INFORMATION UNITY FOR THE AVALANCHE COMMUNITY: XML, DATABASES AND WHIZ-BANG APPLICATIONS

Faerthen Felix*
Utah Avalanche Center, Moab

Jeff Brown
Utah Avalanche Center, Salt Lake City
American Association of Avalanche Professionals (AAAP)

ABSTRACT: As the Internet and Information Technology (IT) expands, the avalanche community has an opportunity to work together for better data management and to develop new information products for both internal and public use.

Avalanche.org currently collects and archives avalanche-related data. Several projects being developed by the US Forest Service National Avalanche Center (NAC), individual US avalanche center programs, ski resorts and other individuals require an expansion of this existing resource to avoid fragmentation and duplication of effort.

We feel it is wise for the avalanche community to adopt a standard data-collection system in cooperation with avalanche.org to support database and document management projects currently under development, as well as in anticipation of unforeseen future applications. This system could also ease the information management burden at the local level.

With input from many avalanche professionals and application developers, the NAC, avalanche.org and the Salt Lake and Moab offices of the Utah Avalanche Center have developed an expanded database, an XML outline and a web-based input system to submit to the avalanche community as a starting point.

We have highlighted several developing projects that use this expanded database and provide tangible, immediate benefits to participation. We also suggest the next steps toward a better input system and a complete snow and avalanche data set.

KEYWORDS: data, database, Internet, information, management, XML

1. INTRODUCTION

Avalanche forecasters have a very clear-cut job description. We accumulate data about snow and avalanche conditions, then attempt to communicate the meaning of this information to the public. An avalanche center is, therefore, a clearinghouse for avalanche-related information.

Although this seems simple enough, our efforts tend to focus on the complex yet clear task of collecting and interpreting the data available to us. Communication is always the intractable tar baby. What is the best form for this information to take? How is it best to distribute this information internally and externally? How much is too much information? Whenever there is communication, there is interpretation–since we have such a strong influence, what flavor of influence do we want to have?

Like many other regional avalanche centers, the Manti-La Sal Avalanche Center is responsible for a ridiculously broad geographic area. Our terrain includes about 1 million acres distributed over 3 widely separated mountain ranges. Soon after starting my job, I began looking for better ways to stretch our limited resources to provide service across this region of dissimilar snowpacks and weather patterns—most of it without historical data. I thought that GIS could help me do this by manipulating the data we do have, expanding it, and presenting it in a more interesting way.

But one of the first things I realized was that our existing system of data management was extremely limiting. Basically, we had 10 years of snow and avalanche data stacked in boxes in the basement, and without some sort of major initiative this pile would

*Corresponding author address: Faerthen Felix, Manti-La Sal Avalanche Center, P.O.Box 428, Moab UT 84532; tel: (435) 260-1192; email: LSAFC@LASAL.NET

simply continue to accumulate. It was difficult for us to access or use this stored information, and impossible for anyone else. I would have liked to examine data for other areas with similar avalanche conditions, but this was also difficult.

It quickly became obvious that we would have to address this problem before we could move forward with other projects for disseminating information to the public. We took cues from successful data managers like Craig Sterbenz at Telluride Ski Area and Jim Kanzler at Jackson Hole Ski Area. With the support of Doug Abromeit and Karl Birkeland at the US Forest Service National Avalanche Center (NAC), we began to explore data management systems and potential products that could be developed from them.

2. THE PROJECT VISION

What does the ideal data-management system look like? That's a tough one. There will always be differences of opinion, based on the fact that compromises always have to be made. There are several goals that are probably universal, however:

- Standardization—everyone's data should match. Steps should be taken to ensure that the data set continues to be useful into the foreseeable future.
- Centralization—all data should be input and accessed at the same location(s) for ease of access and use.
- Simplicity—the system should be intuitive, non-redundant and simple. Whenever possible, using this system should eliminate other archiving and data management duties.
- Accessibility—the data should be stored in a manner that allows for systematic access and use by both manual and automated applications.
- Expandability—the system should accommodate future expansion.
- Flexibility—the system should accommodate very different ways of examining, interpreting and using data.

