USE OF WEATHER INFORMATION BY GENERAL AVIATION PILOTS: PROVIDERS AND PRODUCTS

William R. Knecht
Civil Aerospace Medical Institute
Oklahoma City, OK

Data obtained from 211 general aviation (GA) pilots were examined to determine usage patterns for weather information. Weather products, providers, and en-route information sources were ranked according to relative use and rated by perceived information value, frequency of use, and time invested per usage. The measures were highly correlated. Additionally, voice tapes of 306 calls to Automated Flight Service Stations were analyzed. Conclusion #1: A small fraction of pilots show sparse use patterns. These may be at risk for flying with inadequate preparation. Conclusion #2: There seems to be a strong tendency for many pilots to prefer relatively simple forms of information (e.g. METARS). This may present a problem, given the often-complex nature of weather.

INTRODUCTION

Purpose

This report is a summary of onsite surveys completed by GA pilots concerning their use of weather information products and providers. The intent was to establish actual usage of products and services as compared with the recommended strategy for using weather data.

GA weather products and providers

A weather *product* is a relatively small package of related information constituting a stand-alone report (e.g. METAR, TAF). Weather *providers* are organizations dedicated to bundling weather products, NOTAM, TFR, and flight planning information into convenient, user-friendly form. The Flight Service Station is a good example of a weather provider. Providers try to give us a strategic sense of the weather, to complement the tactical sense given by the separate weather products themselves. There are literally scores of weather providers, most of them commercial, for-profit. Many high-end providers offer features rivaling those available to airline dispatchers.

METHOD

Design and participants

During July and August 2005, the FAA Civil Aerospace Medical Institute surveyed over 230 GA pilots at locations across 5 states (CA, OK, ND, IL, FL). Pilots' median age was 23 years and median flight experience was 245 hours. Women made up 14% of the sample. All were volunteers paid for their services as SMEs.

Procedure

Pilots were asked to a) rate weather products and providers on the basis of how much they typically used them, b) assign each a value based on its information content, c) estimate the percentage of times each was used on a "standard flight" and, d) estimate the number of minutes each was used on this standard flight. This "standard flight" was defined as a 4-hour flight through "weather serious enough to challenge *your* skill level and the aircraft's capabilities."

RESULTS

Weather providers

For each weather provider, Table 1 shows four ratings supplied by pilots plus one rating arithmetically derived from the last two ratings. *Rank* is a rank-ordering of how much pilots felt they used a given weather provider. *Value* is a similar measure of how valuable each pilot felt that provider's information was. *Percent of Flights* refers to the percentage of flights on which pilots used each provider. *Minutes Spent* refers to the amount of time per flight a given provider was used if and when it was accessed. The final column, *Average Minutes Spent* per flight, is the result of multiplying *Percent of Flights* times *Minutes Spent*. As such, *Average Minutes Spent* is a statement about how much time was spent on a given provider on the "average" flight (even though sometimes it may have been used and sometimes not). *Average Minutes Spent* also allows us to estimate an average *Total Minutes Spent Per Flight* across all providers (19.8 in this case).

Note that *Rank* does not have to equal *Value*. For instance, we might highly *value* a Rolls-Royce automobile, yet *rank* it low in terms of use, since we cannot afford to actually own one.

Ranks and values were all normalized to a scale of zero to one to allow for easier comparison of the data. Directionality is such that "0" represents *least* valuable and "1" represents *most* valuable.

Notice that the FSS standard briefing was both ranked and valued highest (1.0), and said to be used on the highest percent of flights (61%). This was closely followed by the public NWS/NOAA Web sites, which actually experienced higher minutes-spent-when-used and overall average minutes used.. Internet DUATS also received high ratings across the board.

Table 1. Normalized ranks, values, frequency of use and time using various weather information sources.

