Developing Greater Flexibility and Resolution in Aviation Accident Analyses[1]

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ABSTRACT

Priorities in aviation safety have been largely influenced by a few published safety summaries compiled from the worldwide objective fatal accident data record which tend to aggregate data into broad categories that cross regional, aircraft and operational boundaries. Derived safety concerns are often interpreted as being representative of (and transferable to) all segments of commercial aviation. However, if in fact these safety concerns are not directly transferable there is the potential for masking unique vulnerabilities, risk exposures and emerging safety trends inherent to subsets of commercial aviation. This paper is intended to demonstrate that the manner in which incorporated data is commonly aggregated leads to comparative errors in most data fields including: number of fatal accidents, fatalities, and accident classification. By changing safety analysis boundary criteria it is possible to reach differing conclusions as to safety priorities of greatest concern relative to regions of operation or aircraft type.

INTRODUCTION

The worldwide aviation accident record is continually surveyed for statistically significant indicators of existing or emerging patterns that might indicate areas of safety concerns. Such surveys then might be utilized as guides for directing corrective actions. Any such analysis would undoubtedly utilize raw data from multiple sources, minimizing error. However; it can be shown through comparison that in various commonly cited compilations of the raw data (published as statistical analyses or summaries) significant discrepancies exist in most data fields. This does not necessarily dictate a failure of any single analysis or raw data source. Instead, it is a function of the segments of aviation (subsets) included in the analysis as well as the manner in which this data is aggregated. Two examples of such summaries and associated safety priorities are below:

A: The often cited Boeing Statistical Summary of Commercial Jet Airplane Accidents – Worldwide Operations (Boeing, 2003) is a market specific resource; one which is invaluable when assessing the safety state of the worldwide commercial large-jet aviation industry. However; this is also a rigid summary of the accident dataset which leaves only minimal latitude for extracting information about more specific subsets of the large-jet segment of aviation. One specific example being North American operations, independent of aircraft type. The Boeing summary indicates that the areas of most critical concern are by far "Controlled Flight into Terrain (CFIT)" and "Loss-of-Control-in-Flight" (LOC-Flight) (Boeing, 2003). These conclusions are based on the worldwide fatal accident dataset, yet if just domestic large-jet operations are considered such accidents become a near statistical anomaly. By aggregating only U.S. registered operations, other accident classifications assume an equally significant importance (strictly based on the fatal accident data).

B: Depending on the source cited: in 1996 the number of fatalities contained in the aviation accident record totals; 380, 1300 or 2100 (NTSB, 2003; Boeing, 2003; and United Kingdom CAA, 2000). Each of these three analyses incorporates different aircraft and operating demographics (Scheduled/nonscheduled departures, engine type, and aircraft mass). Though no full verification has been pursued, each of these three analyses is likely to be accurate. The variations between them would therefore not be some measure of failure, but indicators that each contains unique embedded biases that tend to highlight concerns of the producer of the individual safety summaries.

This paper is concerned with further similar and more detailed comparative analyses of multiple existing safety studies. The end product demonstrates that a significant portion of the objective accident record of worldwide commercial civil aviation operations might not be fully represented in the more dominate aviation safety summaries; in fact some emerging segments of aviation may not be represented at all. It is further demonstrated that established safety priorities derived from commonly cited safety summaries and analyses might not be directly transferable to other subsets of commercial aviation, nor necessarily applicable to civil aviation as a whole. Instead, it leaves the possibility that individual subsets of aviation have unique vulnerabilities and risk exposures, possibly each with equally unique intervention measures needed to minimize this exposure.

Primary Drivers

Two primary drivers that have led to this examination of the accident data and associated analyses are: the 1997 release of the White House Commission's Final report on aviation safety and security, and the 2002 Presidential Commission's report on "the Future of the United States Aerospace Industries".

Methodology:

To developed a greater resolution of the underlying aviation accident data, six analyses and datasets spanning two periods have been considered in this paper. Detailed descriptions of the methods of delineation and aggregation used in each database are included so that the incorporated data might be juxtaposed to the greatest extent practicable. Datasets spanning 1959 - 2002 provide a long-term detailed analysis for projecting trends. Datasets spanning

1990 – 1999 provides a focus for a more micro analysis of results and for determining the validity of any trends. Datasets from the 1990-1999 period are utilized (despite it being somewhat dated material) because multiple governmental and private entities concerned with aviation safety used the end of the decade as a benchmark to examine 10 years of accident data, allowing for a greater comparative analysis.

DISCUSSION AND ANALYSIS

In 1997, the White House Commission on Aviation Safety and Security issued its final report recommending that the worldwide fatal accident rate be reduced by a factor of 5 by 2007 (White House Commission, 1997). The FAA established, and has since reaffirmed, this as a goal (FAA, 2003). NASA has issued a related goal of reducing the total (fatal & non-fatal) accident rate by a factor of 10 in 20 years (NASA, 2003). Also noted in the Commission's final report was that a primary driver for over 60% of all aviation accidents world-wide had been flight crews; and 70% of all fatalities for the previous 5 years involved the accident classifications LOC-Flight and CFIT (White House Commission, 1997). These primary driver and accident classification are essentially identical to those cited in the annual Boeing accident summary (Boeing, 1996 through 2003), and would seem to be fundamental to the establishment of the accident reduction goals of the Commission, FAA and NASA. Yet, Figure 1 demonstrates that when considering just U.S. registered large-jet operations (over 27K kg maximum takeoff mass MTOM), a different set of priorities in terms of fatal accident classification begins to emerge. It can clearly be seen that fatalities stemming from structural failure, fuel tank explosion and in-flight fire each are effectively of equal relative importance as LOC-Flight and CFIT.