So, with a $15,000 grant from the NAC, we have contracted with GIS and other IT specialists. Our project focus has been to:

1. Create the background skeletal structure of a data management system that addresses these goals.
2. Demonstrate some potential ways of using this system to provide new products for both the public and for internal use. These demonstrations will be available to the public on or before December 15, 2000.
3. Encourage universal participation and develop partnerships within the avalanche community for both data input and manipulation.
4. Develop a plan for front-end user interfaces. We would like to explore your desires and goals for current and future data needs. This will help in designing useful future interfaces.

In addressing centralization and access needs, we have settled on the Internet as the appropriate venue for our efforts. There are several reasons for this.

First, the Internet conveniently addresses our wide distribution across the country and potentially, the world. If we were structures like a major corporation, we might have a corporate HQ and a LAN of interconnected computers that could do the same thing from a private server, but we would still have to use the Internet for external communication.

Second, we don't want to reinvent the wheel. It is only sensible to build on the excellent efforts and pre-existing data collection structures and records that were developed by folks like Art Judson, Knox Williams, Bob Hauk, Dan Judd, Dan "Howie" Howlett and Randy Trover at avalanche.org. Happily, avalanche.org has agreed to host this project and tie it into their existing SQL database. We have acquired a new Windows 2000 server to augment the current Linux server. This will expand capacity and allow us to run applications that are not currently Unix-compliant (more on this later).

Third, the Internet is our current large-scale pipeline to the public. Through the web, US avalanche centers present a unified front. While there are disadvantages to our current model of data input over the web, most of these problems can be addressed through server security and the design of a "thin-client" interface program (similar to your web-browser) that lives on your computer. Given additional funding and your assistance designing a useful interface, this would be the

focus of a second stage of this project--hopefully in association with software to be released at this conference by avalanche.org (Dan Judd, Dan Howlett and Randy Trover).

Finally, we want to shift the burden of technical support from the individual avalanche personnel, to a centralized IT point, while maintaining local control. This is more efficient, ensures compatibility, expands future product options and potentially frees data contributors of the responsibility for many mundane yet technical and time-consuming data management duties such as software upgrades and crashes, back-ups, normalization, internal and external reporting, etc. AAAP is working on a funding package that would include money for a full-time avalanche.org web master to assist Dan and Howie with these and other duties.

3. THE HIDDEN BACKBONE...THE DATABASE

We have built a relational database using Microsoft Access, which is compatible with the avalanche.org SQL database. At present, we have designed input forms and related tables within this database for public and/or proprietary information about:

- Avalanche activity
- Accidents
- Weather collection points; and
- Current snow and avalanche conditions (forecasts).

The full description of our existing and planned tables, fields and list options is available for examination and comment on the web at http://www.avalanche.org/~data/database.HTM

One of the major strengths of a relational database is that it is expandable. Future tables and input forms will most likely include:

- Daily observations
- Snow layer information (new snow layers, crown profiles and snowpits)
- Explosives
- Georeferencing data
- Other winter recreation information of interest to the public, i.e. mountain huts and campgrounds, trailhead locations, winter access roads, trails and ski resort boundaries.

The fields for the avalanche-related tables were developed through an on-going e-mail forum over the past year. A sample field-observation input form was circulated through the community for anyone who cared to comment. Strong, useful input and direction was received from many sources, including Karl Birkeland, Mark Moore, Bruce Tremper and official Utah Avalanche Center field observers. At this point, this list of existing and proposed tables and their fields should include all the snow and avalanche data that is currently being collected. We recommend that this list be used as the starting point and--after an appropriate comment and adjustment period--as the standard for future data management systems and IT projects in the avalanche world.

Note: With the exception of daily observations, we have intentionally avoided weather data fields, since avalanche.org and the University of Utah Mesonet program (http://www.met.utah.edu/jhorel/html/mesonet/) already collect, control, archive and display most of the weather information we produce or use in the western US. The last thing we want to do is get into huge quantities of manual data entry.

It will eventually be necessary for someone to figure out a reasonable means of accessing this weather data set, however, and it may eventually be necessary to duplicate Mesonet efforts in order to accommodate weather data from other regions. This is a project for another time, but the expanded avalanche.org database as designed should be able to structurally accommodate these future additions.

4. THE OUTER FACE...THE WEB PAGES

For access to the data input system and available products, Jay Gress at Snow Stream, Inc. has designed a very clean and intuitive "Data" web page (http://www.avalanche.org/~data).

