

AVATECH: AVANET – CROWDSOURCED, REAL-TIME SNOWPACK INFORMATION

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ABSTRACT: Sharing snowpack data and other observations is of utmost importance to the professional community. Today, leading data sharing programs like the Canadian InfoEx, provide terrific examples of how sharing information quickly amongst a community can promote enhanced decision making and improve public safety. At AvaTech, we are seeking to improve professional information sharing by introducing the SP1, a professional snowpack assessment device which crowd sources snow data in real-time via Bluetooth to a smartphone application and the cloud, AvaNet. In this paper, we will focus on the development of 1) Our data platform AvaNet and 2) a special software tool, SnowPit Editor, which makes manual profile data entry fast and easy.

KEYWORDS: Crowd-sourcing, data sharing, snow penetrometers, spatial variability, avalanche forecasting

1. INTRODUCTION

AvaTech builds proactive systems that quickly analyze the snow pack and facilitate the sharing of this information real-time in order for individuals and groups to make better decisions. Over the past two years, AvaTech has developed several new snow safety technologies including the SP1, a high precision, portable, lightweight, and web-connected penetrometer that measures snow structure and other critical snowpack information, AvaNet, a global snowpack data platform that crowdsources information from the SP1, and a web-based manual snow profile entry tool (SnowPit Editor).

AvaTech was born out of MIT in September 2012 and was selected as one of 8 MIT teams for the Global Founders' Skills Accelerator program. Soon thereafter, we were fortunate to win a research grant from the American Avalanche Association, and completed a rigorous testing program with 50+ partners spanning six countries around the world. Our team merges MIT driven innovation with decades of experience in the snow industry. As backcountry enthusiasts ourselves who have lost friends in avalanches, we want to do everything we can to help make the backcountry safer.

The AvaNet data platform allows professionals to share and view snowpack data all over the world. SP1 and manual profiles are tagged to a specific geolocation on a topographical map, allowing professionals to search this data in real-time and historically. Professionals can search data by aspect, elevation, slope angle, depth of weak layer, and more. AvaNet also includes the signal processing and database analytics aspects of the SP1 data. Snowpit data stored in AvaNet allows AvaTech to improve graphical representations of snowpack data and begin to understand fundamental similarities and differences between penetrometer and hand hardness measurements.

Beyond crowdsourcing SP1 snowpack data, we also wanted to make it faster and easier for professionals to input their own manual profile assessments. Inputting manual snowpit data and field observations as plain text can be time consuming and difficult. Single snowpit observations can take professionals as long as 15-20 minutes to document and share; this is taxing, especially when time is limited. We have developed an entirely web-based, graphical interface for entering snowpit observation data. This allows professionals to input snowpack information in a fraction of the time it takes on other platforms. Professionals can visually drag layers into place, significantly speeding up the profile generation process. By speeding up data entry, SnowPit Editor improves productivity and supports broader data aggregation. Automatic calculation of yellow-flags can be

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enabled to aid user groups, such as avalanche professionals or educators in training courses. Finally, geo-located profiles are overlaid on a topographical map that displays all geo-located snowpits in the region.

2. METHODS

2.1 Summary of testing partners and goals

From January to May of 2014, AvaTech and a team of 50+ partners rigorously tested 25 prototype SP1 units as well as version 1.0 of AvaNet. The testing program included both lab and field-testing, with snow professionals across six different countries around the world. We selected testing partners with a wide variety of avalanche experience as well as geographic diversity to ensure testing in every type of snowpack possible.

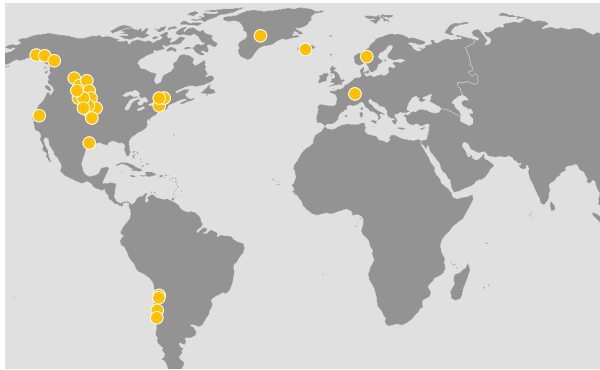


Fig. 1: Map of testing partner locations.

Our testing program included 20 ski resorts, 7 avalanche education providers, 9 avalanche forecast centers, 8 guiding companies, 5 heli-ski / cat operations, 3 universities, military special forces, departments of transportation, professional athletes and others.



