

Massive Uncertainty

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Massive Uncertainty

- **Objective: To present realistic context of forecasting exercise**
- **Topics**
 - **Evidence**
 - **Consequences**

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Causes of Uncertainty

- **Underlying variability of phenomenon**
- **Difficulties in measurement or estimation**
- **Unforeseen or “unpredictable” circumstances**
- **Limits to valid measurement**
→ for example: behavioral patterns

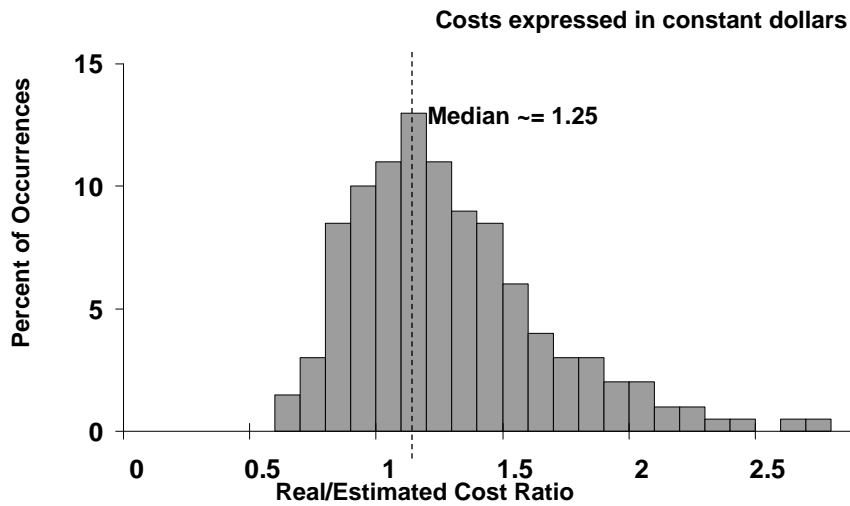
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Evidence

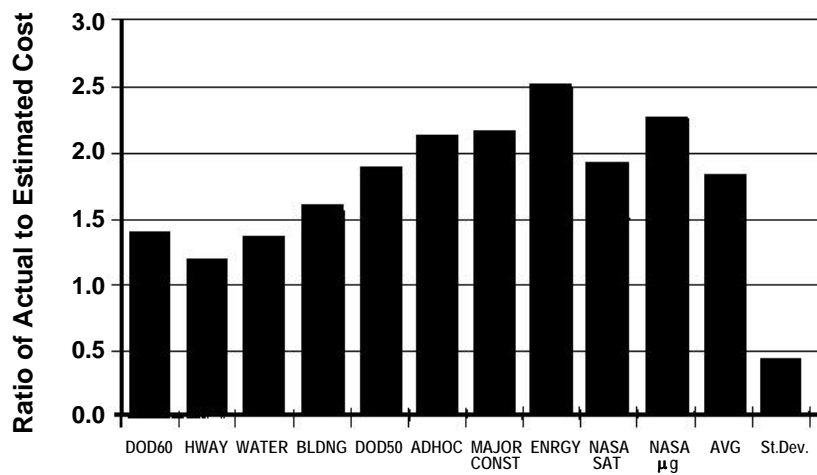
1. **Simple Physical Systems**
2. **Overall Traffic**
3. **Local Traffic (Worse)**
4. **Other Operations**

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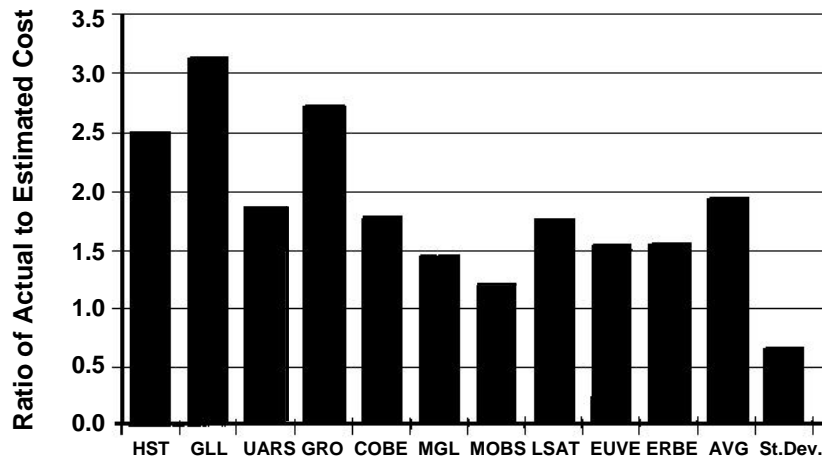
Ratio of Real Costs to Estimated Costs for Airport Projects



