TOWARD A WEB-BASED FLIGHT DISPATCHER TRAINING TOOL ON ICING

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ABSTRACT

The Icing Branch at NASA Glenn Research Center has funded an exploratory effort to identify requirements for a flight dispatcher-centered web-based icing training program. Our Capstone team has followed an Instructional Systems Design approach, focusing on the analysis stage. We gathered information from several sources, including the Federal Aviation Regulations and aviation personnel at a major and a regional airline to complete this analysis. Our approach included identifying the stakeholder constraints, investigating icing-related weather sources, and developing a scenario framework for training. To aid our analysis process, we developed a low fidelity prototype. These steps led to the identification of recommendations for the development of a web-based icing training system for flight dispatchers.

1 INTRODUCTION

Icing remains one of aviation’s leading weather hazards (e.g., Boeing, 2001). Additionally, taking action to avoid icing that does not materialize yields disruptions in planned altitudes and/or routing, significantly decreasing aircraft efficiency and therefore increasing operating costs.

1.1 Why is icing a problem for aircraft?

All aircraft are susceptible to icing — even those with anti-icing equipment. Most aircraft involved in icing accidents are general aviation aircraft, but there is a significant number of larger, commercial aircraft that have been involved in icing accidents (NASA, 1998). Aircraft have different sensitivities to icing as leading edge radius of curvature, wing surface area and sweep angle, and operating altitudes and airspeeds affect in-flight icing accumulation. Also, aircraft are not certified for flight in all icing conditions.

Weather conditions are never totally predictable and icing forecasts are not provided with the temporal and spatial accuracy and timeliness to help avoid hazardous icing encounters. The density, frequency and resolution capability of today’s observation network is incompatible with the micro-scale nature of icing. The problem is made worse when an upper air reporting station is missing data forcing extrapolation over a “hole” in the sampling grid. In addition, there are areas that do not have the equipment necessary to forecast icing (i.e., the far North) (Ryerson, 2000).

Table 1. Types of Icing (ASA, 1999; Lankford, 2000)

<table>
<thead>
<tr>
<th>Type</th>
<th>Required action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rime Ice</td>
<td>Rough, milky, opaque ice formed by the instantaneous freezing of small supercooled water droplets.</td>
</tr>
<tr>
<td>Clear Ice</td>
<td>A glossy, clear or translucent ice formed by relatively slow freezing of large supercooled water droplets.</td>
</tr>
<tr>
<td>Mixed Ice</td>
<td>A combination of rime and clear ice.</td>
</tr>
</tbody>
</table>

Table 2. Intensity of Icing and Required Actions (ASA, 1999; Lankford, 2000)

<table>
<thead>
<tr>
<th>Type</th>
<th>Required action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>Ice becomes perceptible. Rate of accumulation is slightly greater than the rate of sublimation. De/anti-icing equipment is not utilized unless encountered for an extended period of time (over 1 hour).</td>
</tr>
<tr>
<td>Light</td>
<td>The rate of accumulation may create a problem if the flight is over one hour in this environment. Use of de/anti-icing equipment removes/prevents accumulation. Without icing prevention equipment, consider a change of course.</td>
</tr>
<tr>
<td>Moderate</td>
<td>The rate of accumulation is such that even short encounters become potentially hazardous. Use of de/anti-icing equipment or flight diversion is necessary. Light single and twin airplanes may not be able to climb through this type of icing.</td>
</tr>
<tr>
<td>Severe</td>
<td>The rate of accumulation is such that the de/anti-icing equipment fails to reduce or control the hazard. Use de/anti-icing equipment. Immediate flight diversion is necessary.</td>
</tr>
</tbody>
</table>
There is a high dependency on icing pilot reports (PIREPs) that are infrequently and subjectively reported (Kelsch & Wharton, 1996). Icing is categorized by assessing the type of ice and determining the aircraft’s reaction to it (Table 1 and Table 2). Unfortunately pilots are trained to report ice in terms of observable phenomena that are not perfectly diagnostic (ASA, 1999).

