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THE SOCIAL COSTS OF AIRCRAFT ACCIDENTS

By RICHARD GOLASZEWSKI and GREGSON HELLEDY
GRA, Incorporated
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ABSTRACT

There is a large interest in aviation accidents and aircraft accident prevention. There are also substantial differences in accidents and accident rates among various aviation segments when one looks at the smallest single-engine airplane flown for pleasure to the aircraft operated by the large airlines. One of the more important differences is that air carriers holding an operating certificate are obliged to operate at the highest level of safety while private aircraft operations are assumed, at least implicitly, to involve some self assumption of risk. The data bear these differences out.

This paper examines fatal aircraft accidents and activity in different segments of private and commercial aviation over a seven-year period. It tabulates the number of flight hours, the number of fatalities and the cost to society of these fatalities. It calculates fatal accident rates on a per flight-hour basis and fatal accident costs as a percentage of variable and total operating costs. There are marked differences among the various aviation segments. The paper raises interesting questions for policymakers about the potential benefits of safety investments and the appropriate level of risk in various aviation segments.

INTRODUCTION

This paper examines the economic cost of losses to society from fatal accidents in various segments of commercial and private aviation. This is done for the 1990 to 1996 time period using data developed by the National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA). Accident costs are based on the statistical value of a life lost in transportation.[1] These values are typically used to estimate the benefits of safety improvements. They include losses to more than the individual involved in the accident.

The NTSB publishes annual summaries of general aviation and air carrier accidents. These data are presented at various levels of disaggregation. For the purposes of this paper we have divided general aviation accidents into the following categories:

- Single-engine piston
- Multi-engine piston
- Turboprop
- Turbojet
- Piston rotorcraft
- Turbine rotorcraft

We have divided commercial air carriers into Part 121 of the Federal Aviation Regulations (FAR 121 or large aircraft) and Part 135 (FAR 135 or small aircraft). These include scheduled and non-scheduled flights, as well as passenger and cargo operations. While more detailed disaggregations are available, we have chosen to report results in this relatively summary fashion.

The Federal Aviation Administration (FAA) tracks data on aircraft utilization for general aviation and air carrier activity. We have used flight hours as a common measure of exposure although one could argue that landings and takeoffs might be a better measure.

Table 1

Annual Fatalities by Aircraft Type

	Single Engine Piston Airplane	Multi Engine Piston Airplane	Turboprop	Turbojet	Piston Rotor	Turbine Rotor	Airline FAR 121	Commuter FAR 135
1990	599	78	29	22	19	9	39	7
1991	568	110	22	32	23	28	62	99
1992	565	130	74	11	31	41	33	21
1993	514	115	46	11	30	23	1	24
1994	494	125	25	7	26	41	239	25
1995	493	161	19	15	11	27	168	9
1996	421	91	54	18	19	25	380	14
Total	3654	**810**	**269**	**116**	159	**194**	**922**	**199**

Source: Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1996, NTSB/ARG-99/01, (Washington: NTSB, July 1999)
Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1996, NTSB/ARC-99/01, (Washington: NTSB, July 1999

Table 1 shows the number of fatalities in air carrier and general aviation for the 1990 through 1996 time period. As can be seen, the largest number of annual fatalities is in single-engine piston airplane flight, ranging from about 400 to almost 600 per year. Air carrier fatalities, when there is a bad year, can approach these numbers, but the annual number of deaths is more variable and influenced by a small number of accidents. In FAR 121 flight these ranged from one fatality in 1993 to 380 in 1996.

[1]Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs, by S. Hoffer et al., Federal Aviation Administration, FAA APO 98-8 (Washington: FAA, June 1998)., p. 2-1.

Annual flight hours are shown in Table 2. As can be seen, single-engine piston airplanes accounted for 15.6 to 21.3 million flight hours per year between 1990 and 1996, while air carrier flight hours ranged from 11.8 million to 13. 7 million per year over the same period. For the other user types, annual flight hours are lower.