Cost Growth for Various Projects

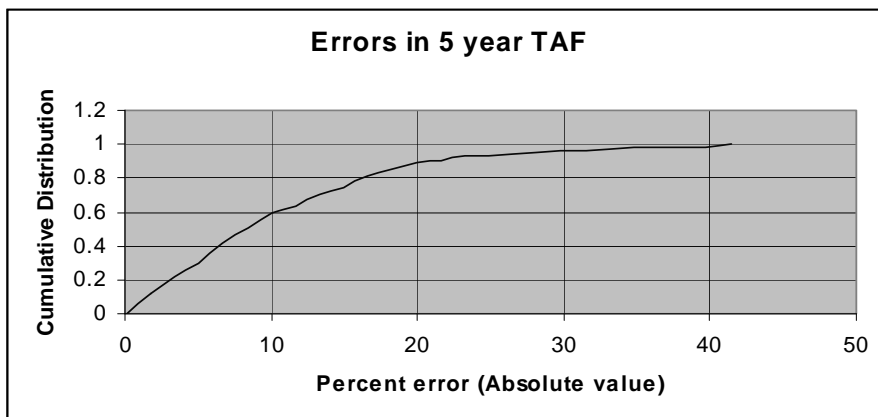


NASA Projects Cost Growth



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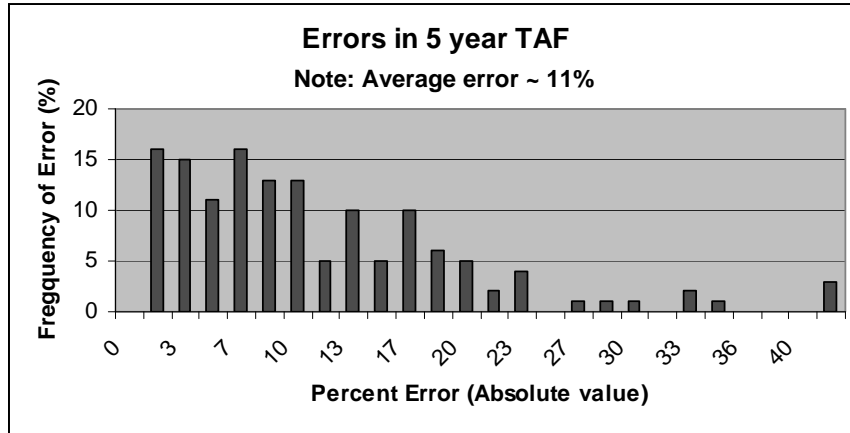
Results of a 2004 study



Adapted from: Terminal Area Forecast (TAF) Accuracy Assessment Results
Jerome Friedman, MITRE CAASD, Sept. 30, 2004

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Results of a 2004 study



Adapted from: Terminal Area Forecast (TAF) Accuracy Assessment Results
Jerome Friedman, MITRE CAASD. Study dated Sept. 30, 2004, but data until
2000. Deliberate omission of 2001, 2002 – when traffic dropped enormously

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Error Data from U.S

Source: MITRE CAASD and FAA

City	5 YEAR FORECAST FROM / TO			
	92 97	93 98	94 99	95 2000
ATL	10.8	-10	-15.5	-13.3
BOS	-0.8	-2.1	-0.2	8.9
BWI	27.4	6.3	-5.8	7.5
CLE	-13.4	-14.6	-17.5	-13.3
CLT	7.8	15.8	10.9	18.1
CVG	-0.9	-4.3	-14.5	-9.5
DCA	7.5	13.8	2.7	-5.1
DEN	18	19.6	19.9	5.5
DFW	2.6	-3.2	7.8	14.2
DTW	-13.2	-6.5	-8.6	3.1
EWR	-12.2	-5.9	-0.1	5
FLL	17.2	3.4	-3.8	-11.6
HNL	28.2	40.9	23	14.9
IAD	-6.4	-9.5	-41.4	-41.2
IAH	-8.1	-12.3	-8.9	-25.4
JFK	-0.9	6.2	11.7	3.8