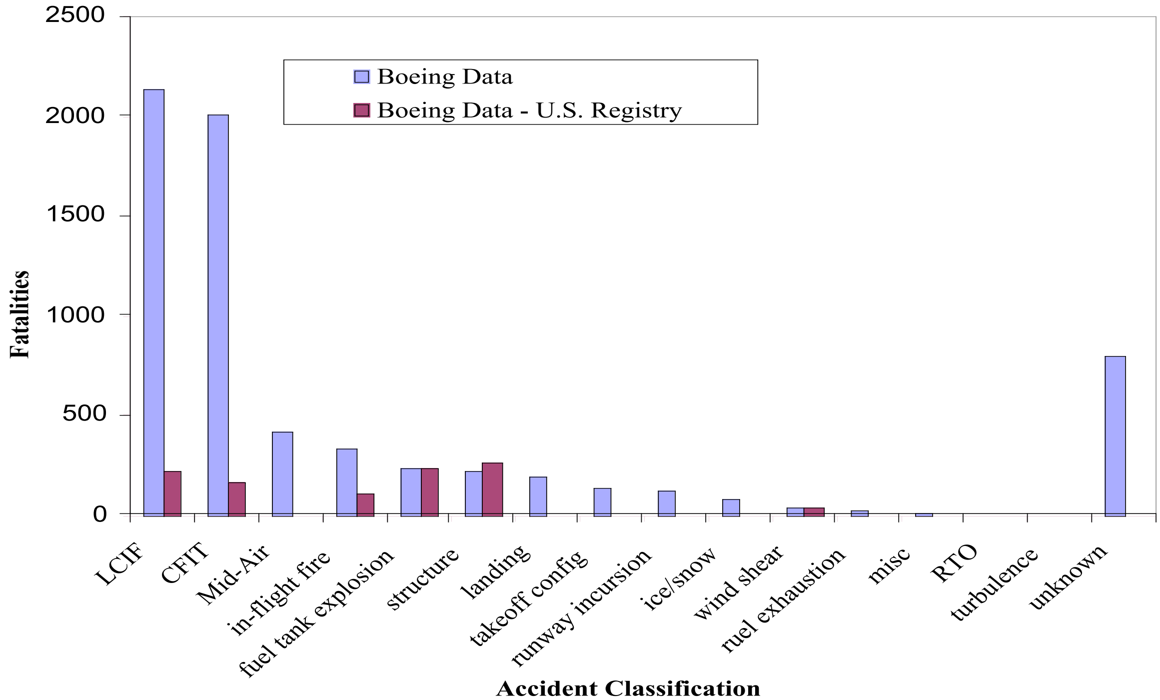

Figure 1: Classification of Accidents: 1993-2002 (Boeing 2003)

A secondary function of Figure 1 is to demonstrate that the method and level of data aggregation adopted by the more dominant organizations negates the capacity for any more micro analysis of the underlying data (that is, the resolution is limited). An example: fatal accident data of the Boeing Summary (Figure 1) groups multiple regions of the world that have variable accident and hull loss rates (Table 1) into greater overriding analyses of aviation safety. Less prominent analyses of the data record have adopted similar analysis characteristics, but have also incorporated data from a still greater

Table 1: Hull Loss Rate By Region of Operation

Region	Per Million Departure
World	1
United States	0.4
Latin America	2.3
Africa	12.4
Europe	0.7
Middle East	3.1
China	0.5
Asia	1.7
Oceana	0

Source: Flight Safety Foundation 2003

range of aircraft and operation types. Each safety study does utilize some degree of delineation of the incorporated data but still with limited resolution of the underlying data, as will be demonstrated.

Aviation Safety Summaries and Analyses:

Table 2 outlines the raw-data sources of the analyses considered in this paper and demonstrates that there are common sources among the various analyses. These commonalities are indicators that some of the variations existing between analyses are functions of the market segment interests of the producers of the analyses rather than being indicative of errors in the original source data accessed in compiling the summaries.

Table 2: Sources of statistical analyses data

	ICAO Reports	Airclaims	AVSoft	Gov Reports	Press Accounts	Operators	Manufacturers	Other
ICAO				X				
Boeing	X		X		X	X	X	X
UK CAA		X						
The Netherlands	X	X	X				X	X
Flight International	X	X	X		X		X	X
NTSB	X			X				X

Sources: (ICAO, 2003); (Boeing, 2003); (UKCAA, 2000); (NTSB, 2003); (Flight Int'l, 2000)

Table 3 outlines the manner in which the summaries included in Table 2 are categorized and aggregated by aircraft, operations and accident characteristic. It demonstrates both the domain of each analysis and the manner in which each dataset is aggregated into subsets. Using the ICAO ADREP Circular as an example: in the section of the circular utilized in this paper, ICAO aggregates the data pertaining to the MTOM such that isolating a single subset of the aggregated data is not possible. i.e. isolating jets between 5.7k and 27k MTOM. It is also noted that the NTSB aggregates data by operating characteristics rather than aircraft characteristics, making any comparison between the datasets almost impracticable.

Because of this level of aggregation, developing any greater resolution from one specific analysis proves difficult. However; the fact that some analyses are near subsets of others (but not identical) might allow for greater resolution in some respects by superimposing data from multiple analyses and assessing the construct of any differential between two analyses. The remainder of this paper utilizes this trait to demonstrate our point that not all subsets of aviation are full represented in the most commonly cited aviation safety summaries and analyses.

