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DECISION MAKING ANALYSIS TO ASSESS THE SILENT AIRCRAFT PROJECT

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WP 13/2004

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Decision making analysis to assess the silent aircraft project

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Abstract

There is increasing concern about aircraft noise as a result of the rising demand for air transport. According to the US National Science and Technology Council, the environmental impacts of aircraft, including serious noise problems, are likely to limit air transportation growth in the 21st century. This paper presents a simple decision making model that examines whether it is worth trying to developing a silent aircraft in order to solve the current aircraft noise problems. The model is designed to capture a first approximation of all aspects of the decision, and the findings give a broad picture of the current state of silent aircraft development. The model is simple, but probabilistic and comprehensive enough to make a first estimate of the business case of this long-term project with huge uncertainty. The predicted mean cumulative net present value of the decision to develop a silent aircraft is US$13 billion, with 5th percentile, and 95th percentile cumulative net present values of US$ - 51, and 139 billion respectively.

Keywords: Aircraft noise, CBA, net present value, uncertainty

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1. Introduction

The UK Department for Transport's official forecasts predicted in 2000 that passenger volumes at UK airports are expected to increase at an average rate of 4.3% per year (DETR, 2000). Long-term demand for air travel could be even higher than previously thought, especially due to rapidly expanding low cost airlines (*Daily Telegraph 19/05/03*). According to National Science and Technology Council, environmental impacts of aircraft, including serious noise problems, are likely to limit air transportation growth in the 21st century (NSTC, 1995). One example in the United Kingdom is the current debate over the expansion of UK airports, such as Stansted airport, and London Heathrow airport (BB*C News Tuesday 16/12/03*[1]). There are many protesters against the plan of building new runways, who are especially concerned about the possible increase in aircraft noise levels and night flights (*BBC News Tuesday 16/12/03*).

Although the form of civil transport aircraft has remained largely unaltered for the past forty years, advances in engineering design capability currently enable consideration of step changes in aircraft design and operations. The term 'Silent Aircraft' defined by the research groups at the University of Cambridge in the United Kingdom and Massachusetts Institute of Technology in the United States, as an aircraft sufficiently quiet that, outside of the airfield perimeter, the contribution of aircraft noise to the general noise environment of a well-populated community is less than other sources, therefore rendering aircraft operations imperceptible to the public. Such aircraft would enable an expansion in air transportation by creating opportunity for new airports and allowing increases in operating hours at existing sites. However, careful examination of such a project's costs and benefits would be required before implementing the silent aircraft project, to reduce the chances of

[1] http://news.bbc.co.uk/1/hi/sci/tech/3324527.stm

following the same path of a high cost and short life the concord project experienced. Air France/British Airways Concorde, capable of flying at twice the speed of sound, was described as a technological marvel. Since entering commercial service in 1976, and its retirement on 26 November 2003, it made a cumulative loss. According to Professor David Henderson of University College London, the cost of Concorde, developed by Britain and France, was £4.26 billion adjusted to 1975 prices and interest charges of 10 percent[2]. Britain also invested £40 million a year in Concorde between 1962 and 1974, although, there will probably be no direct recovery of any part of the Concorde research and development costs in straight accountancy terms[3].

There is increasing concern about aircraft noise as a result of the rising demand for air transport. Thus deeper economic understanding of this field is urgently required in order to tackle the issue. It has been estimated that approximately 20% of the European Union's population, or 80 million people, suffer from noise pollution (EU, 1996). It is also estimated that up to 170 million citizens of the EU are living with noise levels that cause 'serious annoyance' during the daytime (EU, 1996). Based upon a survey carried out in Germany in 1986[4], 47% of households were annoyed by aircraft noise; and 16.5% were highly annoyed. Van Praag and Baarsma (2000) show that about 2% of the households living in the wider Schiphol area in the Netherlands are always annoyed; 5.2% often annoyed; 10.6% regularly annoyed; 37.6% sometimes annoyed by noise.

In order to reduce the noise annoyance of these people, the legislation on aircraft noise is becoming stricter, especially in developed countries. An independent research and consultancy organization, CE (2003) recommends that the Commission for Integrated

[2] http://www.theatlantic.com/issues/77jan/gillman.htm
[3] http://www.concordesst.com/history/eh5.html
[4] See Rothengatter (1989)

Transport (CfIT), an independent body advising the UK government on integrated transport policy, should introduce noise charges or tradable noise permits based on certified aircraft noise production and time of arrival or departure. On the manufacturing side, huge investments are being made to create much quieter, less damaging aircraft. This paper presents a simple decision making model that examines whether it is worth going further and developing a silent aircraft. The model is simple, though comprehensive enough to make a first estimate of the business case of this novel project with huge uncertainty. Following the introduction in Section 1, the model developed in this study is presented with the explanations of the basic concept, and the detailed equations in Section 2. The description of the data used in the analysis, and its sources are also given in Section 2. Section 3 presents the initial findings with the preliminary data sets to examine the reasonableness of the model. Section 4 concludes the study and discusses the strengths and weaknesses of the model.

