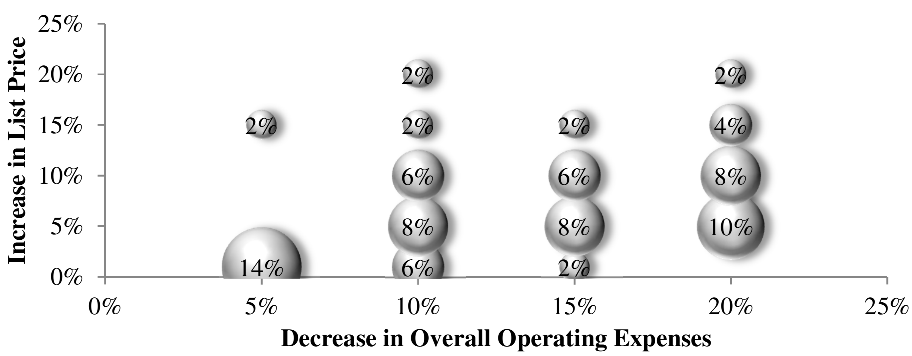


Figure 25: Increase in list price vs. Decrease in overall operating expense.

4. *In your opinion, what should be the level of commonality in the engine and aircraft systems among the aircraft in the family? (Check one.)*

As presented in Figure 26, most respondents, or 40%, selected a "significant partial commonality" between the engine and aircraft systems, while 36% chose the maximum possible commonality among aircraft categories. In general, the overwhelming majority of respondents believe that the aircraft in the family should have significant level commonality in the engine and aircraft systems.

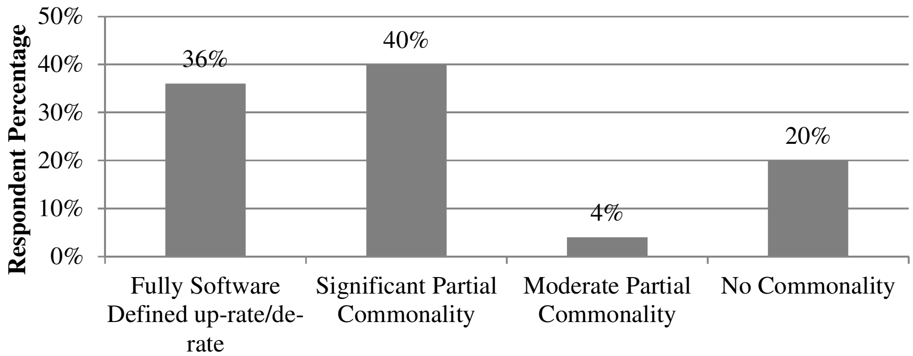


Figure 26: Desired level of commonality in the engine and aircraft systems.

5. *What should be the list prices of the new family of aircraft comparing with the turboprops that currently are in operations for your company to consider the purchase? (Select one.)*

The largest portion, or 41%, of respondents selected a price range between 5% and 10% of the currently operated turboprops in order to consider purchase, as shown in Figure 27. The second largest group included 0% to 5% price range and accounted for 23% of respondents.

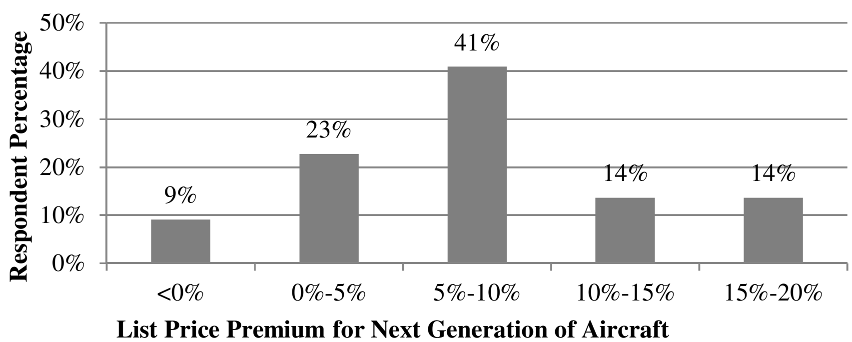


Figure 27: Acceptable list price for new aircraft.

6. *Please, provide your best estimate of the number of aircraft in each category that your company will need in the future. (Specify number of aircraft by category for each year, or N/A.)*

As shown in Figure 28, the respondents expect the demand for 40-50 seat turboprops to increase over the next 17 years. The demand for 30-40 seat turboprops is expected to remain roughly stable, and the demand for 20-30 seat aircraft is expected to decline sharply by 2025.