1.2 Why do flight dispatchers need to know about icing?

Flight dispatchers, licensed airmen that are certified by the Federal Aviation Administration (FAA), have a joint responsibility with the pilot for the safety and operations of the flights that they dispatch. With respect to flight planning, dispatchers are responsible for:

- Flight plan routing based on aircraft equipment and forecast weather,
- Flight cancellation,
- Alternate airport selection,
- Fuel load planning,
- Weight restriction considerations, and
- Flight following.

A major concern for dispatchers is inoperative equipment. The dispatcher must consider:

- What is wrong with the aircraft?
- What types of icing conditions must this aircraft avoid?
- What route and at what altitude can I safely plan for this flight?
- If the altitude is restricted, what related changes do I have to make?

For example, for inoperative equipment can be in the form of inoperative engine or wing anti-ice valves. The type of failure necessitates different actions. An inoperative wing anti-ice valve means that “hard ice” is a problem where an inoperative engine anti-ice valve means that “soft ice” must be considered. Hard ice occurs between 0 and -40° C in visible moisture, and where soft ice (ice that can form once air is cooled) can occur if the temperature is between 10 and -20°C and when the humidity is high (Myszkowski & Rezonya, 1996). Thus, the available route and altitude selections vary depending on the type of inoperative equipment.

Unfortunately, icing is a complex subject and flight dispatcher-centered icing training is not freely available. Many of the current icing resources are not focused on the flight dispatching profession. For example, NASA offers CD-ROMs, computer-based training, and videos (e.g. Icing for Regional and Corporate Pilots) that focus on how icing affects pilots decision-making (Bond, n.d.). This pilot-centered training includes in-flight recovery strategies for icing encounters, an issue that does not directly relate to the flight dispatchers’ jobs. Similarly, COMET web-based icing training modules provides information targeted towards weather forecasters (COMET, n.d.). Since these resources are not customized for flight dispatchers, the scope of knowledge does not cover what is required for a flight dispatcher. Thus, the Icing Branch at NASA Glenn Research Center has sponsored our Capstone team to identify requirements for developing a flight dispatcher-centered web-based icing training program.

2 METHODOLOGY

The training methodology that we employed is Instruc
tional Systems Design (ISD), the system’s approach to training (Gagne & Wager, 1992). The ISD methodology includes a five step process. The Analysis phase defines the goals to be achieved within the training system. The purpose of the Design phase is to develop a method or model to achieve the goals determined in the analysis phase. The Development phase builds this model into a training product. The Implementation phase is when the training occurs. The Evaluation phase reviews the courseware and reviews the previous four steps to ensure the training achieves the desired results.

Given the exploratory nature of the project, our focus was in the Analysis phase, investigating the following:

1. Understand the legal and organizational issues associated with training flight dispatchers.
2. Review existing training practices.
3. Review existing materials and tools used during flight dispatching.
4. Compile a knowledge and task inventory required for the job.
5. Select knowledge and tasks that need to be trained.

3 STAKEHOLDER CONSTRAINTS

The stakeholder constraints were identified by performing research into the Federal Aviation Regulations (FARs) and flight dispatcher certification courses, as well as talking with personnel (flight dispatchers, managers, instructors) at a major airline and a regional airline. Through these efforts, both industry-wide and airline-specific constraints and practices became apparent.

3.1 Industry-wide Constraints and Practices

Our Capstone team’s efforts identified industry-wide constraints and practices related to developing a web-based icing training module for flight dispatchers. These constraints and practices include the impact of the FARs, the role of the Principal Operations Inspectors (POIs), the variance in flight dispatcher experience levels, and the limitations of training instructors.
3.1.1 Impact of Federal Aviation Regulations (FARs)

The FARs, serving as legal guidelines that drive the operations of the aviation industry, add complexity to the flight dispatcher training environment. Specific to our project focus, the FARs (in particular Part 65 and 121) control the certification, training, and operational procedures for flight dispatchers (The Federal Aviation Administration).

FAR Part 65 is devoted to the certification of “Airmen Other than Flight Crewmembers” with subparts specifically devoted to certification process for flight dispatchers. Per FAR Section 65.61, aircraft dispatchers must receive a minimum of 200 hours of instruction in the certification course. Related to icing, the main training content required is the “Causes, Formation, and Dissipation” and “Types” as part of the “Basic Weather Studies”, and “Icing” in the “Weather Related Aircraft hazard” section as outlined in FAR Section A65.1.