2. Model

2.1. Concept of the model

The Cost Benefit Analysis (CBA) model developed for this project calculates the benefits and costs from the proposed development of a silent aircraft in order to examine whether the project is justifiable. Huge development costs would be initially required for this large-scale project. If the development is successful, silent aircraft would be introduced over time, involving extra capital costs, and possibly extra pollution and operating costs in exchange for noise reduction benefits and net benefit from extra flights, such as extra night flights. Once the proportion of aircraft that are silent has exceeded a threshold, new airports can start being introduced over time nearer to city center, giving ground travel benefits, as well as extra casualty costs if a plane crashes in a crowded residential area. Figure 1 illustrates the whole development process.

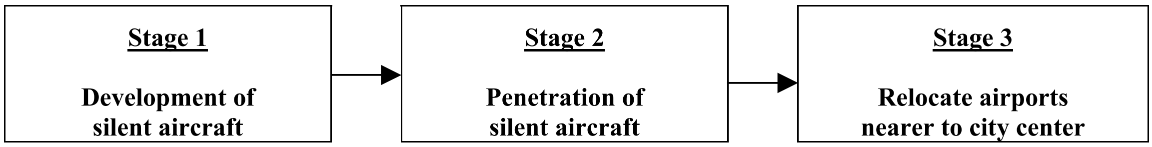


Fig.1. Development process.

The variables used in the model, which are considered to have significant impacts on the project outcome, cover the following eight areas. For the benefits: noise abatement, reduced ground travel, and net benefit from extra flights are included. Development cost, extra capital cost, and extra casualty cost, are the main cost variables. Operation and air pollution costs associated with the new silent aircraft could either increase or decrease depending on the technologies, therefore they can be costs or benefits. Figure 2 illustrates the concept of the model, including the possibility that the development will not be successful, and the silent aircraft will never be brought into use.

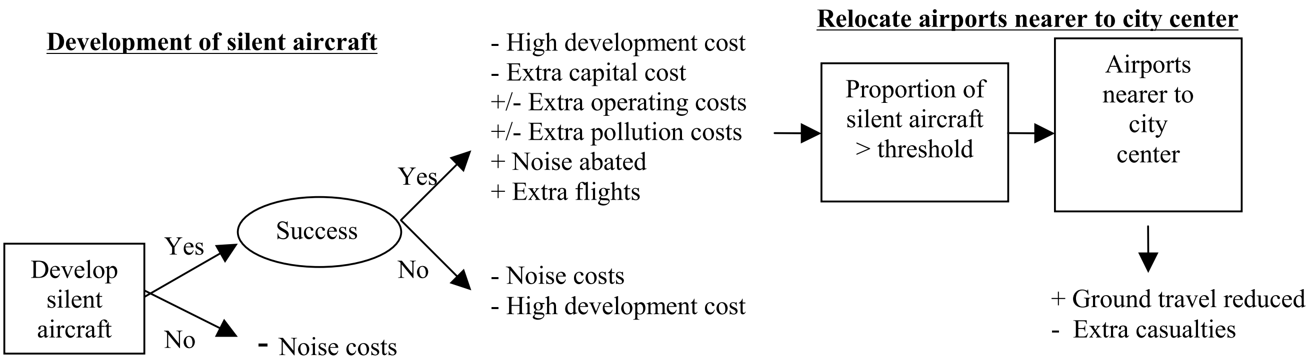


Fig. 2. Concept of the model.

2.2. *Equations*

The model operates at the most aggregated global level, with a probabilistic treatment of uncertainty. The following sets of equations are used to calculate the net present value of expected benefits and costs from the silent aircraft development. Input parameters are presented in *italics*.

Firstly, the global fleet size, total number of flights, and total flight distance are calculated. For simplicity, we assume a constant growth rate of each of these over time.

Fleet size = *base year fleet* for t = 0
= (previous year fleet size)*(1 + *fleet growth rate*) for t > 0 aircraft

Flights per aircraft = *base year flights per aircraft* for t = 0
= (previous year flights per aircraft)*(1 + *flights per aircraft growth rate*) for t>0 flights

Total flights = fleet size*flights per aircraft flights

Mean flight distance = *base year mean flight distance* for t = 0
= (previous year mean flight distance)*(1 + *mean flight distance growth rate*) for t >0 km

Total flight distance = (total flights*mean flight distance)/10^9 billion km

Noise valuation per flight, casualty valuation, ground travel valuation, and net benefit per extra flight are also calculated in the similar manner, also assuming constant growth rates.