Table 2

Millions of Flight Hours

	Single Engine Piston Airplane	Multi Engine Piston Airplane	Turboprop	Turbojet	Piston Rotor	Turbine Rotor	Airline FAR 121	Commuter FAR 135
1990	21.31	2.81	1.23	1.26	0.72	0.86	12.15	2.34
1991	20.19	2.90	0.94	1.06	0.59	1.54	11.78	2.29
1992	18.24	2.41	1.12	1.03	0.41	1.24	12.36	2.34
1993	16.26	2.05	1.03	1.07	0.36	1.06	12.71	2.64
1994	15.58	1.99	0.92	1.16	0.33	1.18	13.12	2.78
1995	17.46	1.91	1.23	1.33	0.33	1.31	13.51	2.63
1996	17.22	1.88	1.38	1.36	0.57	1.16	13.75	2.76
Total	**126.26**	**15.94**	**7.85**	**8.28**	**3.30**	**8.34**	**89.37**	**17.78**

Source: Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1996, NTSB/ARG-99/01, (Washington: NTSB, July 1999)
Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1996, NTSB/ARC-99/01, (Washington: NTSB, July 199

Table 3 shows the annual fatal accident rate per million flight hours as well as the average over the 1990 to 1996 time period for each aviation segment. As can be seen, the Part 121 airlines have the lowest fatal accident rate followed by the Part 130 commuters. Turbojet general aviation has the next largest rate of fatal accidents. The highest average fatal accident rate is in piston engine rotorcraft at almost 40 per million flight hours.

Table 3

Fatal Accidents Per Million Flight Hours

	Single Engine Piston Airplane	Multi-Engine Piston Airplane	Turboprop	Turbojet	Piston Rotor	Turbine Rotor	Airline CFR 121	Commuter CFR 135
1990	16.50	12.40	10.60	7.90	22.40	10.50	0.49	1.71
1991	16.20	16.90	11.60	6.60	32.10	7.20	0.34	3.49
1992	17.70	20.40	17.90	2.90	54.30	15.40	0.32	3.00
1993	18.40	22.50	15.50	2.80	53.20	13.20	0.08	1.52
1994	18.00	27.60	14.10	4.30	63.50	18.60	0.30	1.08
1995	16.80	34.50	11.40	3.80	24.20	11.50	0.22	0.76
1996	15.00	21.30	13.70	4.40	24.50	12.90	0.36	0.36
Average	**16.94**	**22.23**	**13.54**	**4.67**	**39.17**	**12.76**	**0.30**	**1.70**

Table 4 shows the fatalities per million flight hours for each of the years and as an average over the 1990 to 1996 time period. The lowest fatality rate (10.3 fatalities per million flight hours) is by FAR 121 air carriers, but average annual fatalities for FAR 135 operations and turbojet general aviation operations are not substantially higher. Interestingly, the highest count of fatalities per flight hour is in multi-engine piston airplane operations, at over 50 per million flight hours. The range in fatalities per million flight hours among the aviation segments is about a factor of five.

Table 4

Fatalities Per Million Flight Hours

	Single Engine Piston Airplane	Multi Engine Piston Airplane	Turboprop	Turbojet	Piston Rotor	Turbine Rotor	Airline FAR 121	Commuter FAR 135
1990	28.1	27.7	23.7	17.5	26.6	10.5	3.2	3.0
1991	28.1	38.0	23.3	30.1	38.9	18.2	5.3	43.2
1992	31.0	54.1	66.2	10.7	76.5	33.2	2.7	9.0
1993	31.6	56.1	44.7	10.3	84.0	21.7	0.1	9.1
1994	31.7	62.8	27.2	6.0	78.5	34.6	18.2	9.0
1995	28.2	84.2	15.5	11.3	33.2	20.7	12.4	3.4
1996	24.4	48.5	39.1	13.2	33.3	21.5	27.6	5.1
Average	**28.9**	**50.8**	**34.3**	**14.0**	**48.2**	**23.3**	**10.3**	**11.2**

Source: Authors' calculations.

Table 5 shows the cost of fatalities on a per flight hour basis. These were calculated using FAA's standard value for the societal cost of a statistical death in aviation. This is approximately $2.8 million.[2] As can be seen, the cost per flight hour ranges from about $30 in both FAR 121 and FAR 135 flying to about $140 in multi-engine piston and piston rotorcraft flying. (There are other costs associated with aviation accidents including injuries, aircraft damage and destruction and harm to property on the ground. However, fatalities account for the vast majority of these

[2] Ibid.

costs.) Thus, one could look at the social costs of accidents per flight hour as an indicator of the relative burden due to a lack of safety.