This page is split down the middle. The left side is an IN column that lists the input forms for the database tables discussed above. These input forms are password protected to prevent unauthorized access. To

submit an avalanche accident, for instance, the user just clicks on "avalanche accidents", provides his password and fills out the form.

The input forms have been designed to limit the potential for corrupted data through misspelled words or missing information. In most cases, the field will provide the reporter with pre-filled boxes and drop-down lists of options. This has the added advantage of being faster and easier for the reporter to complete. Missing or illogical critical information (location, date, etc.) will be called to the reporter's attention.

Herein lies the biggest drawback to a web-based input form, however: the delay between submission and response. Although we have taken measures to reduce this difficulty through form design and javascripting, a future "thin-client" interface would allow instantaneous data evaluation, as well as permitting local archiving with no additional effort.

The right side of the Data web page is an OUT list of all the available products that use the data. Clicking on the links takes you to web-sites that display these products. Applications can be free, subscription-based or for internal use only, so your click may or may not require a password.

One of the OUT list items is a link to a public web-site that we have developed for displaying the results of our GIS mapping project described below (www.avalanche.org/~avimaps).

Following is a description of applications currently being developed with information stored in the database.

5. THE PRODUCTS...SAMPLE APPLICATIONS

While there are abstract long-range reasons to collect and archive data, it is far easier to get excited about making the effort if there are immediate rewards. This entire project is being driven by our desire for results that can be produced from the data set, as well as by a need to streamline data management efforts at the local level.

Here are some projects currently under development by avalanche professionals from ski resorts, private companies and avalanche centers. Avalanche professionals can use these pre-existing applications for local use, and/or develop their own.

5.1 XML Document Type Definition (DTD)

A tool that we may eventually chose to use in collecting, archiving and manipulating snow and avalanche data is Extensible Mark-up Language. XML is already the de facto standard for Internet e-commerce data management. It offers a unique way of storing data that is not limited to the rigid (and error-prone) tabular or delimited text of traditional databases.

Some explanation: Web browsers are programs that interpret and display documents written in Hypertext Mark-up Language (HTML). HTML is a collection of "tag" pairs that give the browser information about the text that they surround. With HTML, most of this information relates to presentation only—"bold" or "underline", for example--and you are limited to a prewritten library of tags.

Imagine that you could define your own unlimited tag set with tags like "avalanche size class" or "number of victims". These tags can emphasize the meaning of the content rather than how it looks on the page. We can then use this set to database avalanche-related information directly from plain-text documents. This is the promise of XML.

Unlike HTML, there are not many programs available yet for editing XML. This is a good thing. We have an opportunity to standardize Internet avalanche data collection before the problem arrives. What problem is that?

Bridging from inscrutable programming languages to "plain English" is an incredible strength, but it is also a potential weakness. With more people able to produce useful, databasable web content, compatibility problems explode.

Obviously, all related documents must use the same tags. Many industries have grabbed the bull by the horns and defined a tag set that all their members use. These tag sets are called Document Type Definitions (DTDs).

We feel it is wise for the avalanche community to develop a DTD in support of database and document management projects under development, as well as in anticipation of unforeseen future applications.

We propose the fields from the avalanche.org relational database as the starting point for an avalanche-specific DTD. Pete Hawkins of the Manti-La Sal Avalanche

Center has already begun drafting this document.

5.2 Avalanche Notes

Gary Murphy of Alpine Meadows Ski Resort is currently working to resurrect *The Avalanche Notes*. In the past, this excellent product required all participants to copy their snow, weather and avalanche data every day and send it off to someone (usually Knox Williams) who would then compile it and send it out to subscribers. Despite immense popularity and usefulness to the avalanche community, *Notes* finally died due to budgetary belt-tightening.

Using a simple spreadsheet-type application, *Notes* can be completely automated and posted to the web from information already collected in the avalanche.org database. Similar applications could compile daily, monthly or seasonal data reports for operational requirements. This functionality is built into avalanche.org's new data-management software and will likely be included in future user interfaces.

5.3 Powder the Polar Bear

Figure 1: *Powder the Polar Bear* Danger at a Glance icon sample.