Noise valuation per flight = *base year noise valuation per flight* for t = 0
=(previous year noise valuation per flight)*(1 + *noise valuation per flight growth rate*)
for t > 0 $/flight

Total noise valuation = total number of flights*noise valuation billion

Casualty valuation = (*base year casualty valuation*) for t = 0

= (previous year casualty valuation)*(1+*casualty valuation growth rate*) for t>0 $million

Ground travel valuation = (*base year ground travel valuation*) for t = 0

= (previous year ground travel valuation)*(1 + *ground travel valuation growth rate*)

for t > 0 $/flight

Net benefit per extra flight = (*base year net benefit per extra flight*) for t = 0

= (previous year net benefit per extra flight)*(1 + *net benefit per extra flight growth rate*)

for t>0 $/flight

Silent aircraft will be introduced over time, and once their proportion has exceeded a threshold, new airports will start being introduced nearer to city center. This process is expressed by the following equations;

Silent proportion = 0 for t < *development time of silent aircraft*

= {t – (*development time of silent aircraft*)} / *penetration time* for t < *development time of a silent aircraft* + *penetration time*

= 1 Otherwise

New airport proportion = 0 for t< *development time of silent aircraft* + *penetration time*(% silent for new airports to start*/100)

= {t-(*development time of silent aircraft* + (*penetration time*% silent for new airports to start*/100) + *airport replacement time*) for t < *development time of silent aircraft* + (*penetration time*% silent for new airports to start*/100) + *airport replacement time*

= 1 Otherwise

Many costs and benefits are associated with this grand-scale project. The initial investment has to be made for the huge development cost of a silent aircraft. Note that development costs are usually not the same every year in this kind of project, and would phase out over time after the peak of the maximum development cost[5]. Total development cost refers to the 'total' of all the annual development costs.

Development cost = max development cost*{(t + 1 – base year)/time of max development cost}

for t < time of max development cost

= max development cost *{[1 – (t –time of max development cost)]/(development time of a silent aircraft – time of max development cost)}

for time of max development cost <t ≤ development time of a silent aircraft

= 0 Otherwise

Max development cost=(2**total development cost*)/(*development time of a silent aircraft*)

Time of max development cost = *development time of a silent aircraft* parameter which describes the location of the peak of the distribution*

If the development is successful, the following costs and benefits, extra capital costs, noise abated benefits, net benefit from extra flights, such as extra night flights, and extra operating and pollution benefits/costs, would occur;

Extra capital cost = (*extra capital cost of a silent aircraft**addition to silent fleet)/1000

$billion

[5] Similar formulations are found in Morimoto and Hope (2004).

Number of silent aircraft = fleet size*silent proportion aircraft

Addition to silent fleet = *base year silent fleet* for t = 0

= (current year silent fleet) – (previous year silent fleet) for t > 0 aircraft

Valuation of noise abated = total noise valuation*silent proportion $billion

Net benefit from extra flight = (net benefit per extra flight*extra flights)/ 10^9

$billion

Extra flights = 0 for t < *development time of a silent aircraft*

= (total flights)*(*proportion of extra flights*)*{t – (*development time of a silent aircraft*)}/*penetration time*

for t< *development time of a silent aircraft* + *penetration time*

= total flights**proportion of extra flights* otherwise flights

Valuation of extra operation = valuation of extra operation of silent aircraft*total flight distance*silent proportion $billion

Valuation of extra pollution = valuation of extra pollution of a silent aircraft*total flight distance*silent proportion $billion

Once the proportion of aircraft that are silent has exceeded a threshold, new airports start being introduced over time nearer to city center, giving ground travel benefits as well as extra casualty costs if a plane crashes.

Valuation of reduced ground travel = (ground travel valuation*total flights*new airport proportion)/10^9

$billion

Valuation of extra casualties = (extra casualties*casualty valuation**take off/landing crash rate**total flights*new airport proportion)/ 10^9 $billion

All of the analysis to this point assumes that the development of the silent aircraft is a success, but in reality it is not certain to produce an aircraft that can be introduced into regular commercial use. So each of the costs and benefits, except the cost of development, must be reduced to allow for the chance that development will not be successful as shown in the equation below which estimates expected benefits.

Expected benefits = - development costs + (*chance of successful development*)*(noise abated - extra capital cost + valuation of extra operation + valuation of extra pollution - valuation of extra casualties + reduced ground travel + net benefit from extra flights) $billion

$$\textbf{NPV} = \sum_{t=0}^{T} \textbf{expected benefits*(1 + discount rate)}^{-t} \qquad \textbf{\$billion}$$

The following noise valuations are also calculated for information.

Total noise costs without silent aircraft = total noise valuation $billion

Total noise costs with silent aircraft = total noise costs without silent aircraft – valuation of noise abated

$billion

2.3. Data

The model is highly aggregated, therefore the scale of the analysis is the whole fleet and the whole world. The initial data used in this paper are collected from various sources such as reports, the scientific literature, and web pages. They are the most representative currently available based on our investigations in this field. Because the model is so aggregated, and looks far into the future, the data are given as ranges and are assumed to follow a triangular distribution in order to deal with the huge uncertainty involved in the input parameters. A modified Monte Carlo simulation technique is applied, using @RISK from Palisade Corporation. Some of the data are not very accurate or precise, because of the project complexity or simply because they have not yet been adequately measured or collected. Those inputs with particularly large uncertainty are arranged to have a wider range of input values in the model. Repeated runs of the model obtain a probability distribution of possible outcomes, which is a more defensible procedure than just using single values for inputs that are in reality not well known. A summary of the main inputs – minimum, most likely and maximum values for each parameter – is listed in Table 1, and the rest are listed in the Appendix.

