

DEVELOPMENT OF AN INTERACTIVE PSYCHROMETRIC CHART TUTORIAL

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Abstract

The psychrometric chart may be a troublesome tool for undergraduate students to learn to use. The chart's importance in the analysis of industrial systems involving air and water vapor is undeniable, and reading the chart is an important skill for students to master.

The tutorial presented in this paper is an interactive, online supplement to textbook explanations of the chart. Sophomore students in an "Introduction to Process Engineering Calculations" course used the tutorial as their first exposure to the material, and upper division students in a "Mass Transfer Operations" course used the tutorial as a review/refresher on the chart prior to their study of humidification and drying processes.

Student reaction to the tutorial was overwhelmingly positive; the tutorial allowed students to spend as much (or as little) time as they needed to master the use of the chart. Use of the tutorial as an out-of-class assignment has eliminated the need to use class time to teach the basic skills of reading properties from the chart, and allowed greater emphasis on use of the chart in problem-solving.

Introduction

Over many years of teaching the "Introduction to Process Engineering Calculations" course, I developed a set of standard lectures and activities to introduce students to the psychrometric chart. These activities consumed at least two hours of class time. During this time, most students could gain at least a basic understanding of the chart. Other students were still clearly baffled, while still others picked up the material quickly and became bored. My goal in the creation of an online tutorial for this material was to translate my teaching techniques into a web application that would allow students to work with the tutorial as much (or as little) as necessary for them to master the material. I would then be able to concentrate my in-class activities on problem-solving techniques using the physical properties from the chart. Even though there are widely available psychrometric calculators on the internet (e.g. Linric, 2001), I believe that the physical understanding of the air/water vapor system imparted by learning to read the chart is a valuable part of a process engineer's toolbox.

Tutorial Development

The development of the tutorial began during the summer of 2003. The UW-Stevens Point Information Technology (IT) group had an interest in working with faculty to develop "learning objects", which can be defined as small, reusable "chunks" of course content (Wiley, 2000). I

met with a development team to discuss the concept development. The team consisted of a faculty content expert, a graphic designer, a web programmer, and a video production specialist. The work of the team was coordinated by two IT representatives. My responsibility, as the content expert, was to develop storyboards describing the appearance of the screens in the tutorial. As these screens were described, we determined that the tutorial would be best created as a series of HTML pages, using Macromedia Flash for the animations and interactive portions of the material. I provided detailed descriptions of my teaching techniques; the web programmer translated my descriptions and sketches into Flash animations. The demonstration of the use of a sling psychrometer was initially planned as a video clip. The resulting video file for the demonstration was very large, and was not as effective as we wanted it to be. We ultimately decided to create a Flash slideshow, which is a much smaller file, and turned out to demonstrate the concept adequately. The graphic designer scanned a version of the psychrometric chart (Felder and Rousseau, 1999) and touched up the image to make it usable for the interactive parts of the tutorial.

When teaching the psychrometric chart in the classroom, I used an overhead projector with transparencies of the psychrometric chart to demonstrate how to find the physical properties of humid air. Students watched (with encouragement, they followed along in their textbook) as I drew colored lines on the charts. Our web programmer translated these demonstrations into Flash animations with audio descriptions of the procedure. An example screen shot is shown in Figure 1. When using the tutorial, students interact with these animated charts, pointing and clicking on appropriate hot spots and buttons to continue through the lesson.