FAR Part 121 is devoted to “Operating Requirements: Domestic, Flag, and Supplemental Operations”. This portion of the FARs focuses on the operational requirements to which an airline must adhere. In particular, Subpart N (Training Program) and Subpart U (Dispatching and Flight Release Rules) both have sections that relate to our project concerns. FAR Section 121.415 outlines the requirement for airlines to provide “basic indoctrination ground training for newly hired . . . dispatchers including 40 programmed hours of instruction.” The general subjects of the initial and transitional ground training for flight dispatchers, along with the varying requirements (30 or 40 hours) for hours of instruction by aircraft type are provided in FAR Section 121.422. FAR Section 121.427 specifies the varying required hours (8, 10, or 20) for recurrent training, based on aircraft type. Specifics of how a dispatcher should operate in icing conditions are provided in FAR Section 121.629.

It was important to recognize these legal requirements that dictate the organizational structure into which a web-based training system must fit. Further, investigating the FARs revealed the wide array of topics for which airlines are legally required to provide initial and recurrent training; thus, leaving a limited time to devote to icing-specific training.

3.1.2 Role of Principal Operations Inspectors (POIs)

The role of the Principal Operations Inspectors (POIs) also impacts the entire industry. POIs oversee the process of ensuring that an airline meets the FAA operations standards by approving all materials used by the airline, including training materials. Furthermore, our Capstone team found that there is no national FAA-approved training curriculum for flight dispatcher training; rather, each airline’s training must be approved by their regional POI. This finding presents the challenge of incorporating a standard web-based training system into the airlines’ training environments.

3.1.3 Variance in Flight Dispatcher Experience Levels

Throughout the industry, within and among each airline, flight dispatchers have various levels of experience and backgrounds. For example, flight dispatchers at the major airline had varying backgrounds, including former meteorologists, pilots, or other positions within the airline (e.g. maintenance). The Director of Operations Control Center at the regional airline, on the other hand, expressed that their flight dispatchers tend to come “straight from dispatcher school.” The varying backgrounds of flight dispatchers led to differences in the amount of time allocated to the initial training between airlines. These differences display the challenge of designing a training system to meet the needs of multiple user levels.

From our observation, we also observed that the technical skills of the flight dispatchers varied as well. Some flight dispatchers appeared more comfortable and knowledgeable using web-based tools than others. This variance also needs to be considered in designing the training tool.

3.1.4 Limitations of Training Instructors

Although the specific pedagogical approaches differed between the two airlines that we observed, the instructor-led training concept was present at both. A finding common throughout the industry was the limitations of the instructors’ experience with teaching. This limitation derived from the common path of experienced flight dispatchers moving from operations to training; thus, having little or no previous teaching experience. The challenge with airline training is that the characteristic of being a subject matter expert does not necessarily translate into being an effective instructor. Yet, the quality of the airline training lies in the hands of the instructor.

3.2 Airline-specific Practices

Along with industry-wide constraints, there are several airline-specific practices that must be considered in exploring the requirements for a web-based training system. Our Capstone team identified both operational and training practices relevant to our project.

3.2.1 Operational Practices

Each airline has a different fleet and set of flight routes. Generally, regional airlines operate smaller jets and fewer, shorter flight routes. On the other hand, major airlines operate a wider array of aircraft and flight routes. Thus, for an airline’s training to be effective, it should be tailored to their specific operations.
Additionally on the operations side, the work station set-up, and software packages for flight planning and weather sources differ between airlines. The software packages are often proprietary to the airline, and therefore are not publicly available for a web-based training system. Another challenge related to weather sources is the tendency of flight dispatchers to use both FAA-approved (required) tools as well as non-approved tools. An example of such as tool is the *Current Icing Potential* (CIP), a gridded icing diagnostic that updates hourly, which recently became authorized for use (n.d.). Although the FAA-approved tools are legally required for decision-making, flight dispatchers reference other tools that may have features that they prefer. Therefore, the set of weather sources that a flight dispatcher uses is not limited to the approved set that the airline uses. This presents a challenge in identifying the wide array of tools that flight dispatchers use in practice; yet, it is these tools that should be considered for training flight dispatchers.