Table 1
Summary of the main inputs

Parameter	**Unit**	**Minimum value**	**Most likely value**	**Maximum value**
Discount rate	%/year	3 [a]	7 [a]	10 [a]
Base year flights per aircraft	Flights	200 [b]	420 [b]	700 [b]
Flights per aircraft growth rate	%/year	-0.1 [c]	0.5 [c]	1 [c]
Base year noise valuation per flight	$/flight	60 [d]	300 [d]	3000 [d]
Base year reduced travel cost to the airport	%/passenger	10 [e]	12 [e]	30 [e]

Source: [a]: value suggested by FAA cost-benefit guidance for infrastructure projects: also used by Morrison et al (1999); [b]: Average number of airbus operations. (www.airbus.com/product/a330_a340_economics.asp); [c]: In 2000, the total number of take-offs and landings increased by 0.5% at JFK airport (www.panynj.gov/aviation/traffic/coverfram.htm); [d]: Best estimate based on compensations per flight at Schiphol airport in 1999 (f61 per flight), and Long island Macarthur airport noise surcharge of $50,000 per flight on all aircraft operations between 11pm-6:30am effective on Sept 30 2001. van Praag and Baarsma (2000); [e]: London city to Heathrow costs approx $12 return (www.tswoam.co.uk/world_data.html)

3. Findings

3.1. Mean cumulative present values of costs and benefits by year

Figure 3 shows the mean value of the cumulative present values of the different categories of costs and benefits by year. Note that, with the exception of the development cost, these values are multiplied by the probability of success. Initially, the huge development cost dominates. Benefits from extra flights, noise reduction benefits and reduced ground travel benefits would grow once silent aircraft are developed and introduced.

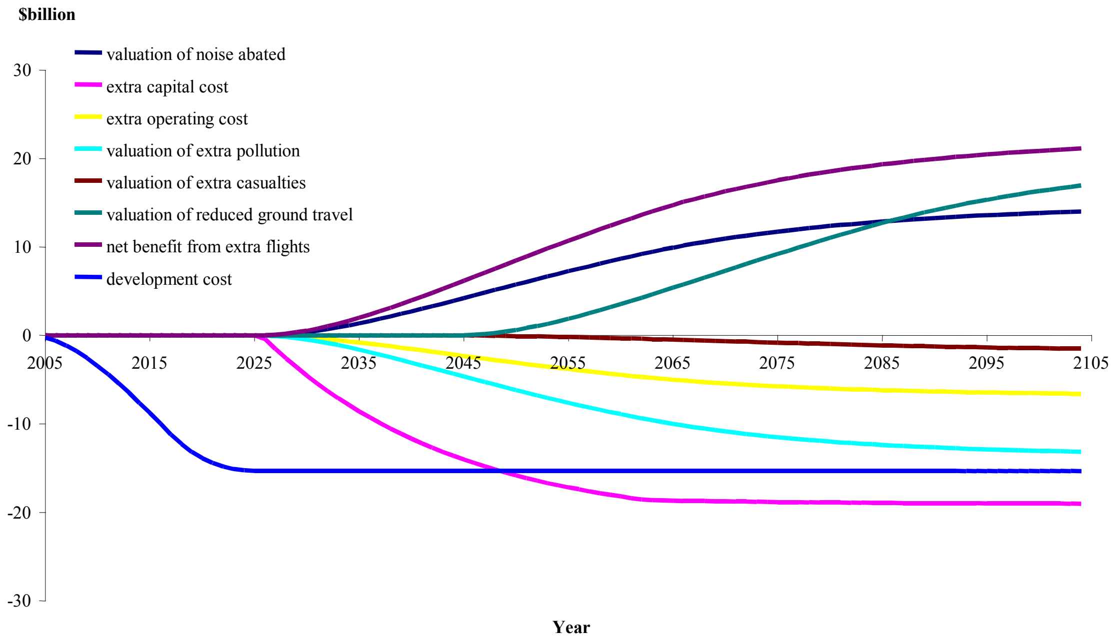
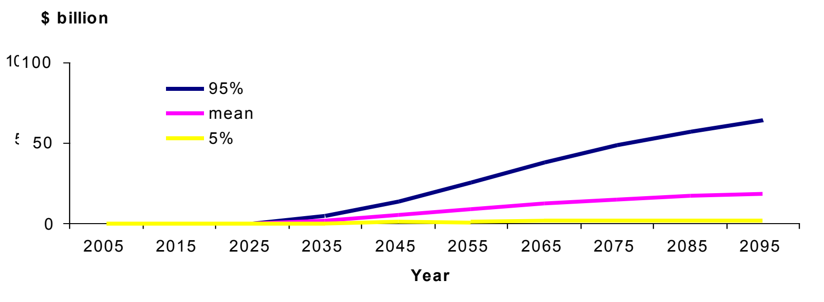