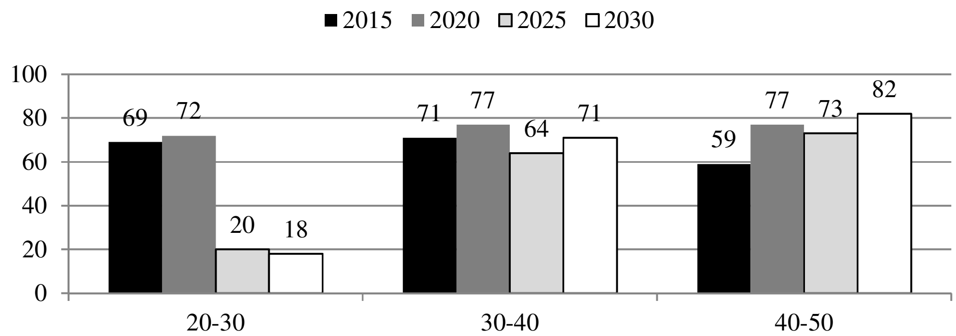


Figure 28: Number of aircraft desired per year.

SURVEY BASED FORECAST AND DISCUSSION

Table 6 summarizes the respondents' estimate of their companies needs for new generation of turboprop aircraft. The respondents believe that a total of 753 aircraft desired within the 20-50 seat category by 2030. This estimate is in stark contrast with the 150 20-59 seat turboprop deliveries forecasted by Bombardier and the 440 30-60 seat turboprop deliveries forecasted by Embraer over the same time period. Considering the respondents represent approximately 9% of the global turboprop market and expect to receive 753 new aircraft over the next 20 years, an extrapolation of this number would suggest 8,367 new small turboprop deliveries by 2030.

Table 6: The survey respondents forecast for turboprop demand.

Seat Category	2015	2020	2025	2030	Total
20-30	69	72	20	18	179
30-40	71	77	64	71	283
40-50	59	77	73	82	291
Total	199	226	157	171	753

Balancing the survey results with industry outlooks and the secondary data analysis, it is purported that due to the aging 19-50 seat turboprop fleets and their practical usage for business, cargo, utility, regional passenger networks, and other niche markets, the 20-year demand for these aircraft has been strongly underestimated, with enough justification for new production.

Turboprop operators will need to replace thousands of these aircraft in 20-30 years, and the current production of Do-228NGs by RUAG and LET-410s is much too limited to fulfill this mission. Perhaps GECI will achieve a financial recovery and re-start their promising Skylander program, or maybe in several years Saab will re-evaluate its own return to the market. The business functions and utility aspects of smaller turboprop aircraft are currently accounted for by the likes of Cessna, Beechcraft, and Viking Air. As for now, the commercial turboprop market appears to be the least competitive segment in any aspect of aircraft production.

The results of the survey indicate current operators of small turboprops welcome potential development of a new generation 20-50 seat turboprops and indicate the desired characteristics of such aircraft are as follows:

- 25-50 passenger seats;
- 650-900 nm maximum payload range;
- 275-330 kts maximum cruise speed;
- 2,700-4,100 ft required take-off distance at sea level;
- Soft-field operation capabilities for the 20-30 seat category of aircraft;
- Designed for 30 minutes turnaround time;
- Design life of 65,000 flight hours and 72,000 flight cycles;
- Designed for 50-70 minutes of passenger to cargo conversion time;
- Galley in the 30-40 and 40-50 categories of aircraft;
- 10-20% lower operating expenses than current;
- Significant level of commonality in the engine and aircraft systems among the aircraft in the family;
- List price of with a 5-10% premium comparing with current turboprop aircraft of similar capacity.

CONCLUSION

Recent fuel price volatility and growing concerns about the efficiency of regional jets have led to a revival of large turboprop aircraft as efficient passenger carriers on short-haul regional routes. However, the overall market for smaller turboprops is much less defined as it is characterized by small and diverse commuter and niche operators in addition to regional carriers. Since most small and mid-size turboprop manufacturers have gone bankrupt or discontinued production due to some other reasons, current operators of this aircraft class are left with aging fleets that would need to be replaced by 2020-2030. With no manufacturers presently developing aircraft that would fill the niche of a 20-50 seat turboprop that can be produced in large numbers, the fleet replacement and expansion needs of flight operators will remain unfilled.

This paper assesses the feasibility of the development a new generation small turboprop aircraft for regional and commuter airline markets through a survey of industry participants. In a mail-in questionnaire the respondents were asked to evaluate potential market and their companies' needs for new small turboprops. In addition, the respondents outlined desired characteristics and design features of a new generation small turboprop. The survey respondents' fleets represent approximately 9% of the global commercial turboprop market in the 20-50 seat class. The results indicate that a market for 20-50 seat turboprops exists and current operators are looking for performance and design characteristics that their aging fleets cannot provide. The survey data and analysis presented in the paper challenge the forecasts for small turboprop deliveries published by Bombardier and Embraer and estimate that about 8,000 of such aircraft will be needed by 2030.