The presence of a meteorology department at the major airline or lack of such a department at the regional airline also impacts the operations between airlines. The lack of a meteorology department adds pressure to flight dispatchers to be knowledgeable on interpreting weather data. The different required levels of knowledge needs to be factored into the development of the content of the training system.

Another important factor specific to airlines is the organization of assignment of flights to dispatchers. These assignments can be broken down by region (with each dispatcher responsible for several aircraft types), fleet, or supported carrier. This structure also impacts how the dispatchers should be trained. If a dispatcher only oversees one aircraft type, the training on several aircraft types would be superfluous.

### 3.2.2 Training Practices

The specific training practices between the airlines vary; differences exist in the set-up (e.g. equipment), pedagogical methods, and schedules. For instance, the training room at the major airline is similar to their operations center. Each flight dispatcher has a computer console with three flat screen monitors. On the other hand, the regional airline’s training room currently does not provide each flight dispatcher with his/her own computer for training. Instead, the instructor leads the training on a projection screen.

Each airline also had different content for the recurrent training materials. Several examples in the training content, such as airline accident reports, flight routes, and aircraft types, were specific to that airline.

Similarities in the training practices existed as well, including a scenario-based approach to teaching the application of icing knowledge on flight dispatcher decision-making. Both instructors at the major airline and the regional airline stressed the importance of using relevant icing-related examples to step the dispatchers through a decision-making process.

Another similarity between airlines was the curricula for meteorological information on icing of both airlines follows the FARs, providing details on the types of icing, formation, etc. The basic schedules for training were similar, following the FARs as well, with initial training for newly hired flight dispatchers and recurrent training a few times a year on various topics.

It is evident that both the similarities and differences of airline training practices need to be considered in developing a web-based training system.

### 3.3 Analysis of Stakeholder Constraints

Based on the aforementioned industry-wide and airline specific constraints, our Capstone team analyzed the impact of these factors on a web-based flight dispatcher-centered icing training system.

A key finding that resulted from this analysis is the impact of the time limitations resulting from the FARs for icing training. One way to rectify this limitation is the concept of developing a web-based system that can be both integrated into the instructor-led training environment and accessed individually as a reference. Nonetheless, the time limitation needs to be factored into the design of the system to ensure that the instructors can step-through the content in the time allotted for icing.

Our Capstone team also identified the impact of the lack of an available standard weather product set. A web-based training system would need to attempt to address this challenge by providing training on general, non-proprietary weather products used throughout the industry.

Our work also highlighted the importance of not assuming that flight dispatchers are knowledgeable about the basic meteorological material related to icing. Our research uncovered the need for dispatchers to have a general understanding of weather information to effectively identify and consider the impacts of a weather system on flight planning. Further, because the backgrounds and experience levels differ between flight dispatchers, it is important that a web-based training system presents this basic meteorological information related to icing.

Another important finding is that the identified constraints limit the ability for one training system to meet the needs of all airlines. Since each airline has different operational structures, procedures, and equipment, they tailor the training to meet their individual needs. Thus, a specific training system would not meet the needs of all airlines, while a more general training system may not be specific enough to meet the needs of an individual airline.
4 PROBLEMS THAT FLIGHT DISPATCHERS HAVE INTERPRETING WEATHER

To aid our understanding of how icing relates to flight dispatchers’ weather assessments, we investigated the weather products that flight dispatchers use. Unfortunately no single weather product gives flight dispatchers all the information they need. In order to plan flights through and around icing conditions, flight dispatchers need to be able to interpret and integrate many weather products. Flight dispatchers have difficulty with icing assessment because weather sources have different characteristics. These different factors contribute to the confusion that flight dispatchers experience when determining areas where different intensities of icing are occurring.

One major difference between the products is their content. Some products focus on weather phenomenon such as the Radar Summary. Some products display data from a single source like a satellite image, while others provide multiple types of information. These multi-parameter sources either contain many details about a particular location, like an aviation routine weather reports (METARs), while others have few parameters but cover a wide geographic area such as the winds and temperature aloft (Table 3).

