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# Weather Information Priorities for Commercial Pilots and Dispatchers

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The Next Generation Air Traffic System's (NextGen) goal is to increase capacity three-fold (JPDO, 2007). Given that approximately 70 percent of system delays can be attributed to weather, planning is focused on reducing weather-related delays by at least fifty percent (Leader, 2007). NextGen plans to integrate information from multiple sources, providing the same information to pilots, controllers, and dispatchers. However, different stakeholders may require different information at different times. This research identifies information needed by dispatchers and commercial pilots for pre-flight and in-flight planning and decision-making.

Thirty dispatchers and sixteen commercial pilots prioritized weather concepts. Results illustrate the information elements that were important to each group during each phase. Results show that pilots pay attention to fewer information elements pre-flight, however the two groups rely on similar information once the flight is airborne. User interface implications are presented.

The United States Air Transport System is at capacity, and the cost of operations and maintenance are too high for the revenue being generated. The solution to this problem will not be found in evolving the current air transportation system, but instead it will require an entirely new design (Arbuckle, et al, 2006). This new system, the Next Generation Air Transportation System (NextGen) has the goal of safely increasing capacity three fold by 2025 (JPDO, 2007). This goal will be achieved by reducing spacing among aircraft, improving departure and arrival arrangements, and potentially running simultaneous operations on a single runway. Scheduling will be enhanced through data driven processes that facilitate planning, make information available to multiple communities of interest, and distribute decision making effectively. Additionally, weather information will be better assimilated into decision making, providing a common weather picture to multiple stakeholders, integrating multiple sources of weather information, feeding multiple weather forecasts, and reducing the need for human interpretation.

This focus on improving weather information is prudent, since approximately 70 percent of national airspace system delays are attributed to weather (Leader, 2007). Indeed, NextGen has the goal of reducing weather-related delays by at least fifty percent (Leader, 2007). An important piece of the effort will be to integrate disparate weather data so that information can be shared among all NextGen users. It is important, however, to recognize that different user groups have different responsibilities, and work in different environments. Consequently, the various user groups will likely require different information at different times.

Whereas general aviation (GA) pilots plan their own flights and conduct their own weather research, commercial pilots rely on a substantial support system including dispatchers and meteorologists. The information needed by pilots and dispatchers may be different, though obviously not contradictory. Pilots and dispatchers are likely to have different information needs and place different priorities on pieces of information at different phases of flight. Showing them the exact same display at all times may not be wise.

Our research focuses on determining what weather information should be shown to pilots and dispatchers and when. We identify the pieces of information that are critical to both groups at all times, the pieces of information that are needed rarely, and the similarities and differences in the requirements of the two groups. Although the Airline Operations Center (AOC) includes many roles, such as supervisors, coordinators and meteorologists, the majority of the AOC personnel work in dispatch. As a result, to simplify exposition we will use the term dispatcher to refer to these research participants, even though they sometimes included professionals in the other roles as well. According to Heuwinkel (1993) dispatchers are responsible for conducting the following activities:

- Develop and file flight plan
- Gather weather information
- Provide weather information to the pilot
- Respond to pilot requests for weather information and rerouting
- Distribute information on changing weather to the pilot
- Reroute aircraft
- Develop strategic flight schemes for group of flights according to weather conditions.

Broadly, dispatch involves two components: flight planning and flight following. Flight planning occupies the most time and is proactive in nature. Flight following is usually uneventful, but can also be the most critical and time-compressed activity. This is especially true when unexpected weather occurs. In such situations, dispatchers need to make decisions quickly, taking into account the location of the airplane, proximity to various airports, details about the airports, airplane configuration, and fuel status. Further, because weather can be geographically broad, it may affect many aircraft at the same time. Generally, the process of flight following involves looking for changes. The dispatchers track the weather, looking for deviations from the forecast. If adverse weather develops, the dispatcher may ask the pilot to hold for a while (while the weather dissipates) before attempting to land. If the adverse weather is not likely to disperse, the dispatcher advises the pilot to proceed to an alternate airport.