Bruce Tremper is using the information collected in the Current Conditions table for *Powder the Polar Bear*. This application combines a series of square, graphic, color-coded elements into a display bar that describes the current avalanche danger and surface snow conditions on various slopes (Figure 1).

These eye-catching and intuitive graphics can then be automatically added to the text advisory, GIS maps, e-mail lists or other products as desired.

5.4 Explosives Management System

Snow Stream, Inc. is developing ski resort avalanche control and explosives management systems for Mt.Hood Meadows. This system uses the database to create web-based displays for internal use. Snow Stream plans to offer this system to other ski areas in the future.

http://www.skihood.com/avalan/

5.5 Field –Based Data Input System

Jeff Brown of the AAAP is developing a partnership with Handspring, Inc. for a portable data input device combining popular palm-type organizer function with GPS and wireless telephone service.

Specialized software written for these devices would allow field professionals to collect snow pit, avalanche and/or control result information as it occurs and synchronize this data from the field to the avalanche.org database via wireless e-mail (available approx. 2002).

Automated web-based applications including snow pit graphing applications and some of the other applications described here could then display this data without the current intermediate steps of transferring field notes, graphing snow pits, writing reports, creating web-pages and uploading this information to the Internet.

5.6 GIS Maps

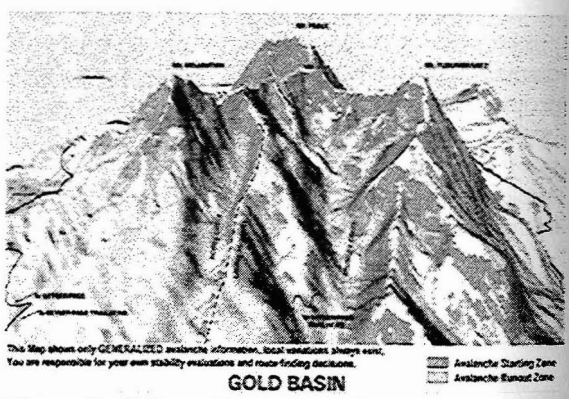

Figure 2: GIS avalanche terrain map sample.

This summer, Bruce Tremper and Jeff Brown secured a large Geographic Information System (GIS) software donation from ESRI (Environmental Systems Research Institute, Inc.).

A GIS holds layers of information about things found on the earth. These things can include points (like accident sites or weather stations), lines (like rivers or roads) or shapes (like forests or slide paths). The layers of information can be overlain like sheets of

acetate to make relationships between features clearer. The resulting displays can also be animated or 3-D.

This software allows the user to display very dry information taken from a database, in an appealing, graphical manner on a personal computer or through a web-site. The resulting maps showing geographic information can then be hyperlinked to tables of other information stored in the database, like reports, photos, graphics, video, URLs, etc.—basically anything you've got stored in your filing cabinet (and more).

Most GIS data that can be used to describe avalanche terrain comes from Digital Elevation Markers (DEMs). DEMs are grids of regularly spaced data points. They can be used to calculate elevation, aspect, slope angle, drainage basins, etc. by comparing adjacent cell values. DEMs come in various resolutions, which describe how far apart these points are. 90m and 30m data sets are widely available, and more and more areas now have 10m data. Finer resolutions are available to those willing to pay—often extravagantly--to have them made.

Obviously, measurements made from DEMs will yield an average value for each 90, 30 or 10m cell. Features that are smaller than the cell will tend to be smoothed out.

There are basically two ways to use GIS:

1. To display **known** information, and
2. To extrapolate **unknown** information through modeling and proximity or spatial analysis.

Most avalanche people have little trouble accepting the first concept. This might include maps with snowpit locations and graphs; avalanche accident sites with official reports; and remote weather station locations with hyperlinks to actual data sources. This type of information display is the thrust of our project.

It's the second category that makes some avalanche pros cringe and which has generated swirls of controversy around this project. Why? Essentially because the data used to generate the new information is not an absolutely perfect representation of the world. It's an average based on the number of measured data points available.

Unfortunately, perfect representations are not possible in any field of human endeavor. For example, topo maps suffer from exactly the same type and scale of inaccuracies that GIS is criticized for, yet they are still a useful tool. We must always decide just how much error we are willing to accept.

This is a sticky issue that requires further discussion within the avalanche community.