BUILDING NOTE-FRIENDLY HANDOUTS

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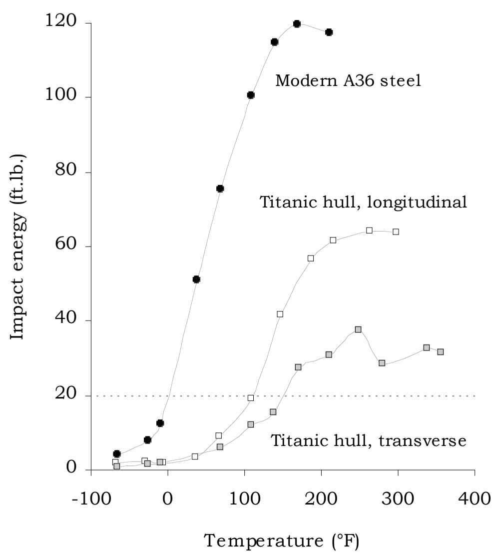
1. ABSTRACT

In a conventional classroom setting, instructors distribute three types of handouts: organizational (syllabus); instructional (graphs, drawings, tables, slideshow miniatures); and assessment (quizzes, exams, surveys). The content of instructional handouts includes material which is not in the textbook; lecture material that is too difficult or time-consuming to copy from a chalkboard; large tables; complex graphs; wordy homework questions; and perhaps most commonly today, miniature PowerPoint slides to accompany a slideshow lecture. Unfortunately, PowerPoint handout formats are not flexible enough for the modern classroom. For example, none of these formats allow one slide to be printed larger than another to show more detail. Furthermore, supplemental images, tables, or text cannot be added to the handout unless they are inserted into slides. To correct these issues, handouts can be improved by exporting the slide images to a word processor. An integrated approach to handout design includes images from the slides at appropriate sizes; thinner lines; consistent font sizes; planned whitespace and missing labels to encourage annotation; tables; homework assignments; and reminders of upcoming events. This integrated approach combines many functions in a single, "note-friendly" handout for each lecture.

2. SLIDESHOWS AND HANDOUTS

Instructors use a variety of tools to help students learn: we lecture in classrooms; we demonstrate problem-solving methods on chalkboards; we use 35mm and PowerPoint (PP) slides; we conduct experiments in classrooms and laboratories; we assign reading and homework; and we create handouts to supplement these other methods. I spent my first year of teaching developing lectures for chalkboard delivery, supplemented by handouts like Figure 1, which covered material not in the lecture or textbook. Homework was assigned on handouts like Figure 2. The next year, I converted lectures from four survey courses into PP slideshows. The handouts for these PP shows consisted of miniature copies of the slides printed six to a page, as in Figure 3…a standard PP handout format. Slides selected for the handout included complex graphs, lengthy equations, large tables, micrographs, and photographs. Slides which were not included in the handout contained solutions to homework problems, and material that was easy to transcribe by hand…such as key words and short equations. In addition, students received the handouts created for the previous year's chalkboard lectures.

MET 180, Class #7
Charpy impact testing of the Titanic's hull



One popular explanation for the sinking of the Titanic is that the hull became brittle in the cold North Atlantic. Charpy impact testing of hull steel shows that the hull would have been brittle in tropical oceans too. Specimens were broken along the grain of the hull plates (longitudinal), and across the grain (transverse). Modern A36 steel, which is comparable in composition to the Titanic hull material, has fewer contaminants and has a higher ductile-to-brittle transition temperature (defined at 20 ft.lb. impact energy)

Data source: Tim Foecke, Metallurgy of the RMS Titanic, NIST internal report NIST-IR 6118.

Figure 1: This supplemental handout from my first year of teaching is printed as a half-sheet.

MET 180
Homework Assignment #7

Reading
Read Chapters 7 & 8.

Textbook Problems
[1] Solve Problem 7-6.

[2] Solve Problem 7-11.

[3] What is the degree of polymerization of polystyrene having a molecular weight of 70,000 g/mole?

[4] Solve Problem 8-20.

[5] Use a spreadsheet (such as Excel) to plot the thermal conductivity of a ceramic vs. porosity, over the range 0 to 40% porosity. For this ceramic, k_o = 0.75 W/mK.

Figure 2: A typical first year homework assignment handout printed as a half-sheet has plenty of space for wordy problem statements, as well as reminders about upcoming exams and laboratory experiments.