<table>
<thead>
<tr>
<th>Table 3. Example Weather Sources</th>
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<tbody>
<tr>
<td><strong>Source</strong></td>
</tr>
<tr>
<td>Current Icing Potential (CIP)</td>
</tr>
<tr>
<td>Freezing Levels</td>
</tr>
<tr>
<td>Low-level significant weather prognostic charts</td>
</tr>
<tr>
<td>METARs</td>
</tr>
<tr>
<td>PIREPs</td>
</tr>
<tr>
<td>Radar Summary</td>
</tr>
<tr>
<td>Infrared Satellite Images</td>
</tr>
<tr>
<td>Visible Satellite Images</td>
</tr>
<tr>
<td>SIGMETs</td>
</tr>
<tr>
<td>Winds and Temperature Aloft (FD)</td>
</tr>
</tbody>
</table>

Weather products can focus on different geographic regions and have different levels of precision. Some weather products are graphic in nature, while others are text based. Flight dispatchers can have difficulty understanding to what geographic area a text-based report applies. Some products are based on observations, while
others forecast possible weather conditions. Obviously, there is uncertainty associated with the forecasts. However, there is also uncertainty associated with the observations because they are not continuously updated. Forecasts are valid for different time frames, and coupled with their uncertainty can create difficulty when determining whether icing will impact a flight. Unfortunately, flight dispatchers have to integrate many weather products to get a good feel for the icing conditions (Table 3).

In terms of icing, these weather sources are used to interpret possible areas where severe storms with liquid or frozen precipitation will be located. Icing is a complex phenomenon that takes into account many different weather factors, requiring a flight dispatcher to relate relevant information when planning their flight route. Radar and satellite images should be combined with textual reports such as PIREPs and METARs, as well as forecasting products, to accurately determine the most prevalent icing areas. Because of the multitude of weather products and information disseminated to the dispatchers through these weather sources, additional training is required to provide them with a methodology when making icing related decisions. The real-time data should be given the most weight, while the information provided by forecasts and satellite images should be secondary. The flight dispatcher needs to combine all of the relevant information from these weather sources to determine the safest and most economical flight route.

5 SCENARIO DEVELOPMENT

The instructors we interviewed suggested that we use a scenario-based approach to icing training. In order to identify the content of this scenario, we completed a task inventory of a flight dispatcher’s decision-making process. The task inventory consisted of the relevant tasks, skills, knowledge, and abilities required to perform the task. The data that were used to create our task inventory were gathered via interviews with flight dispatchers, meteorologists, and instructors at a major and a regional airline. Our Capstone team also examined the regional airline’s training and procedure manuals.

5.1 Developing a Task Inventory

Flight dispatchers have many other tasks to accomplish and decisions to make beyond accessing the weather. Their major responsibilities include preparing flight releases and performing flight following. To prepare flight releases, flight dispatchers consider weight and balance, passengers, luggage, cargo, and fuel. Computer software assists with the calculation. They also make sure there are crewmembers assigned to the flight. It is not the flight dispatcher’s job to assign the crew, but he/she must double check that

the aircraft has a complete crew (both pilots and flight attendants).

The flight dispatcher must also consider items that may have been deferred on the aircraft. Minimal Equipment List (MEL) procedures were developed to allow the continued operation of a flight with specific items of equipment inoperative under certain circumstances. The FAA has found that an acceptable level of safety can be maintained with specific items of equipment inoperative until repairs can be made. There are MELs that limit an aircraft’s ability to fly through icing.

Once the specific MELs on the aircraft are understood, the flight dispatcher can determine if the aircraft should be considered an “Ice” or a “No Ice” release. If the aircraft has an MEL listing a malfunctioning part that is critical to the aircraft’s anti-icing or de-icing system, it is a “No Ice” aircraft. If this classification is made, the flight dispatcher can only dispatch this aircraft if the flight route contains no forecasted icing during the time frame and along the route for the flight. The flight dispatcher must also consider what future legs the aircraft will fly so it does not land at a destination and is unable to depart.