APPENDIX A

ACTIVE AND DISCONTINUED COMMERCIAL TURBOPROP AIRCRAFT

	Country of Origin	Models (seats)	Years in Production	Active	On Order	Status
ATR	France and Italy	ATR-42 (46-50), ATR-72 (68-74)	1984–present	851	198	Active
Beech Aircraft Corporation	United States	Beech 99 (15), 1900 (19)	1960-present	724	0	Active
Bombardier	Canada	DHC-8-400 (78)	1983-present	597	48	Active
Antonov	Ukraine	An-24 (44), An-140 (52)	1962-present	500	11	Active
Cessna	United States	208 Caravan (14)	1984-present	492	0	Active
Britten-Norman	United Kingdom	BN-2 Islander (9)	1965-present	82	0	Active
Let	Czech Republic	L-410 (19)	1971-present	74	0	Active
AVIC XAC	China	MA60 (60)	2000-present	45	10	Active
CASA	Spain and Indonesia	C-212 (26)	1974-present	21	6	Active
Iae	Indonesia	C-212 (26)	1974-present	19	4	Active
Viking Air Limited	Canada	DHC-6 Twin Otter (19)	2008-present	7	17	Active
RUAG	Germany/India	Do-228 (19)	2008-present	2	1	Active
De Havilland Canada	Canada	DHC-6 (19), DHC-7 (50), DHC-8 (37-78)	1928-1992	804	0	Discontinued
SAAB	Sweden	Saab 340 (34), Saab 2000 (50-58)	1983-1999	303	0	Discontinued
Fairchild	United States	SA226-T Metroliner (19)	1972-2001	242	0	Discontinued
Embraer	Brazil	EMB-110 (19), EMB-120 (30)	1968-1985	237	0	Discontinued
BAe	United Kingdom	ATP (64), Jetstream 31 (19), Jetstream 41 (30)	1980-1997	175	0	Discontinued
Fokker	Germany	F27 (28-32), F50 (58)	1955-1997	154	0	Discontinued
Dornier	Germany	Do-228 (19), Do-328 (30-33)	1982-2000	130	0	Discontinued
Short Brothers	Northern Ireland	330 (30), 360 (36)	1974-1992	72	0	Discontinued
Convair	United States	CV-580 (34)	1947-1954	29	0	Discontinued
Hawker Siddeley	United Kingdom	HS 748 (40-58)	1960-1988	22	0	Discontinued
Douglas	United States	DC-3 (21-32)	1936-1942	7	0	Discontinued

Source: OAG Aviation's FleetNet, December 2012

ADDITIONAL INFORMATION ON DISCONTINUED TURBOPROP MANUFACTURERS

Manufacturer	Country of Origin	Years in Production	Active	Reason for Discontinuation
De Havilland Canada	Canada	1928-1992	804	Acquired by Bombardier in 1992
SAAB	Sweden	1983-1999	303	Production ceased in 1999 due to declining sales, shifted focus to defense, aeronautic systems, and support services.
Fairchild	United States	1972-2001	242	Acquired by private equity in 1999 and eventually divested to M7 Aerospace (later purchased by Israeli Elbit Systems) and Fairchild Controls Corporation, a subsidiary of EADS North America.
Embraer	Brazil	1968-1985	237	Reduced demand led to production focus on regional and business jets
BAe	United Kingdom	1980-1997	175	Reduced sales led to a production focus shift to defense contracting; commercial aerospace divisions sold to Raytheon in 1993, became BAE Systems in 1999.
Fokker	Germany	1955-1997	154	Declared bankruptcy in 1996, purchased by Stork B.V., a Dutch conglomerate, and re-organized into Fokker Industries as component development and support.
Dornier	Germany	1982-2000	130	Acquired by Fairchild in 1996.
Short Brothers	Northern Ireland	1974-1992	72	Acquired by Bombardier in 1989
Convair	United States	1947-1954	29	Acquired by General Dynamics in 1954, and sold to McDonnell Douglas in 1994.
Hawker Siddeley	United Kingdom	1960-1988	22	Nationalized in 1977 into British Aerospace, then divested in 1993 to Raytheon, and then sold again to become Hawker Beechcraft.
Douglas	United States	1936-1942	7	Merged with McDonnell Douglas in 1967

APPENDIX B

SURVEY RESPONDENTS

Company	Country of Origin	Establishment
1	Australia	1989
2	Australia	1990
3	Austria	1957
4	Bahamas	1993
5	Belarus	1996
6	Canada	1977
7	Canada	1965
8	Canada	1987
9	Dagestan, Russia	1927
10	Denmark	1989
11	Guam	1974
12	Japan	1996
13	Kyrgyzstan	2001
14	Malta	1978
15	Mauritius	1972
16	Mongolia	2006
17	Netherlands	1991
18	New Zealand	1940
19	Norway	1934
20	Russia	1993
21	Russia	2000
22	Russia	1993
23	Scotland	1991
24	Scotland	1962
25	Slovenia	1991
26	Sweden	2002
27	Sweden	1955
28	Ukraine	N/A
29	United States	1981
30	United States	1992
31	United States	1981

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