P 1.28   Applying interactive Learning tools in the Advanced Warning Operations Course

James G. LaDue[1*], Kevin Manross[2,3], Dale Morris[1,4], and Paul Schlatter[1,2]
[1]National Weather Service Warning Decision Training Branch
[2]Cooperative Institue for Mesoscale Meteorological Studies
[3]National Severe Storms Laboratory,
[4]Oklahoma Climate Survey
Norman, OK

1. INTRODUCTION

The Warning Decision Training Branch (WDTB) created a course called the Advanced Warning Operations Course (AWOC; Ferree et al. 2004) that included components relating to warning decision making, severe convective storm threat forecasting and interrogation. WDTB instructors delivered AWOC to all NWS forecasters in fiscal year 2005.   To help accomodate learning style diversity and increase the relevancy of AWOC, WDTB instructors worked to enhance student interactivity through a variety of means (Stolovich and Keeps, 2003). Interactivity in AWOC includes exercises, testing, simulations (Magsig and Page 2004), student support, and tools.   This paper elaborates on the AWOC interactivity through two tools: the Hail Detection Algorithm Toolkit (HDA toolkit) and the radar Volume Coverage Pattern Ray Path Explorer (VCPExplorer). The HDA toolkit calculates expected hail size in the same method as the operational HDA (Witt et al. 1998). VCPExplorer allows forecasters to explore the effects on three dimensional radar observations by topography, discrete vertical sampling, and anomalous beam propagation (Manross et al. 2005). This paper will examine the motivation behind how and why the toolkits were built in section 2, then in sections 3 and 4, each toolkit will be described followed by section 5 on how they were implemented in AWOC.

---

*Corresponding Author Address: James G. LaDue NOAA/NWS/WDTB, 3200 Marshall Ave. Suite 202, Norman, OK 73072, email: James.G. LaDue@noaa.gov

2. MOTIVATION FOR TOOL KIT DESIGN

AWOC asynchronous web modules can be described as mostly receptive training with relatively little interaction. This type of training has an advantage of quickly introducing content but it tends to promote loss of learner retention. The full simulation with the Weather Event Simulator at the end of the course could promote the desired interaction from a learner as it represents the application of all material in AWOC in a work-like environment (Magsig et al. 2006). However, the simulation occurs at the end of the course and requires a long period of involvement by the student and the onsite facilitator. AWOC developers believed that interaction was needed within the course content which could be used to diversify the education delivery and increase learning retention while not exhausting large amounts of learner resources. A blend of self exploratory and guided discovery methods (Stolovich and Keeps, 2003) was desired thus tools were created to deliver training content while potentially be used on the job.   Both the tools to be covered can be described as being a simulation of reality as mentioned in Alessi and Trollip, 2001. They are not complete simulations of a NWS forecaster work environment, but they do simulate a small component of reality. This form of multimedia interaction was sought after for the core content in AWOC.

3. THE HDA TOOLKIT

The HDA estimates Probability of Severe Hail (POSH) and Maximum Expected Hail Size (MEHS) from convective storms observed by a WSR-88D (Witt et al. 1998). The inputs are loosely based on a vertical reflectivity profile in a storm, and the heights of the 0 and -20 C levels manually input into the radar product generator. However, a forecaster can see the inputs and the answers, not how the algorithm derives its answers. The HDA toolkit reveals the process in which the algorithm derives its answers (fig 1). It is available to anyone on the web located at (http://www.wdtb.noaa.gov/courses/awoc/ICSvr3/hda_vil_tool.html) and is based on Macromedia Flash 7.0®.

Along the top left part of the display in figure 1 (labeled 'A'), the user can input the environmental parameters, review the online help, and select the radar elevation, or select a radar if the elevation is not known.   A user then inputs the maximum reflectivity in a storm from each radar elevation angle and its associated altitude (labeled 'Z inputs'), starting at low altitudes at the bottom of the toolkit and then going up in rows as the user enters higher altitude maximum reflectivity values. As the user enters in the values, the toolkit shows the intermediate outputs in the HDA (labeled intermediate) that the user typically would not see from any operational algorithm. The red row contains the final outputs ('B'), only a few of which are displayed in operations. The row containing the legends for the values ('C') is hypertext allowing the user to understand what each column below it indicates. Figure 2 shows an example of a popup window explaining the meaning of the column containing the MEHS.