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Error Data from U.S

Source: MITRE CAASD and FAA

City	5 YEAR FORECAST FROM / TO			
	92 97	93 98	94 99	95 2000
LAS	-5.1	-2.2	-10.4	8.5
LAX	2.2	-1.6	-1.4	0.6
LGA	7.7	3.9	-3.2	-4.8
MCO	15.9	15.1	18.6	14.9
MDW	33.9	-21.3	-32.9	-5.2
MEM	9.1	16.3	10	4.7
MIA	3.9	3.8	13.1	21.5
MSP	-5.4	0.4	5.6	0
ORD	-6.8	-5.1	-3.4	2
PDX	-3.9	-12.2	-9.5	3.5
PHL	-3.2	-7.2	-4.2	0.1
PHX	6.1	6	4.1	-2.8
PIT	9.4	9.9	8.2	6.6
SAN	21.6	20	15.6	20.6
SEA	6.3	-0.8	-15.3	-9.3
SFO	25.7	22.5	17.4	10.7
SLC	-6.7	-0.2	-0.3	9.8
STL	-7.4	-1.3	-3.3	4.9
TPA	16.5	12.4	6.9	5.6

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Locid	City	Airport Name	Preliminary CY08 Total Enplanements	Forecast 2004 TAF in thousands	% Difference
CVG	Cincinnati	Cincinnati/Northern Kentucky International	6,488,422	13193	-103.3
IAD	Washington	Washington Dulles International	11,287,621	15861	-40.5
MDW	Chicago	Chicago Midway International	8,019,338	10714	-33.6
MSP	Minneapolis St. Paul	Minneapolis-St Paul International/Wold-Chamberlain	16,352,653	21361	-30.6
BWI	Baltimore Washington	Baltimore/Washington International Thurgood Marshall	10,206,399	13135	-28.7
HNL	Honolulu	Honolulu International	9,000,365	11483	-27.6
DTW	Detroit	Detroit Metropolitan Wayne County	16,993,820	20183	-18.8
LAX	Los Angeles	Los Angeles International	28,612,013	33628	-17.5
ORD	Chicago	Chicago O'Hare International	33,668,545	38760	-15.1
TPA	Tampa	Tampa International	8,869,806	10182	-14.8
BOS	Boston	General Edward Lawrence Logan International	12,784,965	14658	-14.7
LGA	New York	La Guardia	11,549,790	13225	-14.5
PHL	Philadelphia	Philadelphia International	15,577,122	17817	-14.4
PHX	Phoenix	Phoenix Sky Harbor International	19,433,827	22175	-14.1
FLL	Fort Lauderdale	Fort Lauderdale/Hollywood International	11,018,382	12557	-14.0
SLC	Salt Lake City	Salt Lake City International	9,889,030	11180	-13.1
MCO	Orlando	Orlando International	17,271,885	19192	-11.1
STL	St. Louis	Lambert-St Louis International	6,644,199	7359	-10.8
ATL	Atlanta	Hartsfield - Jackson Atlanta International	43,737,608	47130	-7.8
DFW	Dallas/FTWorth	Dallas/Fort Worth International	27,206,541	29202	-7.3
LAS	Las Vegas	McCarran International	21,011,949	22424	-6.7
SAN	San Diego	San Diego International	9,007,602	9437	-4.8
SFO	San Francisco	San Francisco International	18,101,502	18496	-2.2
IAH	Houston	George Bush Intercontinental/Houston	19,850,397	20070	-1.1
EWR	New York	Newark Liberty International	17,578,856	17604	-0.1
PDX	Portland	Portland International	7,073,767	6956	1.7
SEA	Seattle	Seattle-Tacoma International	15,815,133	15456	2.3
DCA	Washington	Ronald Reagan Washington National	8,692,131	8336	4.1
JFK	New York	John F Kennedy International	23,601,779	22306	5.5
DEN	Denver	Denver International	24,266,328	22817	6.0
MIA	Miami	Miami International	16,369,998	15369	6.1
CLT	Charlotte	Charlotte/Douglas International	17,271,119	14678	15.0

**Actual 2008 traffic compared to that forecast
in 2004 TAF** Source: US FAA

Sum	-426.5
Average	-13.3
Sum Absolute	507.7
Average Absolute	15.9

Actual vs. Forecast 10 years earlier

Source: FAA Aerospace Forecast FY 2006-2017

Domestic Commercial Emplanements	
Year being forecast	Actual vs. Forecast
1995	11.4
1996	12.2
1997	17.4
1998	14.9
1999	9.9
2000	5.5
2001	4.7
2002	14.5
2003	12.5
2004	20.0
2005	13.9
Median and Average	12.5

Note: These are aggregate data, in which greater local variations tend to cancel each other out

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Older FAA Forecasts vs. Actual Data (% Difference)