Provider	Format	Rank 0-1	Value 0-1	% of flights	Min. spent	Ave. min spent
Commercial vendor	Internet	0.4	0.5	28.7	5.0	1.4
Public NWS or NOAA site	Internet	0.7	0.8	49.8	**13.9**	**6.9**
DUATS	Internet	0.7	0.7	34.0	8.9	3.0
DUATS	at airport	0.1	0.1	11.3	2.1	0.2
FSS (automated TIBS)	telephone	0.1	0.1	8.9	1.5	0.1
FSS (standard)	telephone	**1.0**	**1.0**	**61.5**	9.1	5.6
FSS (abbreviated)	telephone	0.1	0.2	9.2	1.8	0.2
FSS (outlook)	telephone	0.2	0.3	14.4	2.4	0.3
The Weather Channel	Internet,TV	0.4	0.5	27.9	7.0	2.0

Finally, a surprising number of pilots reported using The Weather Channel, even though it is not an FAA-approved source. This was perhaps due to the sheer ease of turning on the television and watching TWC during morning coffee. Also, Internet TWC has a convenient feature allowing the user to type in a zip code and receive easy-to-understand forecasts based on current location. In other words, TWC seems to give pilots something they want—a simple report, local and fast. The other sources are far more comprehensive, but that breadth comes at the expense of extra time and effort.

Weather products

As stated, *Rank* and *Value* were normalized here, so direct comparisons can be made between all four categories of responses. Table 2 shows that the six most highly ranked and valued weather products were TAF and METAR (tied for first place), followed by AIRMET/SIGMET, radar charts, FAs, and ATIS, all more or less tied for second. The total estimated average number of minutes spent was 16.6, reasonably consistent with the 19.8 estimated for time spent using providers (the importance of this will be discussed in greater detail later).

It is quite interesting that the "old standbys," METAR and TAF, rated so highly. Again, this may parallel TWC's popularity in some human tendency to want brevity and simplicity. As human factors researchers, we would all be well-advised to remember this psychological principle.

En-route sources

Table 3 shows results for the en-route information sources. Two relatively simple sources - ATIS and AWOS - tied roughly for first place. ASOS and Flight Watch tied for second. It was not obvious why Flight Watch did not receive higher ratings. Perhaps it was merely because this was a "one-tank" flight. Had we specified, say, a longer flight requiring refueling, perhaps we would have seen a shift in the numbers. The relatively low ranking of weather-related avionics may stem from several sources. It is possible that access to in-flight sources is more likely with the older more established pilots who own aircraft or have invested in portable devices with subscriptions to data-providing up-link services. The average age of the present sample was comparatively young and they might be less likely to have access to these sources.

Table 2. Normalized ranks, values, frequency of use and time using various weather products.						
		Rank	Value	% of	Min.	Ave. min
Product	Format	0-1	0-1	flights	spent	spent
AC (Severe Wx Outlook Narrative)	text	0.1	0.1	4.7	0.4	0.0
AIRMET / SIGMET	text	0.5	0.7	47.6	3.7	1.8
ASOS (Automated Surface Observing System)	radio	0.2	0.2	13.0	0.8	0.1
ATIS (Automated Terminal Information System)	radio	0.4	0.5	41.4	2.0	0.8
AWOS (Automated Weather Observing System)	radio	0.3	0.4	25.0	1.8	0.5
charts, Air- or Surface-analysis	graphic	0.1	0.2	12.8	1.0	0.1
charts, Convective outlook	graphic	0.1	0.1	10.1	1.1	0.1
charts, Prog.	graphic	0.2	0.3	17.8	1.7	0.3
charts, Radar (NEXRAD)	graphic	0.5	0.6	44.2	3.6	1.6
charts, Radar summary	graphic	0.3	0.4	23.7	1.7	0.4
charts, Weather depiction	graphic	0.2	0.3	15.1	1.8	0.3
FA (Aviation area 18-hr forecast)	text	0.5	0.5	36.1	3.2	1.2
FD (Winds and temps aloft)	text	0.3	0.4	30.0	2.2	0.7
FD	graphic	0.0	0.1	5.3	0.4	0.0
GPS (Global Positioning Satellite)	T or G	0.1	0.1	5.1	0.5	0.0
LLWAS (Low Level Wind shear Alerting System)	radio	0.0	0.0	0.9	0.1	0.0
METAR	text	**1.0**	**1.0**	**77.3**	**4.5**	**3.4**
PIREP	text	0.3	0.6	36.4	2.2	0.8
Satellite (images of cloud cover)	graphic	0.2	0.3	20.9	1.8	0.4
SD (hourly weather reports)	text	0.0	0.0	3.9	0.4	0.0
TAF	text	**1.0**	**1.0**	**76.5**	**5.3**	**4.0**
TWEB (Transcribed Weather Broadcast)	radio	0.1	0.1	9.0	0.9	0.1
WW, AWW (weather watch bulletins)	text	0.0	0.0	0.1	0.1	0.0
Other sources		0.0	0.0	0.1	0.0	0.0
		Total minutes spent per flight				**16.6**