<table>
<tr><th colspan="9">Table 3: Delineation of aviation safety analyses</th></tr>
<tr><th></th><th></th><th></th><th>ICAO</th><th>Boeing</th><th>UK</th><th>Nether</th><th>Flight Int.</th><th>NTSB</th></tr>
<tr><td rowspan="14">Accidents, Fatalities, Hull losses</td><td rowspan="3">aircraft mass (kg)</td><td>2.2K - 5.7K</td><td rowspan="3">X</td><td></td><td></td><td></td><td rowspan="3">X</td><td rowspan="3"></td></tr>
<tr><td>5.7K – 27K</td><td></td><td rowspan="2">X</td><td rowspan="2">X</td></tr>
<tr><td>>27K</td><td>X</td></tr>
<tr><td rowspan="2">region of manufacture</td><td>eastern</td><td></td><td></td><td></td><td rowspan="2">X</td><td>X</td><td rowspan="2">X</td></tr>
<tr><td>western</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td rowspan="2">schedule classification</td><td>sched</td><td>X</td><td>X</td><td rowspan="2">X</td><td rowspan="2">X</td><td rowspan="2">X</td><td>X</td></tr>
<tr><td>unsched</td><td></td><td>X</td><td>X</td></tr>
<tr><td rowspan="3">engine type</td><td>piston</td><td rowspan="3">X</td><td></td><td></td><td></td><td rowspan="3">X</td><td rowspan="3">X</td></tr>
<tr><td>turbo prop</td><td></td><td>X</td><td>X</td></tr>
<tr><td>jet</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td rowspan="2">fatal accidents</td><td>passenger</td><td>X</td><td rowspan="2">X</td><td rowspan="2">X</td><td rowspan="2">X</td><td rowspan="2">X</td><td rowspan="2">X</td></tr>
<tr><td>crew</td><td></td></tr>
<tr><td colspan="2">military - terrorism - sabotage</td><td></td><td></td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="8">Source: Boeing 2003; NTSB 2003; ICAO 2003; UK 2000; Netherlands 2000; Flight International 2000</td></tr>
</table>

Comparative Assessment of Accident Data: 1959-2001

Figure 2 (with a few exceptions) shows that the number of fatal accidents in the Boeing summary tracks the same general trend, but with values below that of the ICAO data. However, Figure 3 demonstrates that the datasets merge when plotted as total fatalities; a trend that would be expected if the large-jet accidents of the Boeing summary constituted a minority of the total fatal accident record but a majority of the total fatality record. Such a characteristic was an original operating assumption when this research was undertaken, and it might have seemed intuitive that the large-jets (as defined by Boeing) would constitute the significant portion of the fatality record because of the nature of the ramification of failure: these aircraft carry hundreds of passengers thus this accident effect is an order of magnitude (or two) greater than the failure of smaller aircraft.

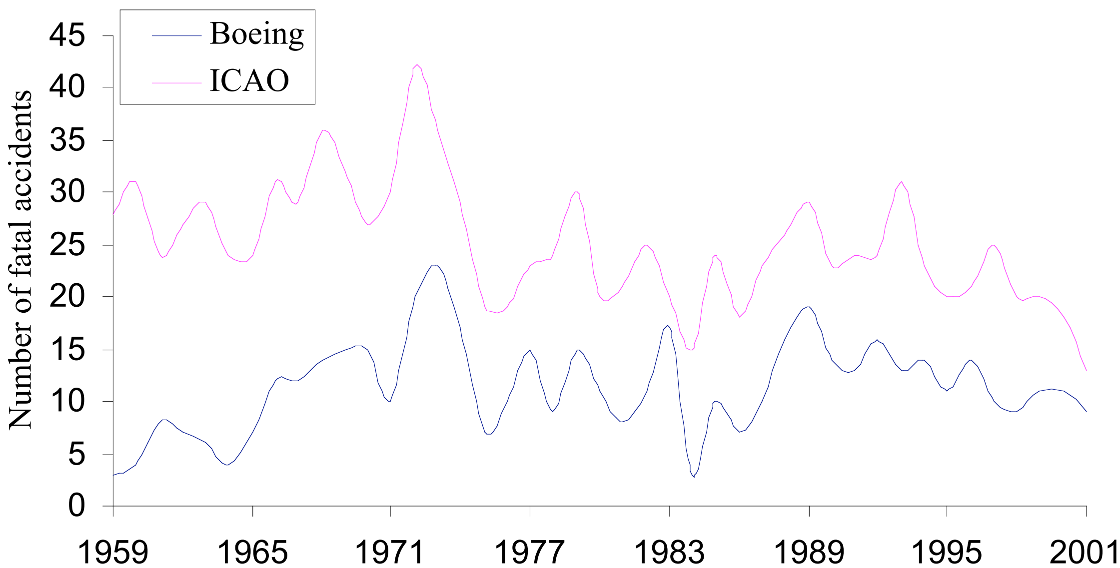

Figure 2: Fatal Accidents - 1959-2001 (Boeing 2003; ICAO 2003)

Initially Figure 3 might seem to be an indicator that large-jets are indeed representative of the remainder of the aviation industry because the significant portions of fatalities stem from accidents involving large-jet aircraft. However; for the fatal accident record of this large-jet subset to be validated as fully representative of the industry as a whole, the trend of Figure 3 would have to remain a constant and similarly plotted data from additional analyses would have to yield similar results.

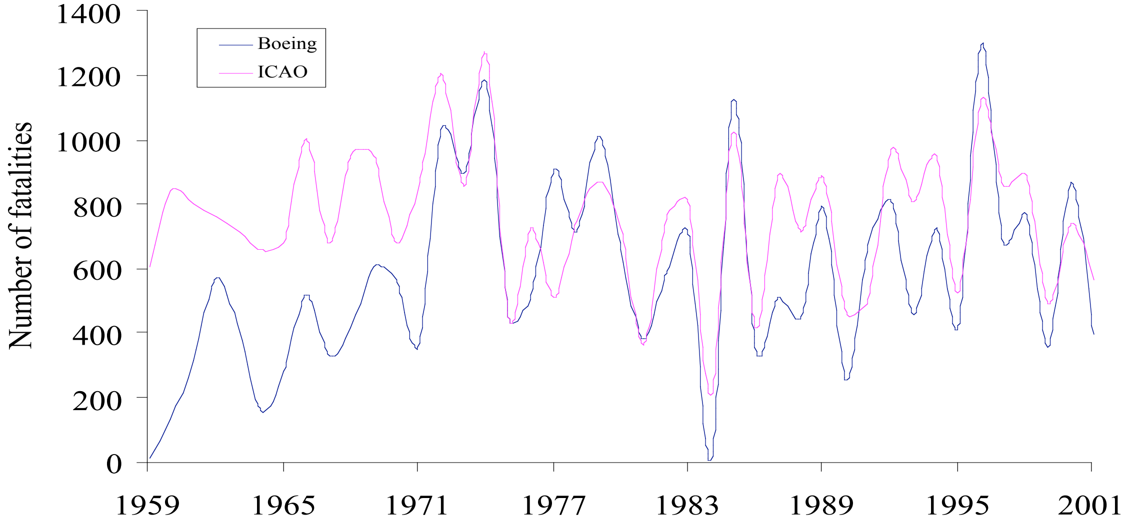

Figure 3: Fatalities 1959 - 2001 (Boeing 2003; ICAO 2003)