Ensuring safety typically requires choosing routes that avoid "big weather", choosing appropriate departure and arrival alternatives, and avoiding turbulence. It is the last of these that is the most demanding, since turbulence can be localized and difficult to detect. Keeping the pilot updated is crucial for dealing with turbulence, ensuring customer safety and comfort. Communicating turbulent conditions to the pilot in a timely manner enables the pilot to change altitude or to warn passengers of impending turbulence.

Several studies have identified important weather factors in aviation (Beringer & Schvaneveldt, 2002; Comerford, 2004; Heuwinkel, 1993; Krozel, Capozzi, Andre, & Smith, 2003). Two of these (Beringer & Schvaneveldt, 2002; Heuwinkel, 1993) have also identified priorities associated with the factors. Schvaneveldt, Branaghan, Lamonica, and Beringer (2008) reviewed these studies and selected the factors shown in Figure 1 as representative of the weather factors identified in all of the studies. The diagram shows that weather factors tend to cluster around five central nodes: precipitation, clouds, wind, visibility and temperature. These informational factors were used in the priority ratings obtained in the present investigation.

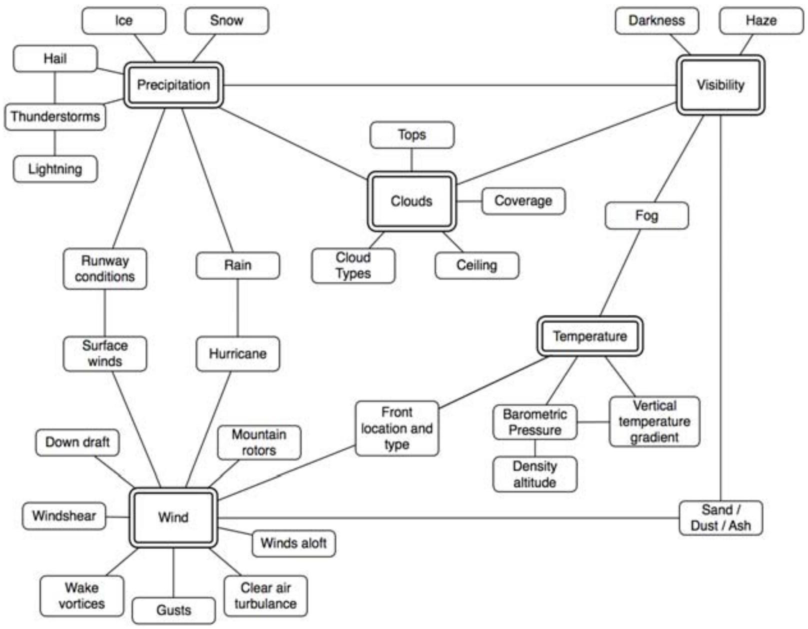


*Figure* 1. Weather factors and relations among them.

## Method

### Participants

Thirty dispatchers employed in the AOCs of four airlines based in the United States and sixteen commercial pilots served as research participants. The airlines included two large operations with substantial international service, one smaller operation with national service, and a small regional operation. Although the general procedures and goals are similar across the various AOCs, there are several differences in the specific weather products being used and in the extent to which individual airlines create their own software systems for the use of their dispatchers and meteorologists.

## Materials

A website, Survs.com, was used to collect priority rating data. Participants accessed the survey via a link sent in an invitation email. In an earlier study of GA pilots (Schvaneveldt, et al., 2008), we included three phases of flight (departure, en route, and arrival) in addition to planning. For dispatchers, it made more sense to consider only two phases, planning and flight following; this is how they organize their activities. Consequently, the data from commercial pilots were collapsed across in-flight phases for comparison by taking the maximum priority for each factor across the flight phases.

## Procedure

The survey presented an introductory page providing an overview of the study and estimating the time it would take to complete. Next, the software displayed instructions for how to complete the survey, and a demographic questionnaire. Participants then rated the of each information element for the activities of flight planning and flight following on a 4 point scale, with 1 representing least important and 4 representing most important. Completion took approximately 10 minutes. Data collection took place over a three-month period. The importance ratings were converted to priorities by subtracting them from 5. Thus, 1 becomes the highest priority and 4 is the lowest.