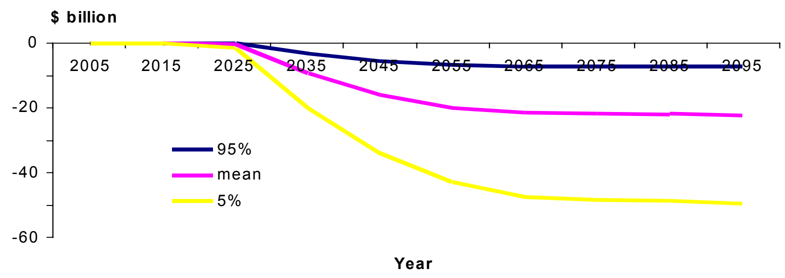
Fig. 3. Mean cumulative present values of costs and benefits by year
Source: model run

3.2. NPV

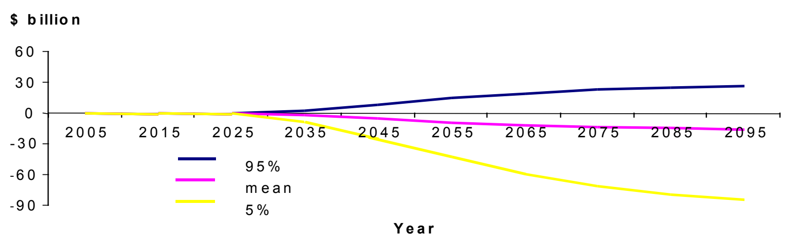
The 5th percentile, mean and the 95th percentile of the NPV of each variable in the model are depicted in Figure 4. With the exception of the development cost, these values are multiplied by the probability of success. Note that vertical scales on the graphs in Figure 4 are different. All the figures show the expected shape and signs. Valuations of extra pollution and operation could be either positive or negative due to uncertainty in the technology that will actually be used in silent aircraft. The 5th percentile, mean and the 95th percentile of the cumulative NPV are US$ - 51, 13 and 139 billion respectively. The result contains a huge uncertainty as can be seen from the wide gap of the 90% range in Figure 5. Although Figure 5 indicates that a substantial amount of time - approximately 70 years in the mean case- would be needed until costs are recouped by benefits, the project seems to be just worthwhile.



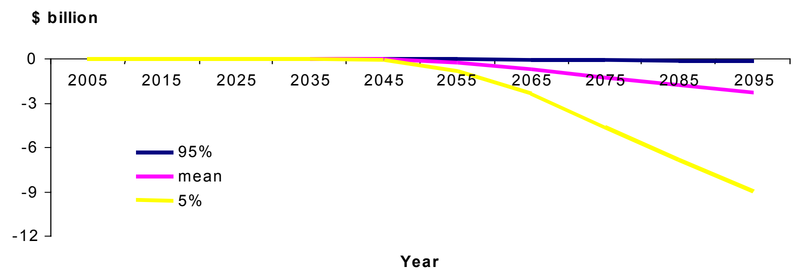
(a) valuation of noise abated



(b) extra capital cost



(c) valuation of extra pollution



(d) valuation of extra casualties

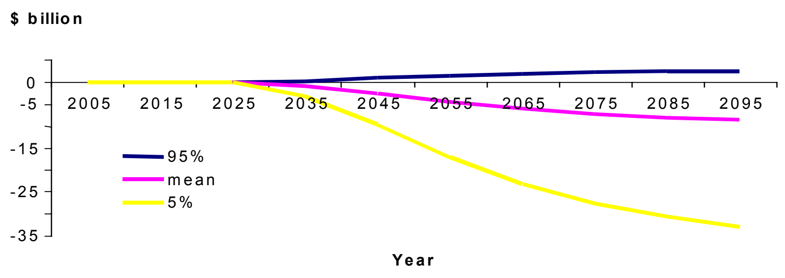
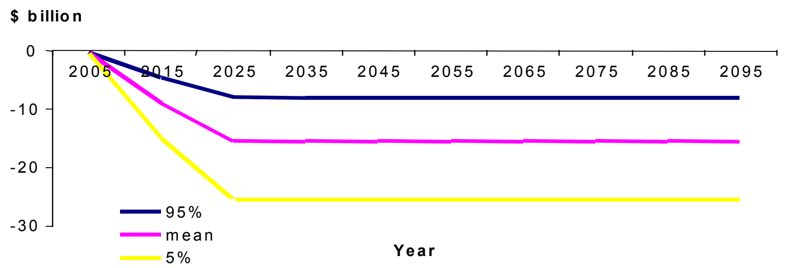
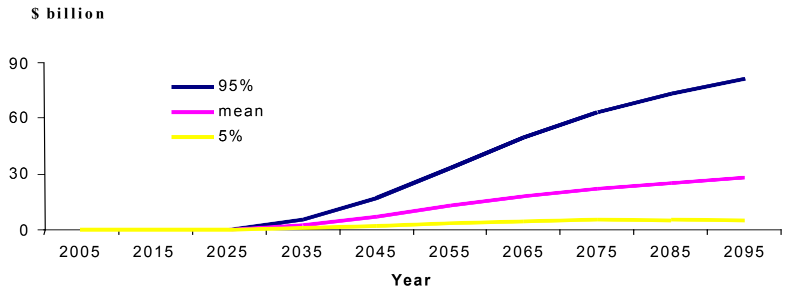
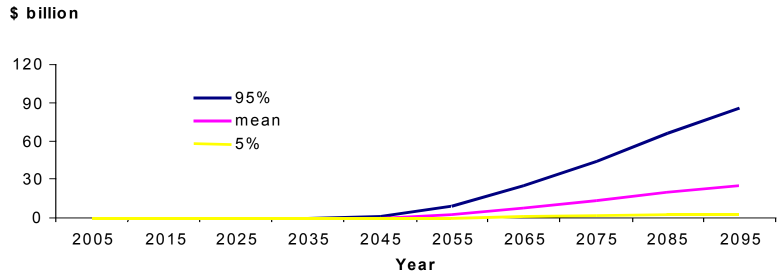
	**(e) valuation of extra operation**
	**(f) development cost**
	**(g) net benefit from extra flights**
	**(h) valuation of reduced ground travel**