Comparative Assessment of Accident Data: 1990-1999

Over the truncated 1990 – 1999 time period, multiple agencies and organizations released additional analyses and summaries (included in Tables 2 and 3) with equivalent compilations of the objective accident record delineated into the common industry characteristics: aircraft mass, region of manufacture, schedule classification, engine type, fatalities, and sabotage/terrorism. The data within each is aggregated into demographics that reflect the segments of the industry of interest to the producers of the analysis: Boeing maintains the same interest in commercial jets over 27,000kg. ICAO is more inclusive with respect to the aircraft type, less inclusive with respect to schedule classification and fatalities. The United Kingdom (UK) and The Netherlands Civil Aviation Authorities' are more inclusive and effectively identical. Flight International is the most inclusive by incorporating "acts of terrorist" and sabotage data. The NTSB is unique in that it aggregates data by the operating designations specified in CFR Chapter

14 Part 121: domestic commercial operations of over 10-seats (NTSB, 1999). This transcends traditional aircraft characteristic boundaries.

Figure 4 is similar to Figure 2, demonstrating that analyses with a more comprehensive scope will plot as containing a greater number of fatal accidents, as would seem intuitive. However; Figure 5 shows that when the data is plotted as total fatalities, the datasets do not tend to merge as they did in Figure 3; instead the individual plots remain essentially independent, leaving merging tendencies as 3 visually distinct groups. The visually notable grouping of datasets in Figure 5 consist of the:

A: UKCAA, Netherlands CAA and Flight International in the upper group (#1)

B: Boeing and ICAO data merged in the central region (#2)

C: CFR Part 121 operations in the NTSB dataset being isolated (#3)

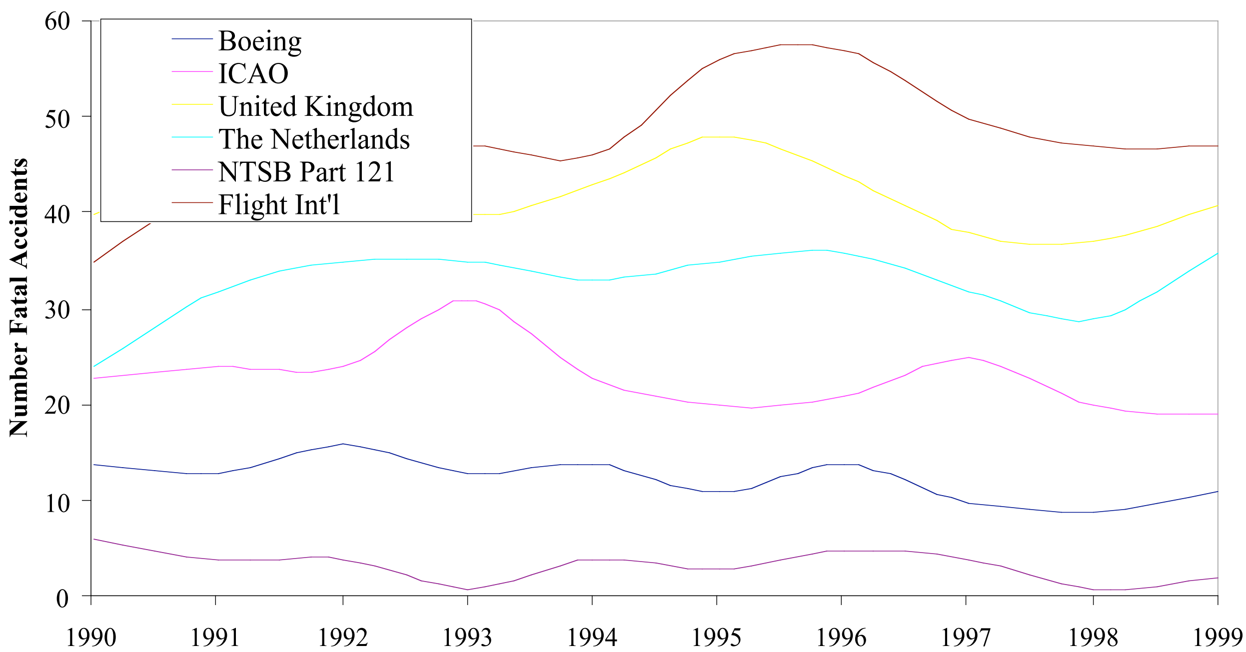

Figure 4: Fatal Aviation Accidents 1990-1999
(Boeing, ICAO, NTSB 2003; UK, Netherlands, Flight Int 2000)