Table 5

Cost of Fatalities Per Flight Hour ($ 1998)

	Single Engine Piston Airplane	Multi Engine Piston Airplane	Turboprop	Turbojet	Piston Rotor	Turbine Rotor	Airline FAR 121	Commuter FAR 135
1990	$ 79.24	$ 78.19	$ 66.68	$ 49.26	$ 74.91	$ 29.57	$ 9.05	$ 8.43
1991	79.32	107.04	65.70	84.86	109.71	51.42	14.84	121.76
1992	87.33	152.38	186.76	30.11	215.78	93.51	7.53	25.35
1993	89.09	158.22	125.90	28.98	236.89	61.05	0.22	25.65
1994	89.41	177.07	76.60	16.98	221.43	97.62	51.34	25.31
1995	79.59	237.37	43.69	31.77	93.68	58.28	35.07	9.65
1996	68.92	136.82	110.15	37.28	93.80	60.60	77.93	14.31
Average	**$ 81.59**	**$ 143.25**	**$ 96.66**	**$ 39.51**	**$ 135.78**	**$ 65.54**	**$ 29.08**	**$ 31.56**

If the cost of accidents per flight hour is expressed as a proportion of aircraft operating costs, some account is taken of the size of the aircraft operated. Table 6 show: the variable and fixed, as well as total operating costs per flight hour for each of the use types. Total costs range from approximately $177 per hour in single-engine piston flying to over $3,000 per hour in FAR 121 air carrier flying. The data at the bottom of Table 6 show that for air carriers, fatality costs are approximately one percent of total operating costs per hour. The cost per hour for turbojet general aviation is of the same order of magnitude. The next highest costs (in percentage terms) per hour for fatalities are for Part 135 operations and turboprop operations. What is most interesting is that for piston rotorcraft and single engine and multi-engine piston general aviation airplanes, accident costs represent approximately 40 percent of total hourly operating costs.

It must be emphasized that we are examining the societal costs of these accidents and using the value of a statistical life, which reflects economic costs to others as well as to the individual involved in the accident. The concept of a statistical life is based on "willingness to pay". If on average, individuals are willing to pay $2 to reduce the risk of a fatality by one chance in a million, this implies that they will be willing to pay $2 million to prevent one fatality. Thus the value of a statistical life is based on the average willingness of the public to pay for increases in safety. Individuals may evidence higher or lower implicit values of life based on their risk-taking behavior. In addition, others would argue on philosophical grounds that the value of life is immeasurable.

Table 6

Operating Costs Per Flight Hour ($ 1998)

	Single Engine Piston Airplane	Multi Engine Piston Airplane	Turboprop	Turbojet	Piston Rotor	Turbine Rotor	Airline FAR 121	Commuter FAR 135
Variable	S124	S233	$627	$1,218	$192	$464	$2,448	$572
Fixed	$53	S147	$961	$2,831	$128	$410	$645	$276
Total	S177	S380	$1,588	$4,049	$320	$874	$3,093	$848
Fatality Cost as a Percent of Total Operating Cost	46.1%	37.7%	6.1%	1.0%	42.4%	7.5%	0.9%	3.7%

Cost of Fatal Injury (Value of Human Life plus Associated Costs)**
$ 2,819,000

Sources:

Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs, (Washington: FAA, June 1998)

Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1996, NTSB/ARG-99/01, (Washington: NTSB, July 1999)

Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations Calendar Year 1996, NTSB/ARC-99/01, (Washington: NTSB, July 1999)

When individuals decide how much they are willing to pay to reduce risk, they presumably include not only the value they place on their own lives, but also the financial impact that their deaths would have on their families. General aviation pilots purchase insurance to shield their estates from liability should the unfortunate occur.

Recent studies, however, indicates that pilots may have difficulty obtaining the coverage required to compensate for this risk. This is especially true for owners of piston-engine aircraft.

Under current U.S. market conditions, insurance for fixed-wing piston aircraft with coverage over $1 million is almost unavailable, and very expensive when it can be obtained. In cases where a pilot has relatively few hours in type, underwriters may limit coverage to $100,000 per person. For owners of twin-engine aircraft, the picture is even bleaker: two of the largest underwriters of insurance for non-commercial light aircraft do not cover twin-engine aircraft at all. No change in these trends is seen anytime soon.[3]

If most GA owners are high net worth individuals, these coverage limits will leave them or their estates vulnerable should they be found responsible for an aviation accident. This means that a substantial amount of the cost of piston GA accidents could fall on the pilots themselves. However, if these pilots do not have a large net worth, then there may be uncompensated losses from fatal accidents.

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[3]Jon Doolittle, "Keep Me Covered" Aviation Consumer., XXIX (December, 1999), 22-25.

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