Fig. 4. Costs and benefits of each variable by year
Source: model run

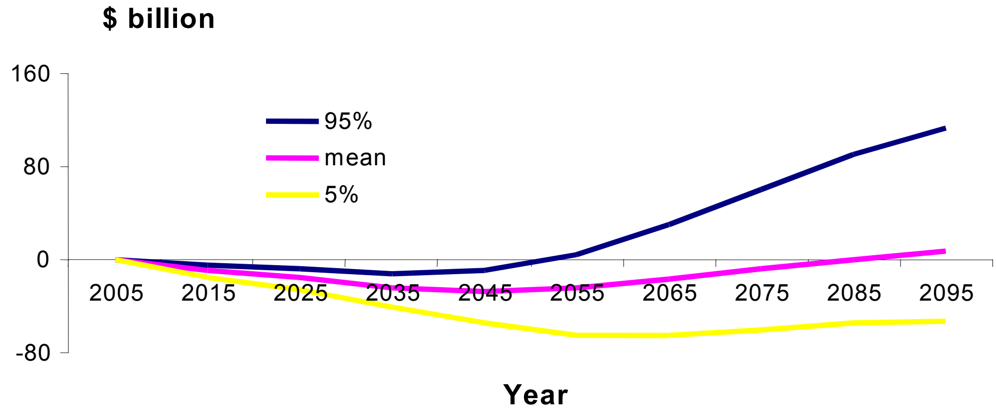


Fig. 5. Cumulative NPV
Source: model run

3.3 Sensitivity analysis

Sensitivity analysis using regression identifies the input parameters that are most significant in determining the output, in this case cumulative NPV. The student b coefficient is a coefficient calculated for each input parameter in the regression equation. Table 2 shows that the discount rate and base year flights per aircraft have significant impacts on the cumulative NPV. Hence these parameters should be treated extremely carefully, as the cumulative NPV is sensitive to changes in their values. This confirms the importance of choosing appropriate discount rates in project assessments. Each parameter has a correct sign, consistent with the model: those parameters where an increase would increase the expected benefit have positive signs and those parameters where an increase would decrease the expected benefit have negative signs. These sensitivity analysis results are the reason that these inputs were described as the main inputs in table 1.

Table 2
Sensitivity analysis

Parameters	Student b coefficients
Discount rate	- 0.46
Base year flights per aircraft	+ 0.40
Flights per aircraft growth rate	+ 0.18
Base year noise valuation per flight	+ 0.15
Base year reduced travel cost to the airport	+ 0.14

Source: model run

3.4. Total noise costs with and without silent aircrafts

Figure 6 depicts the mean values of the annual total noise costs with and without silent aircraft, assuming their development is successful. The total noise cost with silent aircraft sharply decreases after the year 2025 and approaches zero in around 2063. This figure reinforces the importance of developing silent aircraft technologies.