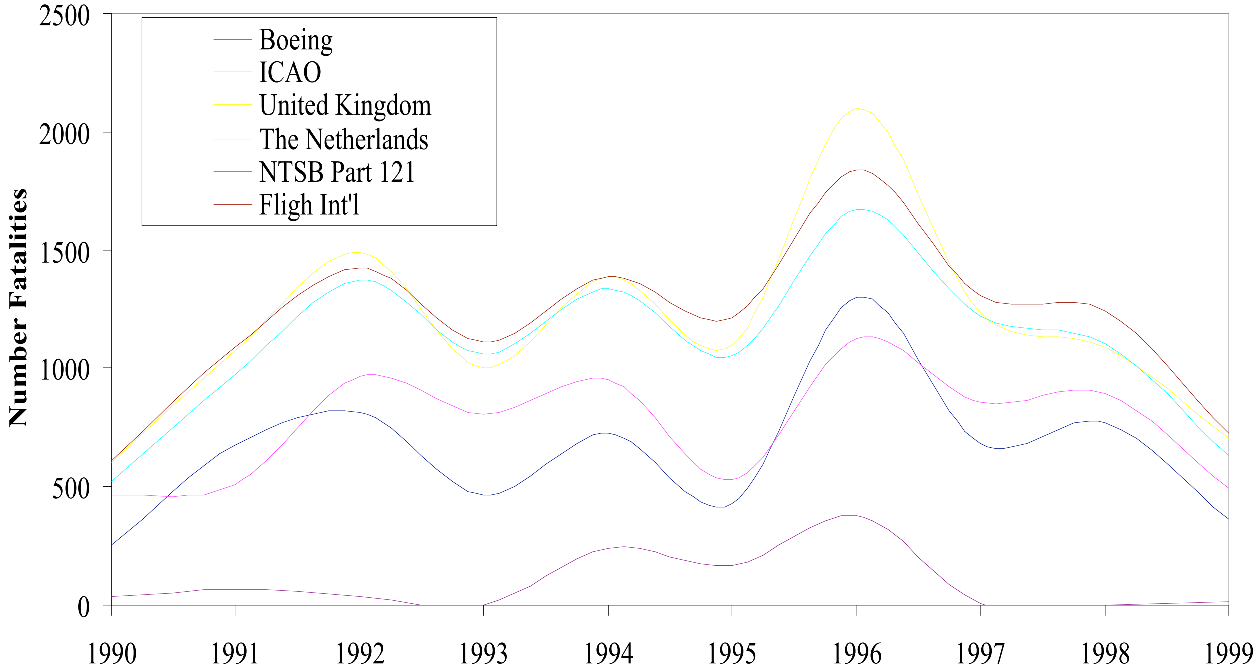

Figure 5: Aviation Accident Fatalities 1990-1999
(Boeing 2003, ICAO 2003, NTSB 2003; UK 2000, Netherlands 2000, Flight Int 2000)

From this it might be extrapolated that if (as is evident in Table 3) the significant portion of the fatal accidents and fatalities of the Boeing and ICAO analyses are incorporated in the three analyses that constitute the #1 grouping of plots in Figure 5, then that would indicate that the Boeing and ICAO analyses do not in fact constitute the significant portion of the fatality record. Instead, it would initially seem evident that on average, over the decade covered in the figure, approximately 50% of the fatality record stems from accidents involving subsets of aviation other that those incorporated in the Boeing or ICAO analyses. If this is accurate, then it would be the second indicator that these two analyses might not fully representative segments of the aviation industry.

The grouping tendency of Figure 5 has yet to be tested for any real statistical significance (and is outside the immediate scope of this paper) yet the figure highlights some of the discrepancies between the different analyses. The intent is to identify which of the subsets of commercial aviation (that initial seem to constitute a fairly significant portion of the fatality record) might be of significance in relation to the accident record, and thus worth further study. Towards this: for the following discussion, these groups are juxtaposed as:

a) NTSB with Boeing and ICAO for applicability of internationally oriented accident datasets to domestic Part 121 type operations
b) the datasets of grouping #1 (using The Netherlands CAA summary data as representative) relative to both Boeing and ICAO summaries to identify subsets of worldwide aviation operations not fully represented in the more comprehensive safety summaries.

Boeing ICAO and NTSB:

The NTSB Part 121 dataset consists of between <1% to 25% of the average number of fatalities included in the Boeing and ICAO analyses. The NTSB dataset reaches 25% of this average in 1996, the year both the ValuJet and TWA 800 accidents occurred. Since neither of these two accidents were CFIT or LOC-Flight, and since the majority of the remaining years represented in the Figure contain an insignificant portion of the average fatality record, this would be a strong indicator that the worldwide orientation of the Boeing and ICAO analyses might not fully represent the safety issues of domestic Part 121 operations.

Boeing ICAO and UK-CAA:

The UK-CAA summary tracks the Boeing data but with an average increase of about 90% from the Boeing data and 50% over the ICAO data. The fact that a discrepancy exists between various analyses should be expected considering the analyses encompass independent domains of the data. However; the scale of this differential is the leading indicator that a significant portion of the fatalities stem from accidents involving demographics not incorporated in either the Boeing or ICAO analyses.

Figures 2 and 4 indicate that significant portions of the fatal accident record involve aircraft and operation demographics not incorporated in either the Boeing or the ICAO analyses. To further this; Figures 3 and 5 indicted that what was the original operating assumption (see page 2) is incorrect and that on average (for the 1990's) approximately 50% of the fatalities stem from accidents involving aircraft other than the large-jet. However; this does not negate the possibility that primary drivers and causal factors of these large-jet fatal accidents transfer as being representative of other segments of aviation. Towards this, a further comparative analysis juxtaposing the methods of fatal accident classifications utilized by these same analysis publishers might further highlight the variable nature of accident characteristics as they relate to aircraft and operation type.

Comparative Assessment of Accident Classifications:

Figure 6 juxtaposes Boeing and ICAO accident categories (using the typical Boeing Statistical Summary format), and is an example of the variable nature of classification of accident data. CFIT and LOC Flight still dominate the plot as they did in Figure 1 weighted as greatest percent of total fatal accidents. But the most critical element of Figure 6 is the noted absence of ICAO data in the majority of the data fields. This is because Boeing delineates the fatal accidents into 17 data fields. ICAO utilizes only 7. Referring to Table 3; it is noted that while the Boeing analysis is limited to one fairly specific subset of the accident record (the "large-jet"), ICAO incorporates the "large, medium and small jet", as well as the "large, medium and small turbo-props and piston engine"; essentially aggregating the whole of the accident record of the world commercial civil aviation fleet into a single data field. There are a number of outcomes of this; the first being the inability to assess the relative importance of accident classifications by aircraft type, region of operation, or type of operation in all aircraft demographics other than the large-jet.