The HDA toolkit is a simulator in that it emulates the operational algorithm by calculating the values starting at the lowest level (lowest row), and then at progressively higher levels (higher rows) until the top of the storm is reached (top row with entries). Some of the values are integrations up the entire column such as the Severe Hail Index (SHI). The POSH, and the MEHS are derived from the SHI, and

therefore, are related to integrations from all the lower levels below. At the top row, the final values are colored red. The right-most columns are not outputs from the HDA but instead show values of Vertically Integrated Liquid (VIL; Greene and Clark, 1972) and VIL density (Amburn and Wolf, 1997), two additional parameters that operational forecasters may use to diagnose hail threat.

This tool allows a user to analyze the HDA by experimenting with different vertical reflectivity profiles, radar altitudes, and different freezing levels. It is conceivable that a NWS forecaster could use the HDA toolkit to immediately prior to warning operations to determine needed vertical reflectivity profiles to produce significant threats of large hail.

4. The VCPExplorer

The VCPExplorer is a Java VisAD based tool that visualizes aspects of radar beam paths with respect to topography and highlights the impacts on algorithm output from discrete vertical sampling given a variety of VCPs (Manross et al. 2005).   The VCPExplorer interface is designed to immediately show the user the position of a radar beam with respect to the topography by viewing the Range Height Indicator (RHI) on the right (figure 3). The user can position the azimuth on the PPI in any direction from the radar and the RHI will refresh to display the topography. Multiple aspects of a radar beam can be modified including the elevation of the beam center point, and the beam width. Since operational radars employ one of many VCPs, the VCPExplorer can display any of the existing VCPs, and any new ones that a user would choose to create. The VCPExplorer can simulate beam blockage in multiple ways to allow the user to potentially recreate the beam blockage.

Students examining this tool can learn how discrete vertical sampling can affect algorithm accuracy. One example application illustrates the differences between the true and radar

detected vertical reflectivity profile of a storm as discussed earlier in section 3. The VCPExplorer also allows a user to enter in a true vertical reflectivity profile but in a more graphical way (figure 4). All the HDA outputs are produced, both with respect to the true reflectivity profile, and from the discrete vertical radar sampling at all ranges from the radar. Figure 5 shows the output on the RHI display. Students therefore can learn exactly how discrete vertical sampling impacts the performance of radar-based algorithms.

Manross et al. 2005 contains more information on the functions of the VCPExplorer that was used during AWOC. Currently, major upgrades are being performed on the VCPExplorer to support a winter weather track of AWOC (Manross and LaDue, 2006) that will support precipitation algorithms.

5. METHOD of EDUCATION in AWOC

More was needed than simply delivering the HDA toolkit and the VCPExplorer to the NWS as part of AWOC. The tools themselves are not in the list of approved operational software to be used by NWS forecasters. Yet they reveal aspects of operational data that are extremely relevant to their jobs. The developers wanted to maximize the student encoding (Mayer and Clark, 2003) of the principles the tools displayed rather than emphasizing the tools themselves. Their strategy then was to show real cases that can occur on their jobs; examples include severe storm cases and how the HDA would work, real situations of discrete radar sampling impacting algorithm performance, and cases of beam blockage. The best way to do that was to create job sheets emphasized the important aspects of the tools.

Two job sheets were created, one for the HDA toolkit (figure 6) and another for the VCPExplorer (figure 7). Both job sheets have specific objectives telling the student what will be learned. The student is given specific directions on how to use the tools to display the requested data. The questions to the student then emphasize the understanding of the data and its implications to their jobs as forecasters. An instructor version of the job sheet accompanies the student version and allows for quick answers.

There is no formal evaluation system for students completing the job sheets. It was designed mostly as a personal exploration, although a formal evaluation system could be applied. The reasons for not making these job sheets mandatory were the time involved vs. priority of the training, and the large CPU requirements to run the VCPExplorer. Although computers recently purchased should have the resources to run VCPExplorer, we could not assume that every office had the necessary equipment at the time AWOC was being developed.