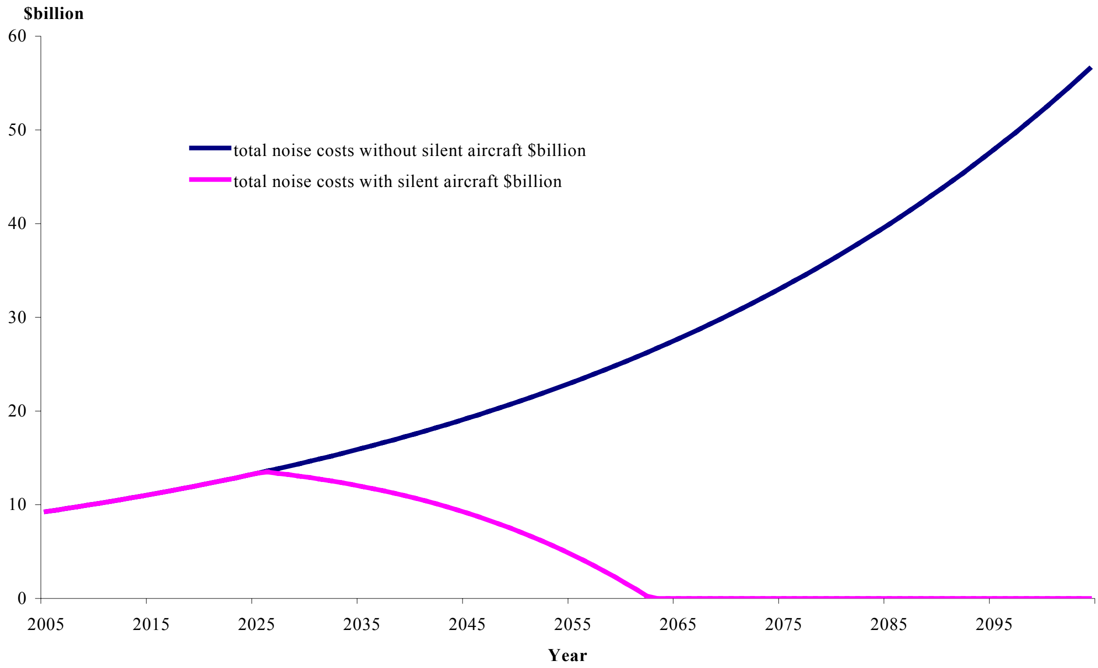


Fig. 6. Total noise costs with and without silent aircraft

4. Conclusion

This paper presents a simple decision making technique that is applied to assess a proposed silent aircraft project. This approach is particularly robust for this type of project with huge uncertainty and a long time horizon, as the model is probabilistic.

The parameterisation is conducted as simply as possible: for example all the growth rates are constant and the rate of introduction is linear. The strength of the model is its simplicity, focusing upon the most influential variables for developing silent aircraft, and requiring only the most general input data. More details would be hard to justify given the uncertainties. The model is designed to capture a first approximation of everything that needs to be analysed, and the findings give a broad picture of the current scene of silent aircraft development.

The assumption of relocating all airports nearer to city centers within a few decades of the market penetration of silent aircraft might be fairly optimistic. All sorts of political, land use and planning constraints would have to be overcome. However, there is no doubt that city center airports will be more favored without the constraints of aircraft noise in the decision concerning where to locate a new airport in the future. At the least, more airports will likely to be built in city centers, and the current majority of airports that are far from city centers, will be in less favor if that happens.

The model results show that the 5th percentile, mean and the 95th percentile of the cumulative NPV are US$ - 51, 13 and 139 billion respectively. The result contains a huge uncertainty as can be seen from the wide gap of the 90% range. Although the results indicate that a substantial amount of time - approximately 70 years in the mean case- would be needed until costs are recouped by benefits, the project seems just to be worthwhile.

Developing a silent aircraft would be costly and time consuming, however the model results suggest that its benefits are expected in the long term. Environmental and social benefits from noise reduction are often difficult to quantify, and the figures used in this study are at the lower bound. Thus, even larger benefits from developing a silent aircraft could be expected and the silent aircraft project could be justified even at the higher confidence level.

The main weakness of the analysis is the lack of accuracy of the data used. We have used the most reliable and reasonable data we could obtain at this stage, however further improvement in the accuracy of the data will enhance this analysis. Many refinements such as regional splits, reduced landing fees, stimulation of demand, substitution of planes for trains, multiplier effects on the economy through improved infrastructure and more job opportunities around the existing as well as relocated airports are omitted at this stage. These impacts should also be considered in future research. The model in this research is fairly simple compared to those detailed models, such as input-output models, that try to capture indirect effects as much as direct effects. This model is just a starting point; further modification is planned to improve its robustness. But it can already be considered to make a useful contribution to the development of simple integrated assessment models for major, long-lived projects.

Acknowledgement

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Appendix

Table A.1. Description of data

Parameter	(min, most likely, max)	Description	Source
Base year fleet	(17700, 18670, 20000) fleets	Total number of world fleet	http://www.boeing.com/companyoffices/aboutus/brief.html
Base year mean flight distance	(2000, 4000, 6000) km	Average flight length	http://www.airbus.com/product/a330_a340_economics.asp
Fleet growth rate	(0.1, 0.5, 1) %/year	Best estimate based on the figure of total orders of new aircraft for the airlines are forecasted to increase at about 3.4% annually for the next 10 years	www.air-transport.org/public/industry/display1.asp?nid=1175
Mean flight distance growth rate	(-0.5, 0, 0.5) %/year	The world's first jumbo Boeing 747 (1969) was able to travel 6,000 miles and Boeing currently developing a plane which can travel 9,000 miles by 2005.	www.pbs.org/kcet/chasingthesun/planes/747.html
Noise valuation growth rate	(0, 0.5, 2) %/year	Best estimate - subtracting expected reduction in the rate of noise per flight (EU Vision 2020 target is 50% reduction in perceived aircraft noise in 20 years) from the average world economic growth rate (OECD countries such as UK, Germany, their GDP growth rate in 2001 is 3.0%.	http://www.tswoam.co.uk/world_data/world_data_2001_gdp_growth.html; Morrocco.J.D and J.Flottau 'Europe seeks global leadership in aeronautics', (www.aviationnow.com/content/publication/awst/20010205/vision.htm)
Total development cost of a silent aircraft	(10, 20, 50) $billion	Development cost of aircraft A380 is expected to be $9-10 billion.	http://216.239.39.100/search?q=cache:Y7IJ2bHJTg4C:www.aworldaway.com/a3xx.html+development+cost+of+most+recent+Boeing+jet+in+%24billion&hl=en&ie=UTF-8
Development time of silent aircraft	(18, 20, 24) years	It is estimated that commercial technology necessary to significantly reduce the noise foot print around a major airport will be available in 20 years according to NASA	www.grc.nasa.gov.WWW/PAO/PAIS/fs03grc.htm
Parameter which describes the location of the peak of the distribution for the development cost	(0.54, 0.6, 0.72)	Best guess	
Chance of successful development	(20, 40, 60) %	Best guess	