Fig. 2: These organizations took part in AvaTech's testing program.

Feedback from this broad set of professional users helped us focus on the solutions that the professional community valued most. By presenting professionals with a functional prototype device, we tested usability and functional requirements for maximizing value and dissemination of snowpack data.

Working with our testing partners resulted in an extraordinary amount of learning. This report summarizes the key learnings from the testing program.

2.2 Testing program approach & methodology

During our testing period, we conducted focus sessions with our testing partners, where we showed them version 1.0 of AvaNet, and asked what they would like to see improve before our official launch for the 2014 – 2015 northern hemisphere winter. In addition to these focus sessions, we received regular feedback from testers as they used our beta platform over the winter.

3. DISCUSSION

3.1 Summary of results

Overall, the professional community received our efforts at streamlining data entry and simplifying data sharing positively. AvaNet version 1.0 was in beta development, and, at the time, its main benefit was our graphical interface for entering hand hardness profiles, SnowPit Editor. While this was seen as a time-saver compared to plain-text based data entry, or hand drawn graphs, we quickly learned that our professional partners required many features beyond simple stratigraphy input.

Our cloud-based web platform for uploading SP1 profiles worked smoothly, with a simple workflow for associating manual profiles with SP1 profiles measured at the site of the professional snowpit.

3.2 SnowPit Editor

Our testing partners requested the existing SWAG and CAAML standards, and we are fortunate for the excellent documentation of these frameworks. Quickly, SnowPit Editor grew into a more comprehensive tool:

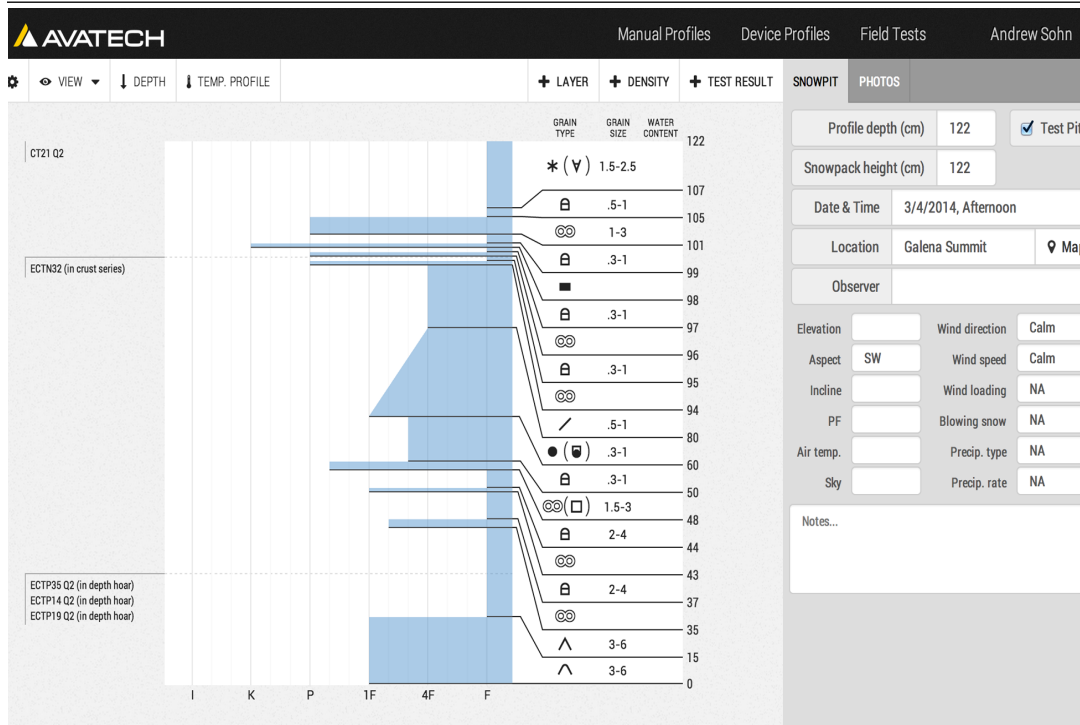


Fig. 3: SnowPit Editor's graphical user interface.

Perhaps the single most important feedback we received from testers regarding the benefit of SnowPit editor was its speed and ease-of-use. Allowing users to visually develop their snowpits by dragging and dropping layers and temperatures speeds up the data entry process and also reduces errors (since users can correct them immediately). Additionally, we also received very positive feedback on features which allow geo-tagging profiles on a topographical map, photo uploads, and multiple format export capabilities.