6. CONCLUSIONS

This paper described the need to create tool-based interactivity for the AWOC course in order to explain the function of the operational HDA, and the impacts of radar data ambiguities on the interpretation of radar algorithms and base data. Since the tools were not designed to be part of the operational software portfolio of a NWS office, the interaction with the tools was facilitated with the use of job sheets. The two job sheets were designed such that a learner could concentrate on the data the tools displayed rather than the operation of the tool itself. The learner is intended to use the job sheets as a self-guided exploration of the data that he or she may encounter in the course of an operational shift.

The first tool developed was the HDA toolkit. It was designed for the user to show how the operational HDA creates its products such as maximum hail size and severe hail probability. The second tool, the VCPExplorer, visually shows how a variety of factors affect radar base data and algorithmic performance. The VCPExplorer shows the impacts of discrete vertical radar sampling on algorithms such as the HDA. It additionally shows the impact of topography on beam blockage, even being able to show impacts from non-standard beam refraction.

The main parts of AWOC, the core and severe tracks, have been completed for this past fiscal year. To date, no formal evaluation of the interactive tools has been completed. However, informal responses from many students were favorable towards both tools. Several offices were not able to operate the VCPExplorer owing to its CPU or video card requirements. However, those that did use it believed it was a valuable tool because it displayed the effects of data ambiguities in a way that has not been shown for their own radars.

In the future, the VCPExplorer will be expanded to include the impact of data ambiguities on the precipitation detection and accumulation algorithms (Manross and LaDue, 2006). The new version of the VCP Explorer will play an important role in a new winter weather track of AWOC to be delivered in 2006 and 2007.

7. ACKNOWLEDGEMENTS

Greg Stumpf helped with the design of the VCPExplorer, Ed Mahoney provided valuable consultation on the VCPExplorer.

8. REFERENCES

Alessi, M. S., and S. R. Trollip, 2001: *Multimedia for Learning: Methods and Development.* 2nd ed. Allyn & Bacon, 302-333.

Amburn, S. A., and P. L. Wolf, 1997: VIL density as a hail indicator. *Wea. Forecasting*, **12**, 473-478.

Ferree, J. T., E. M. Quoetone, and E. M., Magsig, 2004: The Advanced Warning Operations Course (AWOC). Preprints. *22nd Severe Local Storms Conference*, Hyannis, MA. Amer. Meteor. Soc., P2.2.

Greene, D. R., and R. A. Clark, 1972: Vertically integrated liquid water – A new analysis tool. *Mon. Wea. Rev*., **100**, 548-552.

Magsig M.A. and E.M. Page, 2003: Weather event simulator implementation and future development. Preprints. *Interactive Symposium on AWIPS*, Long Beach, CA. Amer. Meteor. Soc., CD-ROM, P12.9.

_____, T. Decker, and N. A. Said, 2006: Builds Five and Six of NOAA's NWS Weather Event Simulator. Preprints. *22nd International Conference on Interactive Information Processing Systems for Meteorology, Oceanography, and Hydrology*, Atlanta, GA. Amer. Meteor. Soc., CD-ROM, P7.7.

Manross, K. L., J. G. LaDue, and G. J. Stumpf, 2005: The Volume Coverage Pattern Explorer: A New Tool for Visualizing Radar Beam Paths. Preprints, *21st International Conference on Interactive Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology*, San Diego, CA. Amer. Meteor. Soc., CD-ROM, P5.5.

_____, _____, 2006: New Features of the VCPExplorer: Simulated Precipitation Sampling. Preprints, *22st International Conference on Interactive Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology.* Atlanta, GA. Amer. Meteor. Soc., CD-ROM, P2.11.

Mayer, R. E., and R. Colvin-Clark, 2003: Does Practice Make Perfect? *E-Learning and the Science of Instruction*, Pfeiffer, 149-171.

Stolovitch, H. D., and E. J. Keeps, 2003: *Telling ain't Training.* ASTD publications, 193 pp.