Penetration time	(25, 30, 55) years	Boeing introduced its mammoth 314 flying boat 25 years after they started their business, and 55 years for the world's first jumbo jet 747	www.pbs.org/kcet/chasingthesun/companies/boeing.html
Extra capital cost of silent aircraft	(10, 20, 30) $million/aircraft	Capital cost for current aircraft is approx $50million. DC-8 Aircraft - the UPS fleet of 49 DC-8 aircraft already has been re-engined with CFM-56 engines at a cost of US$784 million. The re-engined aircraft easily meet Stage 3 requirements.	Based on Fig 16 in Lee et al (2001) - 'direct operating cost - price relationship-appropriate value for average current model new prices, data from Airline Price Guide; http://www.ups.com/about/inits.html
Valuation of extra operation	(-0.7, -0.1, 0.2) $/km	Operating cost of B747-200 in 2000 is approx $0.7/km higher than the one for B747-100.	http://216.239.53.100/search?q=cache:s49_TGqfC5EC:www.icao.int/icao/en/ro/allpirg/allpirg4/wp28app.xls+aircraft+operating+cost+of+747+in+%24&hl=en&ie=UTF-8
Valuation of extra air pollution	(-2, -0.2, 1) $/km	Cost of carbon offsets is approx $2/km, according to Carbon Storage Trust.	www.bata.uk.com/emissions.htm
% silent for new airports to start	(45, 50, 60) %	Best guess	
Airport replacement time	(25, 45, 50) years	Kansai airport in Japan was opened a quarter century after the project was conceived	http://www.kiac.co.jp/english/history/history.htm
Extra casualties per crash	(0, 6, 32)	Best guess based on the past record at Duwamish Valley in Seattle (1943 (32), 1949 (7), 1951 (11))	www.cityofseattle.net/emergency.mgt/odf/ch02-PlaneCrash.pdf
Base year casualty valuation	(3, 4.5, 5) $million	Estimated value of statistical life in developed countries	*QALY* - Mauskopf & French (1989); *WTP* - Hanson & Marckham (1992)
Casualty valuation growth rate	(0.5, 1, 2.5) %/year	Best estimate based on the average world economic growth rate (OECD countries such UK, Germany, their GDP per capita growth rate in 2001 is 2.5%).	http://www.tswoam.co.uk/world_data.html
Takeoff/landing crash rate	(3.9, 4.3, 5.2) crashes/million flights	The accident rate per flight in US in 1999	http://flight.com/news/shownews.asp?newsID=196
Number of passengers per flight	(100, 165, 200) passengers	Average seats per aircraft is 165 (estimated by MIT)	based on Fig.8 in Lee et al. (2001) — 'Historical trends in load factor and seating capacity'— approximate value for 1998, data from DOT Form 41
Reduced travel valuation growth rate	(0.5, 1, 2.5) %/year	Best estimate based on the average world economic growth rate (OECD countries such UK, Germany, their GDP per capita growth rate in 2001 is 2.5%).	http://216.239.39.100/search?q=cache:o9V0kk3n0LAC:www.caa.co.uk/erg/ergdocs/annexdv.pd

			erg/ergdocs/annexdv.pdf+%24+profit+per+flight+&hl=en&ie=UTF-8
Base year net benefit per passenger	(40, 60, 100) $/passenger	An extra of $33 for short-haul services and $71 for long-haul services in 2000-1 prices.	http://216.239.39.100/search?q=cache:o9V0kk3n0LAC:www.caa.co.uk/erg/ergdocs/annexdv.pdf+%24+profit+per+flight+&hl=en&ie=UTF-8
Net benefit per extra flight growth rate	(0.5, 1.2, 1.3) %/year	Best estimate based on the fact that, on average, net benefit per extra flight increased by 1.75% between 1996 and 2001	
Proportion of extra flights	(10, 15, 20) %/year	Best guess	

Note: Set base year as the year 2005; Triangular distributions are used for all the input distributions.