Based on the forecast for the destination, the dispatcher also decides whether or not an alternate destination is required. An alternate is generally assigned if the ceiling (altitude of the clouds) is below 1500 feet and the visibility is less than three miles. The alternate is required to have better weather forecasted than the actual destination. More fuel will be required for the aircraft to reach the alternate. Therefore, the flight dispatcher will reconsider the weight and balance information when an alternate is required.

A flight dispatcher will generally add extra contingency fuel (an extra 30-45 minutes) so that the crew can maneuver around areas of bad weather or so they can accept Air Traffic Control vectors. Again, weight and balance considerations are important. Sometimes the flight dispatcher must coordinate removing cargo or even passengers when safety requires extra fuel.

Once dispatchers are satisfied with what the computer calculations or their manual adjustments, they will build the actual dispatch release using a software package. The flight release is available for the crew at the gate. When pilots print out the release, they also get the weather briefing. If any weather changes after the flight departs, the dispatcher will report it to the flight crew so that they are aware of the changes. Pilots will also tell the dispatchers what conditions are like along the route of flight so that they can plan accordingly for the next flight.
The composition of an icing scenario should include the following:
1. Aircraft type
2. Aircraft equipment status
3. Flight route
4. Weather conditions, at the origin and the destination as well as en-route
5. Selection of alternate airports
6. Weight and balance issues
7. Crew issues

These components define the information that would be required to create a training scenario. The scenario would train the flight dispatchers to consider how each of these items impacts the flight release. The scenario content could derive from several sources, including previous accident data, airline-specific cases, or other available case studies such as COMET Case Study Library on the WWW (JOSS, n.d.).

6 REQUIREMENTS FOR A WEB-BASED TRAINING TOOL

Based on our analysis, the training system should be designed to support both stand-alone and instructor-led training. The airline subject matter experts suggested that they would most likely prefer to use the system in the instructor-led approach as issues related to airline-specific changes or stale content would be less of a problem. The instructor could point out any updates, thereby minimizing the concern for the content being different from what the airline wants its trainees to know. The instructor-led approach would also allow the trainees to either follow along on their own computer or watch the instructor step through on the screen. The student could also visit the website separately for supplemental training or as a reference.

Four sets of requirements were developed during the exploratory study. One set focused on architectural issues related to defining the curriculum. In addition, human-computer interface requirements were developed. Another set focused on progress tracking requirements to allow a system user to know what parts of the curriculum have been visited. The fourth set focused on user initialization requirements. In addition, a prototype was developed to help the team investigate the implications of the requirements and to help to identify gaps in the requirements.

6.1 Curriculum Related Requirements

In the training system, the curriculum author should be able to define different types of content. One type of content should be strictly declarative, providing defined knowledge that flights dispatchers should know. The other type of content is problem based, allowing the users to determine the correct answer to a problem based on the declarative knowledge provided.

6.1.1 Declarative Content

The declarative content can be defined as a “page turning” type of learning method, where the users are forced to learn the information presented by the training tool. For example, the basic meteorology knowledge, the definition of the weather sources, and the aircraft specific details (such as MELs) are a part of the declarative content.

6.1.2 Problem Based Content

To ensure that the users can integrate the information provided in the training system, it should provide problems and guide the user through these problems.

In the weather sources curriculum, problems on how to determine icing should be posed to the user. This section of the weather sources curriculum will guide a user through an icing problem, while providing subsections on specific weather sources related to the problem. However, the training tool should not force the user to view these subsections if the user already has knowledge in that area; instead it should allow the user to skip over the subsections and determine icing based on the information he/she already knows.

In addition, an infrastructure should be developed to support flight dispatcher decision-making training through the use of scenarios. A scenario poses a dispatch problem that the user has to solve, and it follows the process of the development and release of a flight plan. A scenario will allow the user to access the appropriate declarative knowledge in the context of a particular example. This infrastructure should be modifiable in order to comply with the specific equipment and operations of different airlines.

6.2 Human-computer Interface Requirements

While the flight dispatchers operational work stations had more than one monitor, the training infrastructure was more limited. The design of the training system cannot assume that the user has a multiple monitor workstation; thus, all of the training systems’ functionality must be designed to fit within a single monitor.