# Results and Discussion

Table 1 shows the median priority ratings for dispatchers and commercial pilots. Results suggest that, certain weather information related to visibility (e.g., fog, haze, sand and dust), dangerous precipitation (e.g., ice, and freezing rain), dangerous wind (e.g., hurricanes, tornadoes, and windshear) and runway conditions should always be salient. These high priority items are highlighted in the table.

Other informational needs depend on the stakeholder’s role. Specifically, during both flight planning and flight following, pilots seem to depend on dispatchers to identify some information about clouds, precipitation, visibility and wind. This may be due to the fact that dispatchers are generally monitoring certain routes to begin with, and likely already have this information for several flights. It also may be due to the fact that dispatchers have substantially more room for informational displays.

Table 2 illustrates the correlations among the priorities assigned for phases and roles. Again, it highlights that dispatchers and pilots require somewhat different information. Indeed, while pilots require slightly different information during flight planning and flight following, dispatchers seem to require pretty much the same information the entire time. This suggests that in-flight weather systems designed for the pilot could layer information, placing the most critical information on the top layer and less critical information at the next layer.
Table 1.

*Median Priority Ratings for Dispatchers and Commercial Pilots.*

| Information Element | Planning | | Flight Following | |
|---|---|---|---|---|
| | Dispatch | 121 | Dispatch | 121 |
| Barometric pressure | 3 | 3 | 3 | 2 |
| Clouds/ceiling | 1 | 2 | 1.5 | 2 |
| Clouds/coverage | 1 | 3 | 2 | 2 |
| Clouds/tops | 2 | 3 | 2 | 2.5 |
| Clouds/types | 2 | 2 | 2 | 2 |
| Density altitude | 3 | 2 | 3 | 2 |
| Front location & type | 2 | 2 | 2 | 2 |
| Precipitation/Ice/freezing rain/sleet | 1 | 1 | 1 | 1 |
| Precipitation/Rain | 1.5 | 2 | 2 | 2 |
| Precipitation/Snow | 1 | 2 | 1 | 2 |
| Present/Forecast Temperature | 2 | 2.5 | 2.5 | 2 |
| Runway conditions | 1 | 1 | 1 | 1 |
| Thunderstorms/Hail/Lightning | 1 | 1 | 1 | 1 |
| Vertical temperature gradient | 3 | 3 | 3 | 3 |
| Visibility | 1 | 1 | 1 | 1 |
| Visibility/Fog (dew point) | 1 | 2 | 1 | 1 |
| Visibility/Haze | 1 | 2 | 1.5 | 2 |
| Visibility/Sand/Dust/Ash | 1 | 2 | 1 | 1 |
| Wind/Clear air turbulence | 1.25 | 2 | 1 | 2 |
| Wind/Downdraft | 1.25 | 2 | 1 | 1 |
| Wind/Gusts | 1.25 | 2 | 1.25 | 2 |
| Wind/Hurricanes | 1 | 1 | 1 | 1 |
| Wind/mountain rotors | 1.25 | 1 | 1.5 | 1 |
| Wind/Surface winds | 1 | 2 | 1.25 | 1 |
| Wind/Tornadoes | 1 | 1 | 1 | 1 |
| Wind/Wake vortices | 2 | 2 | 2 | 1 |
| Wind/Winds aloft | 1.5 | 2 | 1.75 | 3 |
| Wind/Windshear | 1 | 1 | 1 | 1 |

*Note*. Shaded items indicate median priority of 1.5 or below.

Table 2.

*Correlations of Priority Ratings Among Pilots and Dispatchers and Phases*

| | | Planning | | Flight Following | |
|---|---|---|---|---|---|
| | | Dispatch | Pilot | Dispatch | Pilot |
| Planning | Dispatch | - | | | |
| | Pilot | 0.58 | - | | |
| Flight Following | Dispatch | 0.92 | 0.69 | - | |
| | Pilot | 0.55 | 0.71 | 0.64 | - |

Ideally, for the pilot, information would be tied to the 4-D profile of the flight. This would provide information about the factors relevant to their particular flight and the appropriate time. The situation for dispatchers is quite different because they are simultaneously involved with several flights with various 4-D profiles. Dispatchers need a bigger picture of the weather to accomplish their tasks. Of course, they have the luxury of having multiple large displays that can be customized to their needs. The limits of the cockpit place more constraints on displays for pilots.

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