Witt, A., M. D. Eilts, G. J. Stumpf, J. T. Johnson, E. D. Mitchell, and K. W. Thomas, 1998: An enhanced hail detection algorithm for the WSR-88D. *Wea. Forecasting,* **13**, 286-303.
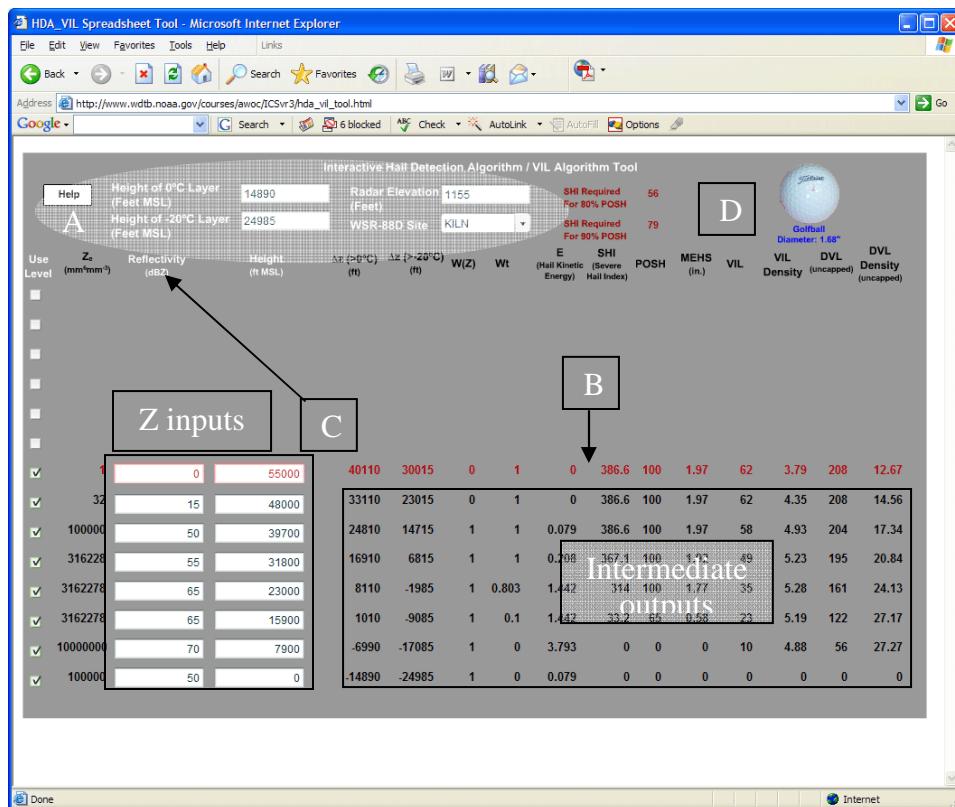
Figure 1. The HDA toolkit user interface. The annotations are explained in the text.
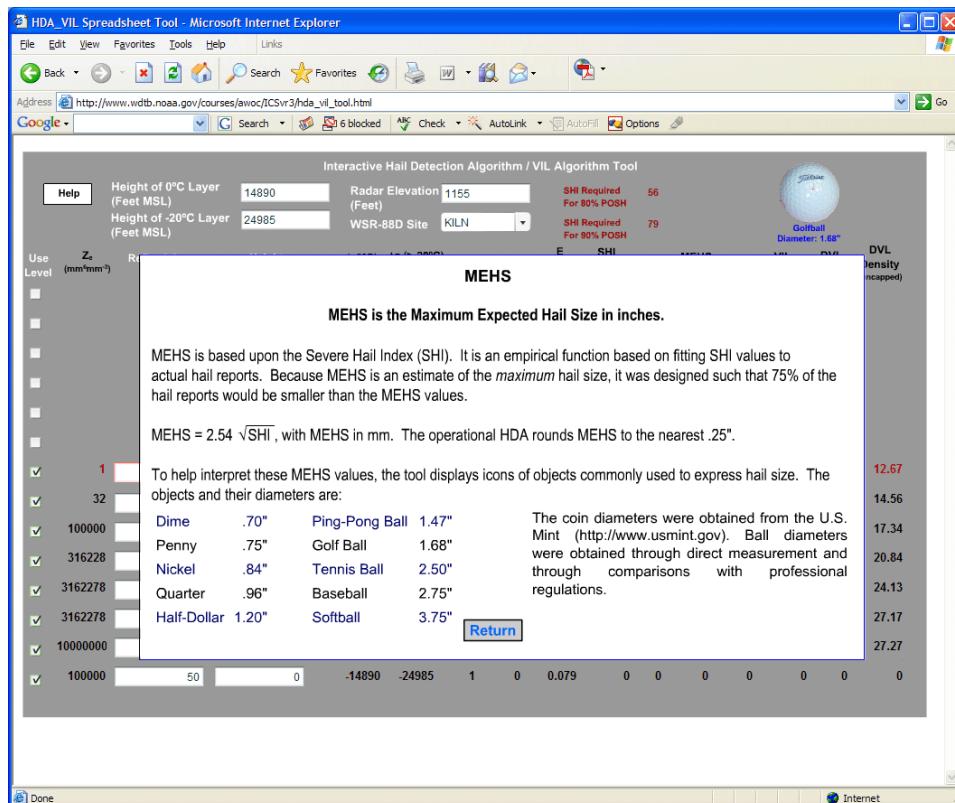