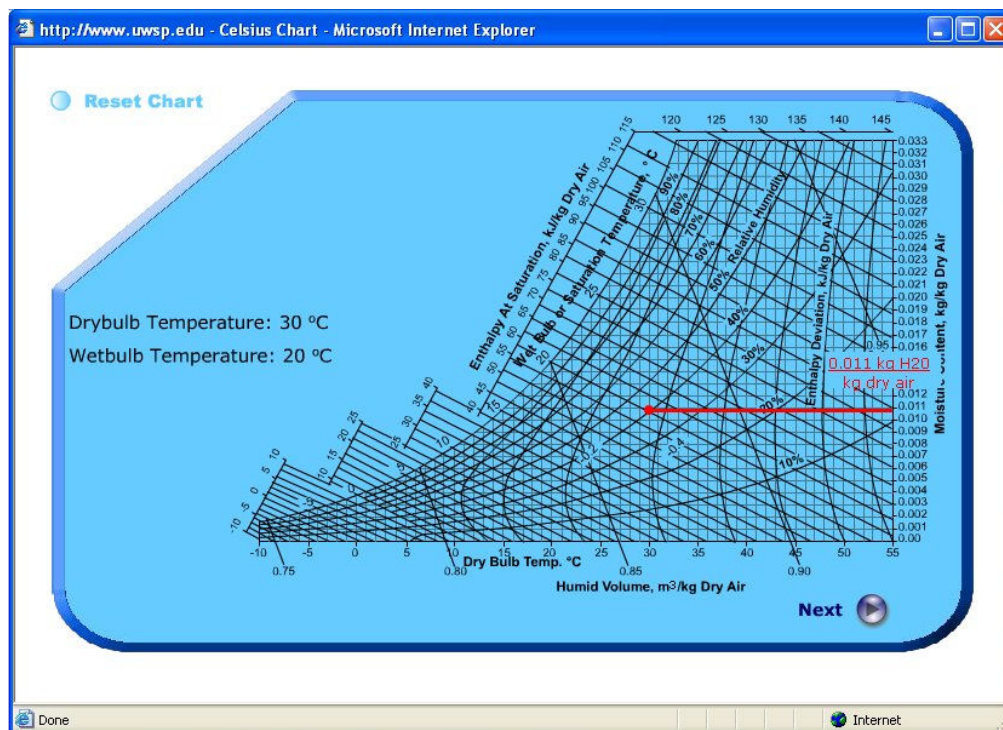


Figure 1. Interactive demonstration graphic.

The most interesting interactive element in the tutorial, however, is a chart which generates random combinations of dry bulb temperature and relative humidity, and directs students to find and click on the correct location on the chart for those conditions (Figure 2). When they do, a

drop-down box appears in which they enter the values for the other four properties from the chart. A “Check” button allows them to determine if their answers are correct. The student answers are judged to be correct if they are within five percent of values calculated from psychrometric equations. Students can reset the dry bulb/relative humidity values as many times as they wish, providing unlimited opportunities to practice using the chart.

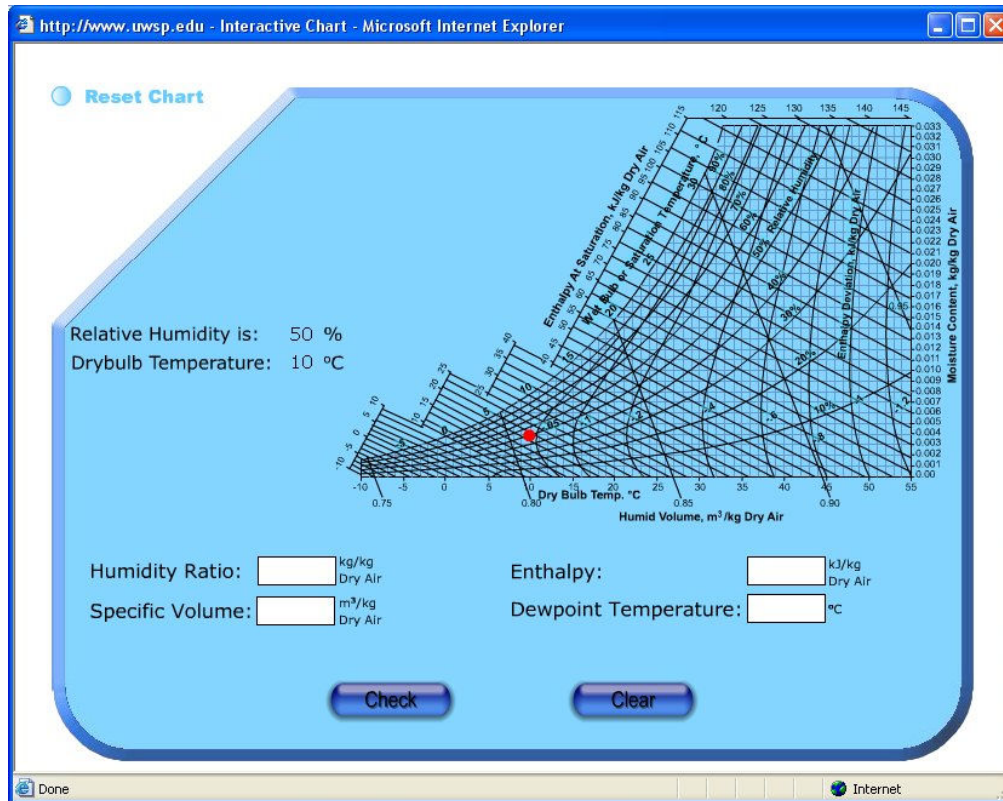


Figure 2. Interactive psychrometric chart.