In a curriculum, there can be many lessons. To support navigation through the curriculum, a navigation menu should display the high level information for all lessons and detailed information about the current lesson. When a new lesson is started, the sub-topics of the previously viewed lesson should no longer be displayed. As the user moves through an individual lesson, the topics that have been completely viewed should be displayed with grey background shading to indicate the user has completed it. Topics that are partially viewed should be displayed in red.
text. These features should eliminate the need for users to search through the system to find the next lesson.

To support the curriculum requirements, in particular the problem-based content, the training tool should allow the users to navigate between a specific part of a problem and the rest of the software. Progress tracking should indicate the section of a problem that the user is currently viewing, allowing the user to go back to the problem immediately.

### 6.3 Login/Initialization Requirements

Related to login and initialization, requirements were identified for registration, usage mode, and starting point indication.

#### 6.3.1 Registration

To support progress tracking, the system has to provide a capability for a user to register. This registration would allow the user to define login identification (and an optional password). It would also facilitate associating any progress tracking information with the user’s login.

#### 6.3.2 Usage mode

When a user logs into the system, he or she should be able to indicate whether or not progress tracking should be enabled. For a person wanting to move through the curriculum without missing any portions, the progress tracking should be enabled. However, it is possible that a person would want to browse the information within the training system. Such a user may not want to take advantage of the progress tracking functionality. For example, an instructor may want to use some of the pages from the system as part of a lesson. The system should support both of these usage modes.

#### 6.3.3 Starting point indication

A user may want to start the training at the beginning. If the user has already completed a portion of the curriculum and is returning to the system, he or she may want to continue from the last lesson viewed. It is also possible that the user may also want to go to a specific lesson or even a particular page within a lesson. For example, to make a certain point, an instructor may want to go to a certain page. The system should support all three of these starting point options.

### 6.4 Progress Tracking Requirements

Progress tracking is functionality that should allow the user to see what parts of the curriculum has been viewed and which have not. The idea is that, as the user moves through the curriculum, he or she can know how much material has been covered and what remains. If the user has enabled progress tracking, each section of the curriculum will be tracked separately. A section can be marked as a) never viewed, b) in-progress of being viewed, or c) completed.

A second benefit to the progress tracking capability is that a user can view the training in multiple sessions. If the user exits the system and returns at a later time, progress tracking allows the user to return to the last section viewed.

Currently, the prototype is implemented such that the information pertaining to a user (including the login, password, and the status of the sections of the curriculum) are stored as a cookie file on the user’s computer. When a user login into the prototype, the training system recognizes the user and retrieves the progress information from the cookie. This solution is not the desired one in terms of security and consistency of data (especially if the user deletes the cookie files). In the long run, a better data management strategy should be investigated.

### 7 RECOMMENDATIONS AND FUTURE WORK

At the start of our project, we naively thought that a single training system would serve all flight dispatchers. However, it is now clear that airline-specific training is required. Therefore, the target audience and the specific content of any future system must be negotiated with the sponsor. Related to this issue, the flight planning tools, weather products, fleet information, and the airline-specific considerations should be identified.

Once these steps are taken, the scenario aspect of the training system should be more fully developed. The aforementioned scenario framework should be validated with the target airline(s). Along with the framework, the content of the scenario needs to be developed.

Further analysis should be completed to determine the acceptable time that airline training can be devoted to icing. It will be necessary to ensure that the instructor-led training content fits within the time limitations at the airline training.

In addition to time constraints, resource constraints should also be investigated. If the airlines do not have the technology to incorporate a website into their training, then it will go unused. Therefore, future research into the industry will need to identify the number of airlines that presently have computers integrated in their training setup.

Most importantly, the specific training objectives need to be identified. Based on these analyses, a fully functional prototype of the training system should be developed and evaluated against the specific training objectives to ensure the proper content and usability. The evaluation should include testing using the potential trainees and instructors, to ensure that the proper requirements have been made. This
step will be crucial in the development of an effective training system that can expand NASA’s ability to offer icing resources to help improve aviation safety.

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