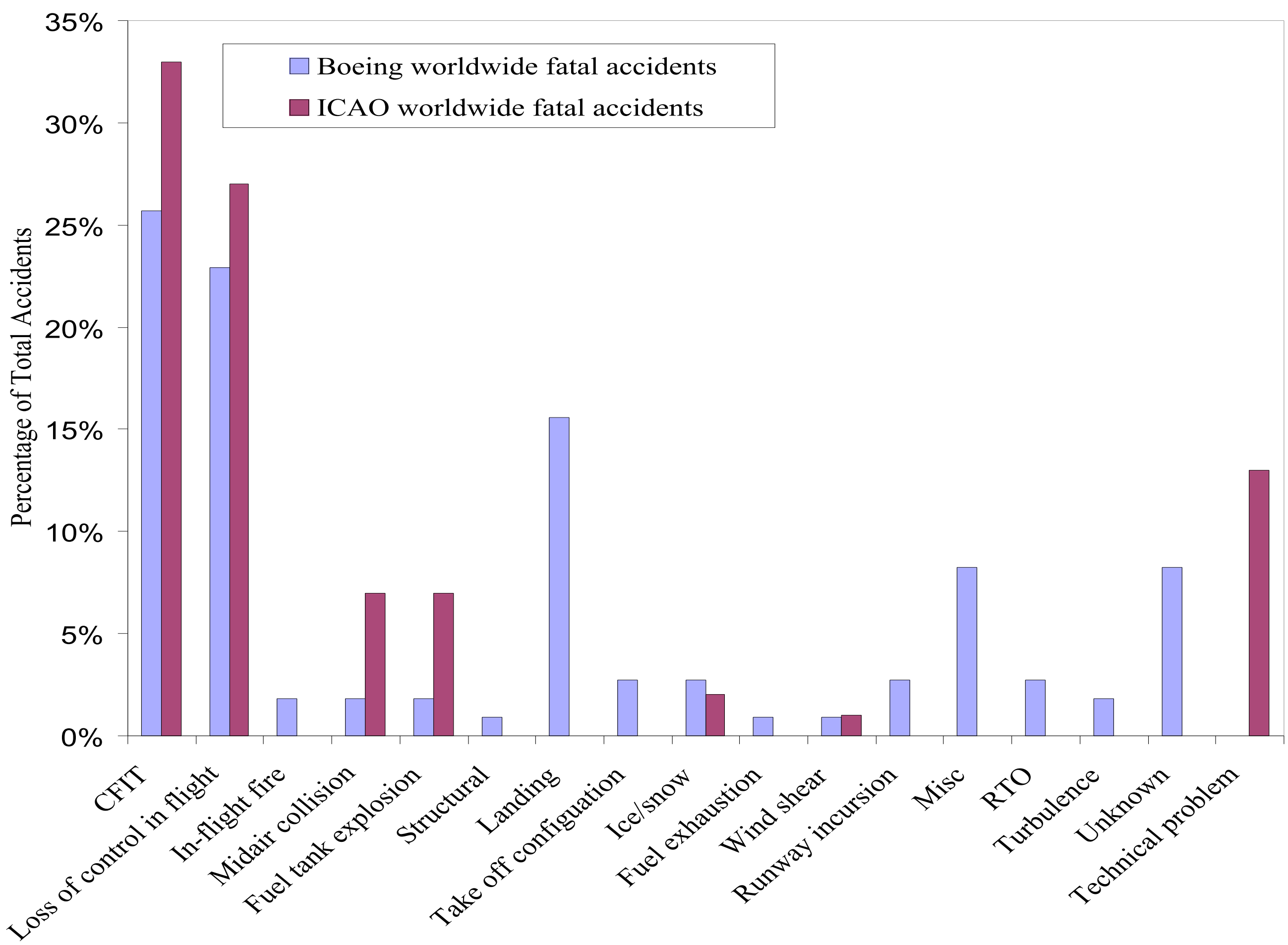

Figure 6: Boeing vs. ICAO; Accident Classifications
Source: Boeing Statistical Summary; ICAO ADREP Circular

Figure 7 presents the accident classifications of the Boeing and UK-CAA analyses in a similar manner as Figure 6, though issues of comparability are somewhat more significant here. An initial impression would be that there is substantial variance in the outcomes of these analyses, and it would seem that a total of 96% of the UK-CAA accident record is aggregated into categories with no equivalence in the Boeing summary. Yet, this is misleading because individual accidents in the UK-CAA analyses are classified and aggregated into multiple accident categories dependent on the "outcomes" of primary causal factors. This means that any specific accident can and is "categorized" by multiple outcomes and classified in multiple categories. Numerically this leads to the UK-CAA plot indicating well over 100% of the incorporated accident dataset. As an example: a CFIT accident would also be considered a "collision", and since it might have resulted in a "post crash fire", this one accident might ultimately be incorporated in 3 separate categories.

Figure 7 demonstrates that, despite the expanded scope of the UK-CAA analysis, if the goal is to assess for the transferability of accident classifications between class of aircraft or type of operation, the format of these summaries does not allow for the required resolution of the underlying data.