Figure 2 Popup display on the HDA toolkit explaining the Maximum Expected Hail Size (MEHS)
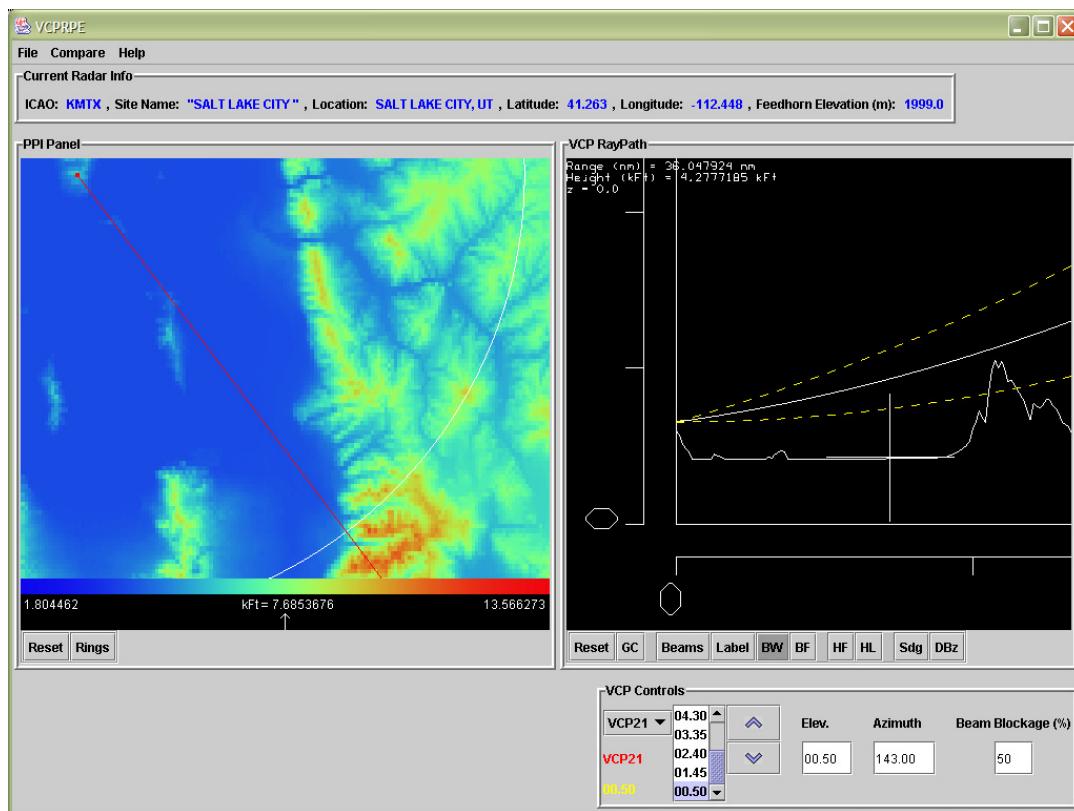
Figure 3The VCPExplorer user interface.