Forecast Year	For Year	Commercial Emplanmtns.	Revenue Pax. Miles	Hrs. General Aviation	GA Ops at FAA Towers	Tot. Ops at FAA Towers
1959	1964	(1.30)	(6.50)	(0.60)	4.60	9.70
1960	1965	(9.50)	(9.70)	(1.20)	(27.80)	(21.60)
1961	1966	(27.50)	(26.00)	(15.30)	(37.70)	(28.90)
1962	1967	(32.10)	(31.40)	(23.60)	(34.70)	(27.30)
1963	1968	(41.30)	(41.30)	*	(38.40)	(32.50)
1964	1969	(31.40)	(33.60)	(23.50)	(27.30)	(24.90)
1965	1970	(14.10)	(19.80)	(16.30)	(2.60)	(5.20)
1966	1971	9.40	0.50	(1.60)	53.70	42.20
1967	1972	23.60	13.00	9.10	72.50	54.90
1968	1973	23.90	15.90	7.40	78.30	58.40
1969	1974	21.10	21.20	4.60	53.60	42.40
1970	1975	26.30	33.00	(0.60)	80.90	25.90
1971	1976	19.00	28.60	(0.60)	42.90	22.90
1972	1977	22.30	33.70	(6.80)	36.90	4.50
1973	1978	14.00	18.30	(10.40)	14.80	8.80
1974	1979	(9.70)	(7.40)	(13.70)	11.80	9.40
1975	1980	(10.60)	(17.30)	(0.20)	34.60	25.70
1976	1981	4.30	(1.80)	15.70	41.30	32.10

Review of the FAA 1982 National Airspace System Plan

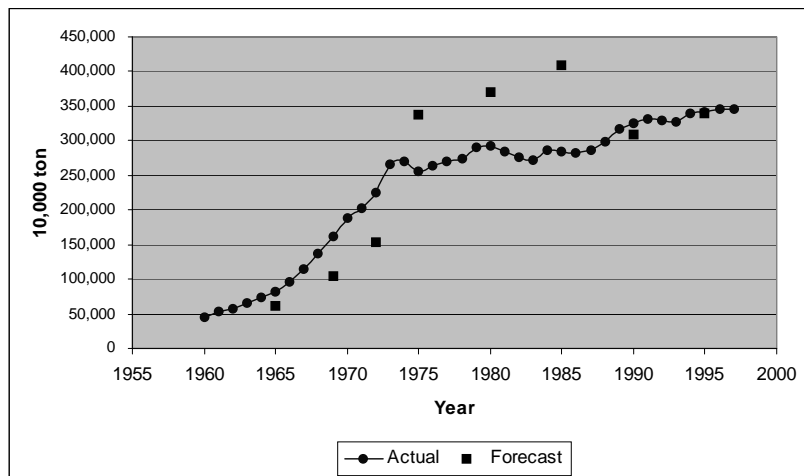
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Forecast vs. Actual International Pax in Japan

Forecast		Passengers (million)		Percent Error
For	Done In	Actual	Forecast	Difference/Actual
1980	1970	12.1	20.0	65
1985	1975	17.6	27.0	53
1990	1980	31.0	39.5	27
1995	1985	43.6	37.9	(13)

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Forecast vs. Actual International Pax to Japan



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Notice the Pattern!

- **Forecasting is an exercise in projecting past into future – ...like steering car by looking into rear view mirror!**
 - **Past low growth => under estimation**
 - **Past high growth => over estimation**
- Almost never right!**

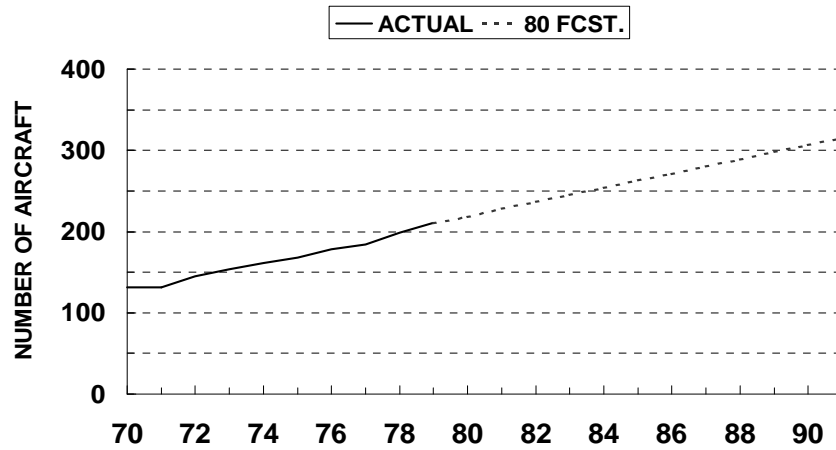
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Forecast vs Actual International Pax in Sydney