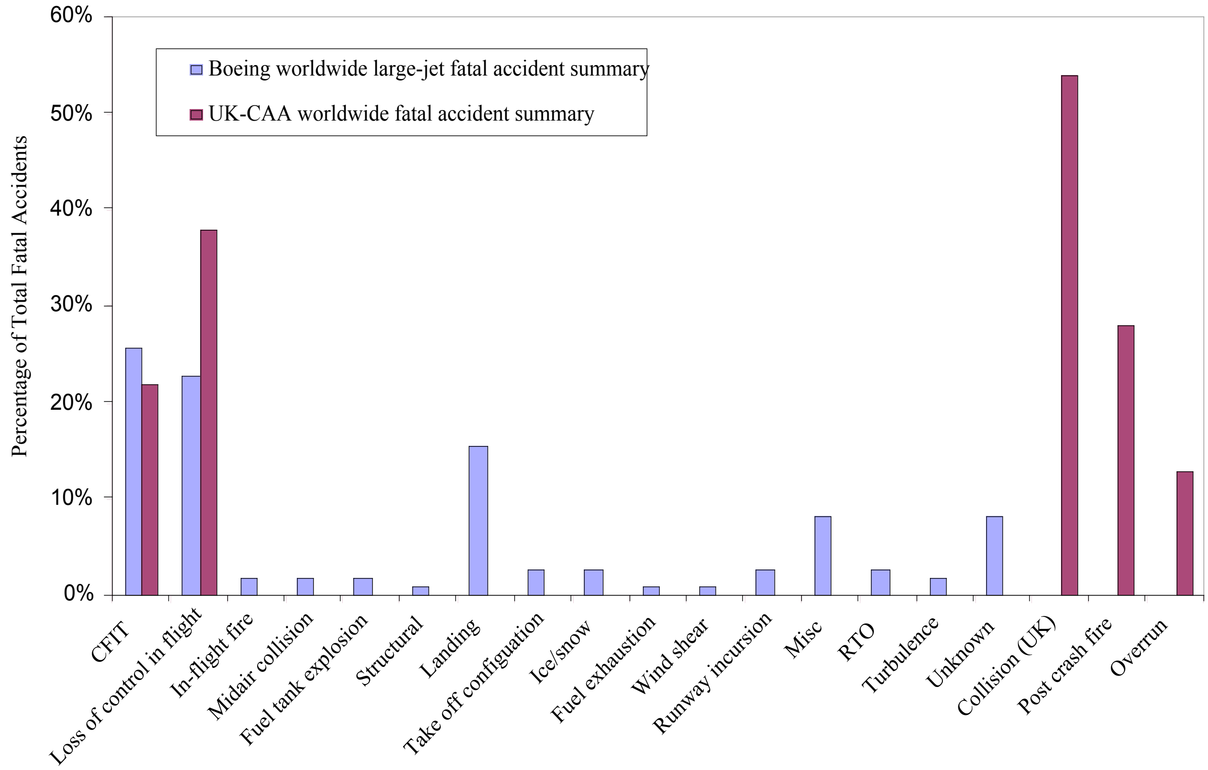

Figure 7: Boeing vs. UK-CAA; Fatal Accident Classification
Source: Boeing Statistical Summary 2000; UK-CAA Aviation Accident Summary 2000

Figure 8 juxtapose the ICAO and UK-CAA analyses. Since these two summaries each have the trait of aggregating individual accidents into more than one accident category, they may demonstrate more of a commonality in the overriding accident classifications than in the previous Figures. However; it again appears that there is little correlation between the analyses in methods of accident classification. When comparing the ICAO or the UK-CAA summaries to the Boeing data, there was significant difference in the scope of the underlying summaries. However, in this case the ICAO and UK-CAA summaries are quite similar in their scope (see Table 3), yet the capacity to identify accident categories for more specific demographics of aircraft or operations beyond the aggregate of the whole is not possible.

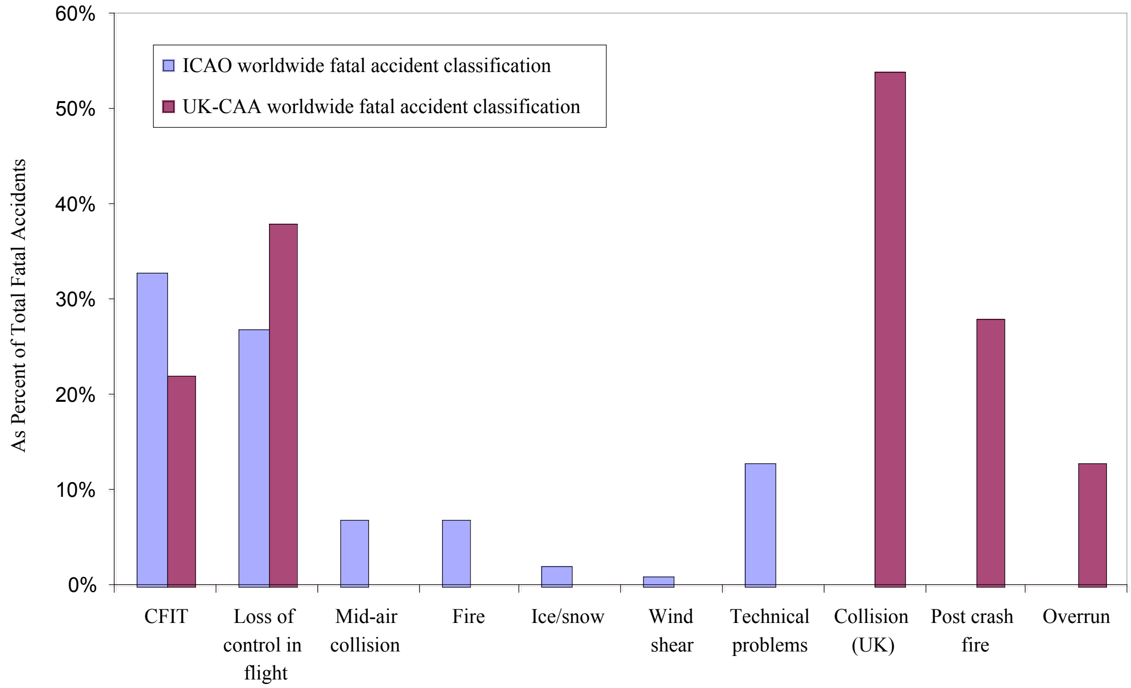

Figure 8: ICAO vs. UK-CAA; Fatal Accident Classification
Source: ICAO ADREP Circular 2000; UK-CAA Summary 2000

These three Figures leave the impression that it may be difficult exercise a meaningful comparative study or assessment to establish commonality of causal factors between subsets of aviation, and that greater resolution of the underlying data is required before further study is possible. The remainder of this paper is dedicated to this topic.