Table 3. Normalized ranks, values, frequency of use and time using various enroute weather sources.					
	Rank	Value	% of	Min.	Ave. min
En-route source	0-1	0-1	flights	spent	spent
avionics	0.1	0.0	8.3	1.2	0.1
ASOS	0.3	0.4	23.6	1.6	0.4
ATIS	**1.0**	**1.0**	75.6	4.6	3.5
AWOS	0.6	0.7	48.7	4.1	2.0
EFAS (FSS Flight Watch)	0.4	0.6	29.1	4.1	1.2
HIWAS (Hazardous Inflight Weather Advisory System)	0.2	0.3	14.0	1.4	0.2
TWEB	0.0	0.0	2.6	0.4	0.0
Other sources	0.0	0.0	4.0	0.3	0.0

Analysis of Voice Recordings from Automated Flight Service Stations (AFSS). One additional focused examination was conducted for the pilots' first-choice information source, the Automated Flight Service Stations (AFSS). The interest was in determining what types of information AFSS specialists provide, what pilots request, and how they might use that information. To answer these questions, three AFSS facilities provided 24 hours of continuous recordings of actual recent conversations that occurred between pilots and specialists staffing the preflight desk. The recordings represented 306 calls made on good (90), typical (80), and poor (136) weather days occurring in the Northwest Mountain Region (95), Southwest Region (105), and New England Region (106). Data extracted from the tapes included whether the pilot requested (259) or declined (47) a preflight briefing and the types of weather information pilots requested or that were provided by specialists. The pilots who called fell into 3 basic groups: (1) local fliers; training schools, students, and aircraft buffs who stay within 30-50 miles of the departure point and return to that airport, (2) fixed base operators (FBO) who rent aircraft and transport passengers for hire, advanced training, and short distance carriers (with stored or pre-filed flight plans), and pilots of larger aircraft, and (3) business, military (training and operations), corporate, and long-distance lifeguard pilots.

Generally, pilots requested standard weather briefings more often (VFR 43%, IFR 37%) than either abbreviated (VFR 38%, IFR 27%) or outlook (VFR 8% IFR 6%) briefings. Regardless of weather conditions, AFSS relayed the following weather items in 85% of the pilot-requested preflight weather briefings: Weather synopsis, sky conditions (clouds), visibility, weather conditions at the departure, en route, and destination point. Also included to a lesser degree were adverse conditions, altimeter setting, cloud tops, dew point, icing conditions, surface winds, winds aloft, temperature, thunderstorm activity, precipitation, precipitation intensity, visibility obscuration, other weather, PIREPs, AIRMETs/SIGMETs, MOAs, MTRs, NOTAMs, and TFRs.

During typical weather conditions, pilots who did not request a preflight briefing still asked the specialist about the weather conditions at their departure point (25%), en route (25%) and at the destination point (25%). On marginal VFR days they also asked about any TFRs, NOTAMs, AIRMET/SIGMET and PIREP as well as thunderstorm activity, winds aloft, cloud tops, and ATC delays or flow control advisories. Whether by asking for additional information or receiving weather information from specialists, 32 pilots decided that it was best to change their flight plans. Some delayed (47%), postponed or cancelled (16%) their flights while others looked for alternate routes and destination points (16%). It was not immediately evident why pilots declined the weather briefing in 15% of the calls, but it could be speculated that currently available weather-information sources such as internet aviation weather services and DUATS allowed these pilots to be comfortable with the information from these sources in lieu of a preflight briefing by a specialist.

Reliability and Consistency of the data

One measure of reliability may be obtained by comparing the time pilots said they spent on weather products versus on providers (16.6 vs. 19.8 minutes). Since providers consist of products plus other services, the number associated with providers should be close to, but slightly greater than, that for products. As expected, that is the case.

Intercategory correlations can also be used to infer some measure of reliability. If data categories are designed so that multiple questions are asked about similar things then, if respondents give logically consistent answers across categories, it can be assumed that most were answering items thoughtfully rather than randomly. *Rank*, *Value*, *Percent Use*, and *Minutes Used* all logically measured related aspects of value to pilots. Therefore, they should all correlate as long as participants did not answer randomly.

In Table 4 we do see very high groupwise intercategory correlations, ranging from 89-99%. From this we can infer a number of things. First, we have at least some indication that our data are reliable. If we did the same study again with the same pilots, we ought to get similar results.