Reflectivity Profile	
Height ARL (kft)	Reflectivity (dBZ)
0	50
7.9	70
15.9	65
23	65
31.8	55
39.7	50
48	15
55+	-10
Temperature Profile	
Temperature	Height (ft)
0ºC	14,890
-20ºC	24,985

Figure 4 Graphical user entry of a vertical reflectivity profile in the VCPExplorer (right) and the data values displayed from a job sheet (left).
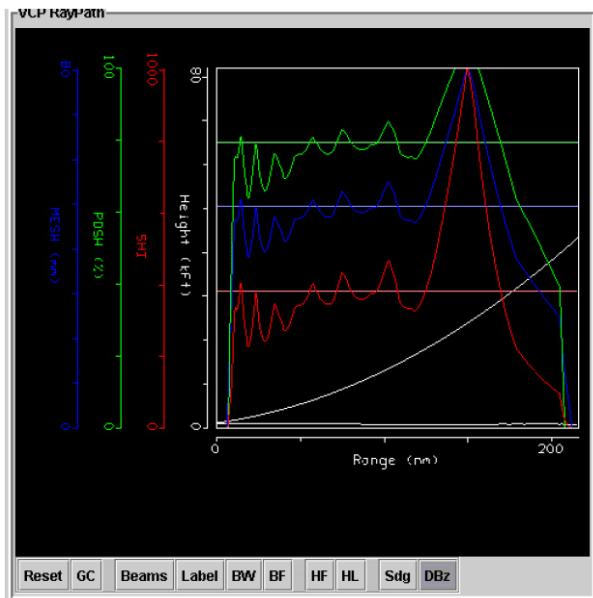
Figure 5 HDA outputs with respect to range from the radar for the entered (true) vertical reflectivity profile (straight horizontal lines) and from the discrete vertical radar sampling for VCP 21 of the WSR-88D (sawtoothed profiles). Displayed are the HDA output for MEHS (blue), POSH (green), and Severe Hail Index (SHI; red). The white curve represents the elevation of the 0.5 degree beam centerpoint.

Figure 6. The front page of a job sheet for the HDA toolkit. The entire job sheet can be found at (http://www.wdtb.noaa.gov/courses/awoc/ICSvr3/HailJobSheet.pdf).

http://www.wdtb.noaa.gov/courses/awoc/ICCore4/lesson5/VCPPRE_jobsheet.pdf - Microsoft Internet Explorer

File   Edit   Go To   Favorites   Help   Links

Back

Address   http://www.wdtb.noaa.gov/courses/awoc/ICCore4/lesson5/VCPPRE_jobsheet.pdf   Go

Google   Search   6 blocked   Check   AutoLink   AutoFill   Options

Save a Copy   Search   Select   75%   Sign

Learner Version

Advanced Warning Operations Course
IC Core 4
Data Quality
Lesson 5

VCP Explorer Job Sheet 6
VCP Explorer 2.x

Objective: The objective of this exercise is to use VCP Explorer to visualize the impact of radar sampling through various VCPs upon parameters of the HDA algorithm.

In this exercise, "LM" refers to the left-mouse button, "MM" refers to the middle mouse button, and "RM" refers to the right-mouse button.

1. Start VCP Explorer, and change to the KILN radar. Set the VCP to VCP 21.

2. VCP Explorer can calculate three parameters of the Hail Detection Algorithm. These parameters are the Probability of Severe Hail (POSH), Maximum Expected Hail Size (MEHS), and Severe Hail Index (SHI). The HDA calculations require a reflectivity profile plus the heights of the 0°C and -20°C isotherms. Use the DBz option under the Compare menu to enter the following profile.

Reflectivity Profile	
Height ARL (kft)	Reflectivity (dBZ)
0	50
7.9	70
15.9	65
23	65
31.8	55
39.7	50
48	15
55+	-10

Temperature Profile	
Temperature	Height (ft)
0°C	14,890
-20°C	24,985

Figure 7Portion of the VCPExplorer jobsheet focusing on the HDA data quality issues. The entire job sheet can be found at (http://www.wdtb.noaa.gov/courses/awoc/ICCore4/lesson5/VCPPRE_jobsheet.pdf).