Comparative Assessment of Variation in Accident Summery Data

A combined review of Figures 1, 2, 3, 5, 6, 7, and 8 collectively demonstrates two critical issues: 1) the Boeing and ICAO summaries do not necessarily contain the significant portion of the worldwide objective fatal accident and fatality record; 2) outcomes of safety summaries can be a function of the method and level of data aggregation rather than being representative of all aircraft and operational characteristics, or region of operation. Ultimately these Figures and Tables demonstrate that there is a significant portion of the total fatality and fatal accident record stemming from aviation operations other than those in the more influential summaries and analyses. This may prove to be a caveat in the current paradigm where there is the potential in significant change within domestic commercial civil aviation. With a burgeoning interest in non-traditional aviation markets and business models, there seems to be slated a substantial transfer of demand from the traditional "hub and spoke" model to more non-traditional aviation

Table 4: Construct of differentials of three analyses

			UK	Boeing	differential	UK	ICAO	differential
Delineation of accident record	aircraft mass (kg)	2.2K - 5.7K			*UK CAA:*		X	*ICAO:*
		5.7K - 27K	X		> 5.7k,< 27K	X		< than 2.7K
		>27K		X				
	region of manufacture	Eastern			none			none
		Western	X	X		X	X	
	schedule classification	Sched	X	X	none	X	X	UK CAA:
		Unsched		X				Unsched
	engine type	Piston			*UK CAA:*		X	*ICAO:*
		Turbo prop	X		Turbo Prop	X		Piston
		Jet	X	X		X		
	fatal accidents	passenger	X	X	none	X	X	*UK CAA:*
		crew						crew only
	Boeing 2003, UKCAA 2000, ICAO 2003							

Comparative Assessment: Boeing & UK CAA

Table 3 first demonstrated that the data incorporated in the Boeing summary is in effect a subset of the UK-CAA summary. The similarity in methods of delineation and aggregation makes the identification of a root source of any differential between the two initially simple. The are highlighted in the "differential" column of Table 4 as: 1) the UK-CAA analyses contains data from the accident record pertaining to aircraft over 5.7K kg, while the Boeing analyses limits the incorporated data to a single fairly specific class of aircraft – the large-jet over 27K kg MTOM; and 2) the UK-CAA includes Turboprop aircraft.

Reviewing Figure 5, there was and on for the decade a 90% increase in the number of fatalities from the Boeing to the UKCAA summaries (ranging from 41% to 150%). This substantial variation in the data would have to originate from accidents involving those subsets highlighted in Table 4: turboprops (independent of aircraft mass) and aircraft of all engine type less than 27K kg MTOM.

Comparative Assessment: ICAO vs. UK CAA

In this case, identifying specific subsets of the data that constitute the significant portion of the differential between these summaries is not as easily identified because the ICAO summary analysis is broader in scope that the UKCAA in some respects yet more restrictive in others. Yet the fact that the UK-CAA summary dominates the plots in both number of fatal accidents and associated fatalities would seemingly indicate that those subsets of the data exclusive to the ICAO summary do not contribute a significant amount to the total accident record. Therefore, the differential must be weighted towards those subsets exclusive to the UK-CAA summary. Table 4 highlights these as: unscheduled operations of all aircraft mass, engine type and type of accident; as well as fatal accidents involving only crew fatalities (again of all aircraft mass and engine type). Figure 5 indicates that for the 1990's the mean differential between these analyses is 49% (ranging from 21% to 110%). This would indicate that for the decade, on average, one half of the fatalities stem from operations that are not included in the ICAO analysis.

Each of the preceding comparative assessments demonstrates that a significant portion of the worldwide fatal accident record stems from fairly specific subsets of the data, and around 50% of the objective fatality data record. With this information (coupled with the accident classification variability issue) it seems evident that the source of a significant portion of the accident record is either not delineated such as to be quantifiable as a separate demographic of aviation. If these subsets of the data in turn constitute a moderate or increasing portion of the number of operations (departures, millions of mile flown, emplacements, etc) then there is the potential for these segments of aviation to face an increased risk profile. Yet, the safety summary as a hazard identification mechanisms, having been so successful leverage towards the reduction of accident and incident rates, are not as readably available for the less dominate and more emerging markets of aviation.

CONCLUSION AND FUTURE WORK

The dominate characteristic of the current "standard" in aviation safety summaries and analyses is the worldwide commercial large-jet operation. The parameter of primary interest is the hull loss and the fatal accident. Operation and accident data that falls within this domain is very salient to aviation safety, however; it has been demonstrated here that there is a significant portion of the fatality record stemming from operations with aircraft characteristics other than this standard. The assumption used predominantly for setting aviation safety priorities (that the large-jet demographic would constitute a minority of the accident record but the significant portion of the fatality record) has been shown to be incorrect. Instead, a significant portion of the accident record actually stems from operations that are not individually highlighted or outlined in commonly cited safety summaries and analyses. If the accident characteristics of the accidents captured by these summaries are in fact representative of all other class of aircraft and operations then this is approach might be appropriate. If however the nature of the casual factors or risk exposures differs between operations, aircraft or regions, then current analysis methodologies might yield results with aircraft, operation or regional biases. The ultimate result might be safety initiatives not directly representative of, applicable or transferable to, all segments of civil aviation.

The data utilized in this paper is of course derived from historical objective accident data record, and thus is representative of the last 10 years of aviation safety. Yet, there are indications that the outlook for the aggregate aviation market may start to diverge from the traditional “hub and spoke” model; with the expansion of regional operations, and the possible inclusion of secondary aviation markets such as some derivative of a NASA Small Aircraft Transportation System (SATS) type aviation system. In either case, the aviation industry will likely begin to develop local and regional characteristics that will differentiate themselves from any worldwide norm.

The two primary points of this paper highlighted in the previous two paragraphs are: 1) the safety record of one “demographic” of aviation may not be representative of all; and 2) aviation may begin to transfer demand to non-traditional markets. Collectively, these indicate a demand for a more broad data summary of the objective accident data that will allow for the aggregation of data along operation, aircraft and regional orientation. Towards this, future projects will include the development of more specific requirements of an annual aviation safety summary package. The goal is to compliment the current dominate analyses and summaries, while giving an available resource that might be utilized for highlighting safety related trends in more specific civil aviation demographics.

Acknowledgement
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