Today, SnowPit Editor's core features include:

- Snowpit site metadata (e.g. snow depth, date/time, GPS location, sky condition, incline, precip. type/rate, and more)
- Hand hardness stratigraphy input
- SWAG grain information input
- Density input
- Temperature input
- Water content input
- Extended column test input
- Compression test input
- Rutschblock test input
- Yellow flag indicators (optional)

- Lemons indicators (optional)
- Persistent grains indicators (optional)
- Photo upload
- Geo-tagging
- PDF export
- CSV export
- CAAML export

SnowPit Editor is already in use by many professionals and we are eager to continue gathering feedback to make it even better.

3.3 *AvaNet Cloud Database*

During our testing program, partners were able to upload SP1 prototype device profiles to the AvaNet cloud, which started out as a platform to validate our SP1 readings. Any data that SP1/AvaNet users uploaded to the cloud was available to that user to download as raw data in CSV format.

This large aggregation of raw SP1 data was used to improve signal processing algorithms leading up to the launch of the SP1 in fall 2014. In addition to the database of SP1 profiles, AvaNet created a special feature, called "field tests" that allowed professionals to link SP1 profiles with manual, hand hardness stratigraphy assessments:

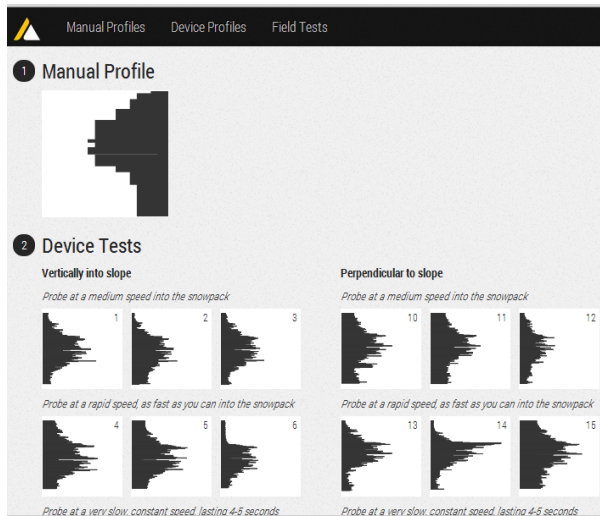


Fig. 4: Field tests were usually comprised of one hand hardness profile, and 9-18 SP1 profiles (3 medium penetration speed, 3 slow, and 3 fast, all at both slope normal and vertical).

Future versions of AvaNet will allow users to view every SP1 profile on a topographic map as seen below:

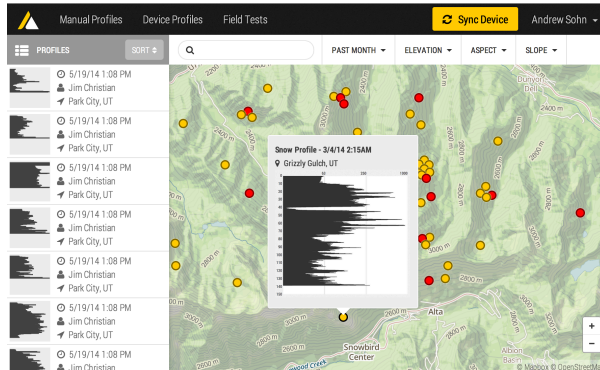


Fig 5: AvaNet geolocation on topographical maps.

AvaNet also allows professionals to comment and provide context and further information to SP1 or manual profile observations.

By aggregating snowpack data over space and time all around the world, we hope to make significant contributions to the broader snow science, avalanche safety, and mountain communities.

4. CONCLUSIONS

Overall, the opportunity to engage in rapid dialogue and feedback with experts in the field and our technical advisors was successful. We were able to gather feedback from a significant cross

section of users and geographically unique snowpacks. This design feedback loop has been invaluable to the final development of the SP1's algorithms and features of AvaNet, such as the SnowPit Editor. In the coming winter of 2014 – 2015, AvaNet and the SP1 will make snowpack data collection, interpretation, and sharing easier than ever before. We hope to continue the dialogue with professionals from around the world and build valuable hardware and software tools that benefit the professional community.

5. ADDITIONAL INFORMATION

5.1 *Conflict of interest statement*

The authors of this paper are employees of AvaTech, Inc. and are involved in the development and sales of the SP1 and AvaNet.

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