Quantification of Benefits
A Winter Storm Example

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Why again do we need this…?

- Airlines need:
  - A quantitative way to compare operational performance with weather forecasting performance to:
    - Build a history
    - Identify trends
    - Conduct post event analysis for decision review and improvement.
- Weather forecast producers need:
  - A quantitative way to measure the value forecasts provide to the aviation community by:
    - Measuring their value on a daily basis.
    - Tracking and comparing forecast performance over time on an impact basis.
    - Being able to provide a historical record of value to justify costs of production.

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Two Distinct Problems to Consider

- Terminal weather forecasts impact:
  - Staffing (Customer Service, Deicing, Overtime callouts, Dispatch, Reservations etc.)
  - Hours of Operation
  - Proactive Customer Accommodation (no charge changes etc.)
  - Customer Behavior

- En route – (NAS Planning)
  - ATC Delays (GDP, GS, AFPs, compression etc.)
  - Fuel Planning
  - Turbulence, Icing and Thunderstorm Avoidance

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Example - Snow at an Airline Hub

- Light snow with good visibility (6 SM –SN) is forecast from 15Z to 18Z.
- Heavy snow with reduced visibility (1/4 SM +SN) is forecast starting at 18Z and lasting through 21Z.
- Precipitation tapers to light snow with improved visibility (3 SM –SN) from 21Z through 04Z.

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Based on that forecast

- Typical strategic planning efforts would result in:
  - Running a reduced operation between 14Z and 17Z by thinning flights wherever possible – 66 flights total – 22 flights affected during the forecast of light snow.
  - Canceling operations between 17Z – 22Z -136 flights total 136 flights affected. Cancelled flights an hour ahead and an hour after forecast of heavy snow "just in case".
  - Resuming normal operations after 22Z – 182 flights scheduled during after 22Z.

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Assuming Forecast Verified

Forecast Time	Forecast Condition	Actual Weather
15Z – 18Z	6 SM -SN	Light snow; Vis > 3 SM
18Z - 21Z	¼ SM +SN	Mod/Hvy snow; Vis < 1 SM
21Z – 04Z	3 SM -SN	Light snow; Vis > or = 3 SM

Time Frame	Number of Canceled Flights	Number of Operated Flights	Cancellation Costs
14Z – 17Z	22	44	$ 165,000
17Z – 22Z	136	0	$ 1,020,000
22Z through COB	0	182	$ 0
Total	158	226	$ 1,185,000

Average cost per flight cancellation approximated at $7,500
Average Diversion cost approximated at $5,000

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Now assume the Heavy Snow Started 2 hours later than forecast and lasted 2 hours longer

Original Forecast

Forecast Time	Forecast Condition
15Z – 18Z	6 SM -SN
18Z - 21Z	¼ SM +SN
21Z – 04Z	3 SM -SN

Actual Weather

Actual Time	Forecast Condition	Actual Weather
15Z – 20Z	6 SM -SN	Light snow; Vis > 3 SM
20Z - 01Z	¼ SM +SN	Mod/Hvy snow; Vis < 1 SM
01Z – 04Z	3 SM -SN	Light snow; Vis > or = 3 SM

“On the Fly” Adjustments

- Since heavy snow started 2 hours later and hung on 2 hours longer, 1 hour of flights were diverted, and an additional hour of flights were cancelled.
- Also note that two hours of “thinned flights” in hindsight didn’t need to be thinned. However, once a decision is made flights can not be reinstated.

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Cost Difference Due to the Change in Conditions From Forecast

Cost Item	Number of Affected Flights	Forecast Penalty
Thinned/cancelled flights in error	22	$ 165,000
One hour of diverted flights	27	$ 135,000
Additional hour of cancelled flights	27	$ 202,500
Total	158	$ 502,500

Average cost per flight cancellation approximated at $7,500
Average Diversion cost approximated at $5,000

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Now Assume that heavy snow forecast was narrowed down to 2 hours versus 3

Original Forecast

Forecast Time	Forecast Condition
15Z – 18Z	6 SM -SN
18Z - 21Z	¼ SM +SN
21Z – 04Z	3 SM -SN

Modified Forecast

Forecast Time	Forecast Condition
15Z – 18Z	6 SM -SN
18Z - 20Z	¼ SM +SN
20Z – 04Z	3 SM -SN

Based on the Modified Forecast

- Modified strategic planning efforts would result in:
  - Running a reduced operation between 14Z and 17Z by thinning flights wherever possible – 66 flights total – 22 flights affected – **No change**
  - Canceling operations between 17Z – 21Z -136 flights total 108 flights affected. – **Saved 27 flights.**
  - Resuming normal operations after 21Z – 209 flights scheduled during after 22Z.

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Cost Savings Due to the Modified Forecast

Cost Item	Number of Affected Flights	Forecast Penalty
Reduced flight cancellations	27	$202,500
Total	27	$ 202,500

Average cost per flight cancellation approximated at $7,500
Average Diversion cost approximated at $5,000

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Cost Summary

- Forecast verified as issued – "cost" to airline $1,185,000.
- Two hour delay in the heavy snow from the "planning forecast" resulted in an additional cost of $502,500.
- A "tighter forecast" for the heavy snow saved the airline $202,500.

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Disclaimers

- Cancellation and diversion costs are industry estimates and may (and probably do) vary greatly among airlines.
- Many Customers do re-book on subsequent flights. The estimates take that into account, but this can be highly variable.
- Diversion costs include factors like airplane cycle time, Crew time, additional landing fees, and fuel.
  - These fees assume that the flight will indeed make it to the original destination. They do not account for loss in Customer goodwill, hotel expenses, or "downstream effects" such as Crew duty time barriers, additional costs for maintenance routings, etc.

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A number is a number….

- It is advantageous to have as close to accurate costs as possible to best measure impact, however, forecast trends, forecast modifications, and forecast improvements can be measured using standardized (consistent) costs.

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Going Forward……

- SWA would like to partner with a local NWS WFO to perform this analysis on a few events this winter to see how difficult this method is to put in practice and see what is learned….