Forecast For Year	Source of Forecast, in Year		
	Consultant 1974	Regional Study 1978	National Ministry 1983
1980	3.77	2.98 - 3.46	
1985	7.4	3.87 - 4.34	2.674 - 3.047
1990	9.8	4.71 - 5.51	2.762 - 3.751
2000 projected	12.0	6.27 - 8.66	2.938 - 5.159
2000 actual	10		

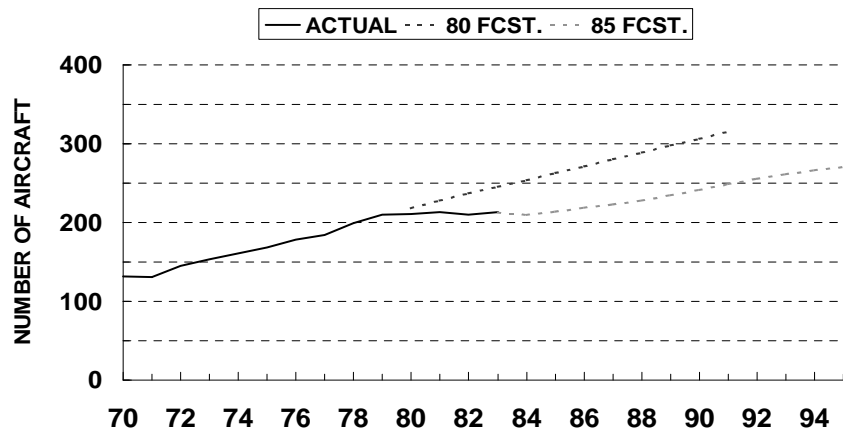
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ACTIVE GENERAL AVIATION AIRCRAFT 1980 FORECAST



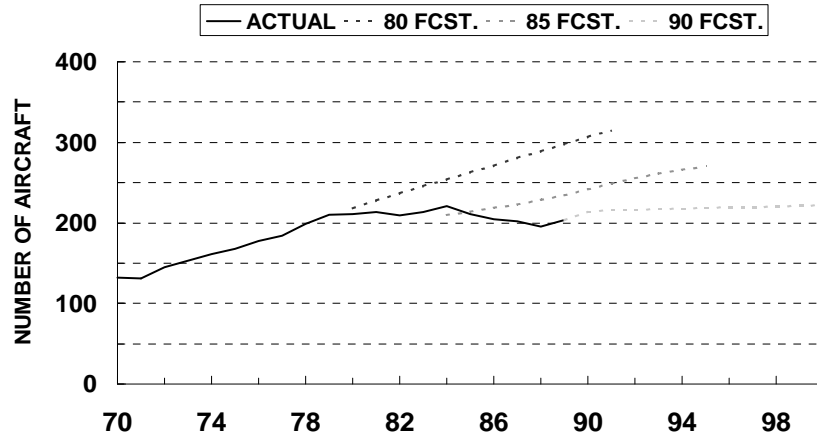
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ACTIVE GENERAL AVIATION AIRCRAFT 1985 FORECAST



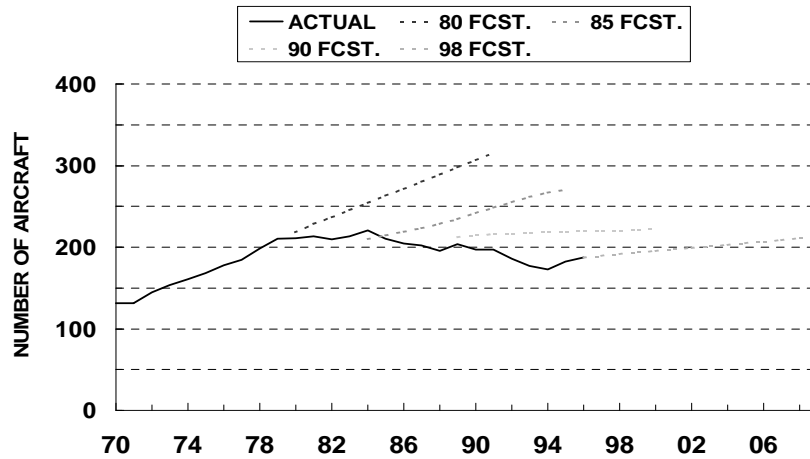
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ACTIVE GENERAL AVIATION AIRCRAFT 1990 FORECAST



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ACTIVE GENERAL AVIATION AIRCRAFT 1998 FORECAST



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Summary and Recommendations

- **Summary**

- Forecast Errors have been large
- Likely to continue

- **Recommendations:**

- Expensive Forecasting is cost-ineffective
- Use general trends
- ...With large ranges
- Flexible Approach to Planning!!!