The tutorial concludes with a short quiz on the material. Four multiple choice questions about the concepts on the chart and the use of the chart allow the students to test their understanding of the material. Students’ performance on the quiz is not part of their grade.

This tutorial is accessible on the internet at <http://www.uwsp.edu/it/tlrn/LOs2003/paperlo/> Our development team is very interested in feedback on the tutorial, which may be addressed to the author (email address is given in the biography).

Assessment of the Tutorial

The first group of students to use the tutorial was a senior level “Mass Transfer Operations” course in the Fall Semester of 2003. I asked the class of seventeen students to use the tutorial to review the psychrometric chart prior to our study of humidification operations. Part of the assignment was to provide me feedback on the tutorial, including suggestions for improvement. The questions asked of the students are listed in Appendix A. The students’ responses were universally positive, even though they found a few errors in the tutorial. Some examples of the feedback:

- “I found the tutorial on the chart to be a good refresher. The program itself was very easy to use and understand.”
- “Was very scary hearing your voice, swear you were at my house giving the lecture.”
- “The ‘using the chart’ section was very helpful in understanding how the chart works.”
- “The interactive aspects are clever and can be fun. (what a nerd I am)”

The positive reactions were very encouraging. We fixed the errors that the seniors identified, and I then used the tutorial for its original purpose during the Spring Semester of 2004, in the “Introduction to Process Engineering Calculations” course. This out-of-class assignment included going through the tutorial and doing several relatively simple problems based on the chart. I presented nothing in class on the psychrometric chart. On the due date for the assignment, I gave the students an unscheduled quiz on the chart, as I have in many previous semesters. My plan was to review any troublesome issues in class following the quiz. Over the years, students have averaged around 75% on this quiz. This group of students, after using the tutorial, averaged 95% on the quiz. Obviously, no in-class review was necessary. The tutorial was clearly effective, and allowed me to move immediately into more complicated energy balance problems, such as air conditioning, drying and humidification calculations.

During the Fall Semester of 2004, I again assigned the tutorial to seniors in the “Mass Transfer Operations” course. Feedback was very similar to that from the previous group of seniors. I plan to use the tutorial again with a small class of sophomores during the Spring Semester of 2005.

The only problematic issue with the tutorial is the use of Flash for the interactive portions. If any changes need to be made to the animations, one must be familiar with Flash to make them. I have not yet acquired the understanding needed to work with Flash, so the web programmer must still be involved in the development of the tutorial. However, the richness of the animations that can be created with Flash and the availability of free software to display the animations clearly outweigh the disadvantages of the program’s complexity.

Conclusions

The tutorial described in this paper has been shown to be effective for both initial instruction and review of the use of the psychrometric chart, although there are still some minor technical problems to be fixed. Since the tutorial was developed in HTML and Flash, it is easy to make available on the Internet. When the technical issues have been addressed, the tutorial can be made available for other instructors’ use in teaching students the concepts involved with the psychrometric chart. This allows the use of class time for more productive student/instructor interaction.

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Biography

Karyn Biasca is an Associate Professor in the Paper Science Department at the University of Wisconsin – Stevens Point where she has taught since 1989. She received her B.S in Chemical Engineering from the University of California at Los Angeles in 1981 and her Ph.D. from the Institute of Paper Chemistry (Appleton, WI) in 1989. Her research interests concentrate in the scholarship of teaching and learning, especially on the effectiveness of online learning materials for engineering education. Her email address is kbiasca@uwsp.edu

Appendix A

Questions addressed to seniors about tutorial:

- Read Chapter 19 in McCabe, Smith and Harriott
- Use the psychrometric chart tutorial found on the internet at <http://www.uwsp.edu/it/tlrm/LOs2003/paperlo/> to review the use of this chart that summarizes the properties of the air/water vapor system.
- Write a brief summary of your experience with the tutorial: is it easy to use? Did it help you remember how to use the chart? Are the graphics and interactive elements helpful? Any reactions that you can provide will help me to finalize the tutorial. Please email your summary to me by Tuesday, October 21, 2003.