Table 4. Provider, product, and enroute source intercorrelations.

	Provider intercorrelations					Product intercorrelations					En-route source intercorrelations			
	Rank	Value	%	Min.		Rank	Value	%	Min.		Rank	Value	%	Min.
Rank	1					1					1			
Value	0.993	1				0.975	1				0.979	1		
%	0.988	0.987	1			0.987	0.993	1			0.994	0.961	1	
Min.	0.896	0.910	0.902	1		0.954	0.972	0.966	1		0.927	0.960	0.898	1

Second, the high intercorrelations imply: a) Pilots do generally seem to use the information they value most (unlike our example with the Rolls-Royce), and; b) In future studies it is probably unnecessary to use all four measures. *Percent Use* and *Minutes Used* are probably sufficient, both to check reliability and to estimate the total minutes each pilot spends on weather briefings.

Table 5. Ranks, values, frequency of use, time used, and estimated total times involved in weather briefing.						
	Rank	Value	% of	Min.	Ave. min	Total min. spent
Top Weather Information Providers	0-1	0-1	flights	spent	spent	on all sources
Public NWS or NOAA site	0.7	0.8	49.8	**13.9**	**6.9**	**19.8**
FSS (standard)	**1.0**	**1.0**	**61.5**	9.1	5.6	
Top Weather Products						
METAR	**1.0**	**1.0**	**77.3**	**4.5**	**3.4**	**16.6**
TAF	**1.0**	**1.0**	**76.5**	**5.3**	**4.0**	
AIRMET / SIGMET	**0.5**	**0.7**	**47.6**	3.7	1.8	
ATIS (Automated Terminal Information System)	**0.4**	**0.5**	**41.4**	2.0	0.8	
charts, Radar (NEXRAD)	**0.5**	**0.6**	**44.2**	3.6	1.6	
FA (Aviation area 18-hr forecast)	**0.5**	**0.5**	**36.1**	3.2	1.2	
Top En-route Weather Information Sources						
ATIS	**1.0**	**1.0**	75.6	4.6	3.5	**7.3**

DISCUSSION AND CONCLUSIONS

Table 5 summarizes the top weather information providers, products, and en-route sources, as rated by the pilots sampled. The first question that comes to mind is whether 16-20 minutes preflight preparation and 7-8 minutes en-route followup are sufficient to prepare for a 4-hour flight into weather challenging to both the pilot's skill and the aircraft's capabilities. If the time is sufficient, a) how efficiently is the time spent, and b) what is the minimum time necessary? Although this study can't address cognitive efficiency, it may be able to address minimums.

Table 6 summarizes the estimated average number of minutes spent on weather briefing for preflight providers and products, and for en-route sources. Minimums, maximums, ranges, and standard deviations are also shown.

Table 6. Estimated average time spent on weather briefings by providers, products, and enroute sources.			
	Providers	Products	En-route
Average time spent	19.8	16.6	7.3
Minimum	**3.10**	**3.97**	**0.99**
Maximum	138.5	154.6	92.0
Range	135.4	150.63	91.01
Standard deviation	24.5	23.9	12.9

Conclusion #1 is that, despite the acceptable group averages, given the wide range and large standard deviation, *there seem to be individuals spending as little as 3-4 minutes on preflight weather briefing, and less than one minute on updates, once airborne*. Perhaps these numbers point to a group we should be concerned with, namely those at the short-time end of the distribution. Conclusion #2 is that, while many pilots seem to value and use the modern, sophisticated information providers, *there seems to be a strong, counter-tendency to value and use that which is simplest*. As Table 5 shows, the most popular weather information products and en-route sources sampled here seem to be among the simplest. This has implications for user interface design, certification, and training. It also may reflect a deep problem for some pilots, given the inherently complex nature of weather.

Regarding suggestions for further study, it is recommended that fewer polling variables are needed (specifically *frequency of use* and *Average Minutes Spent*). Future studies should also consider exploring flight duration as a variable, and should explore whether the "low-use/simple-use" pilots described here constitute an at-risk group.

REFERENCES

Miles, M.B., & Huberman, A.M. (1994). Qualitative Data Analysis. Thousand Oaks, CA: Sage.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the efforts of Jerry Ball and of the various site points-of-contact who made data collection possible, Roni Prinzo who was responsible for acquiring and analyzing the AFSS voice tapes and contributing to the manuscript, and Dennis Beringer for data collection and editorial contributions.