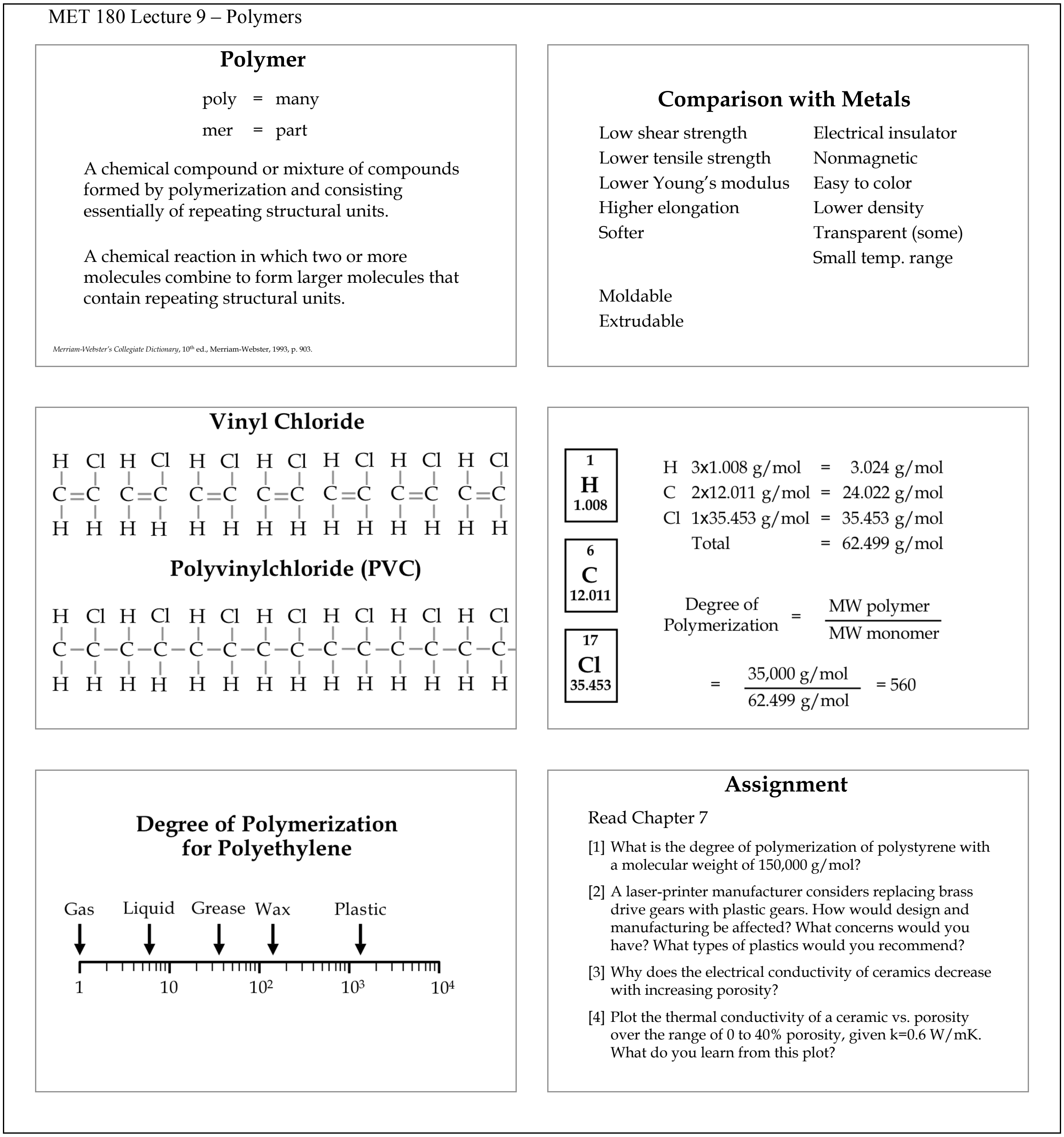


Figure 3: Six slides are printed on each PP slide handout from the second year. This format limits the whitespace available to write notes, and limits the length of the homework assignment to what will fit legibly in a small box.

During this second year, students appeared to take very few notes in the first half of the semester of a freshman Materials course. However, they asked more questions during the lecture, and appeared to be more engaged in thinking about the material than their predecessors in the chalkboard class the year before. For example, they would respond more readily to questions from the instructor, perhaps because they did not have to change from “scribe mode” to “thinking mode”. After the midterm exam, notetaking appeared to increase. They appeared to understand that the handouts were not “the notes”…they were a framework for taking notes, but not an ideal framework. As the year progressed, several shortcomings of the 6-slides-to-a-page format became obvious:

1. Line thicknesses appropriate for a projection screen are too thick on a printed page, so graphs and engineering diagrams look like cartoons. These lines should be thinner, because 600 or 1200 dpi laser printing shows detail not visible with the current generation of low resolution projectors, and a reader can adjust the position of the page relative to the eye more easily than an audience member can move closer to a screen in a crowded lecture hall. Slides are designed to be legible by the student at the back of the classroom, not just the student in the front row.

2. There is little space around the slides for taking good notes, especially if the slides are printed with borders (the default in PP). Students must either write very small, write notes on a separate page, or take fewer notes.

3. With all the text from the PP show on the handout, there was little incentive for students to annotate the diagrams. Some students sat through classes without taking any notes at all.

4. Some detailed figures were too small to be useful (or legible) on the printed page. There is no flexibility in PP (or its competitors) for printing some of the slides larger than the rest.

5. Multiple sequential slides in a PP show cannot be displayed in a row or column. There is no flexibility in PP for printing five slides on one page, two on the second page, three across the width of a third, with strategically planned whitespace.

6. Homework assignments were limited to what would fit easily on a slide, which made it difficult to assign wordy problems, or problems using graphs or pictures.

7. Supplemental handouts, such as Figure 1, were stapled to the end of the PP handout, not in the order of discussion during the class. The only way to insert this material within a PP printout is to create a new slide within the PP show.

The solution to all of these problems was to import figures, tables, graphs, and text into a word processor. Images were rescaled, and line thicknesses were reduced to make them less cartoonish. Graphs, pictures, and tables were resized for legibility and to enable better notetaking, with extra white space where needed. Some figures were significantly expanded compared with the standard 6-to-a-page PP handout format used in the previous year. Some labels and lines were deleted to encourage students to mark up graphs and pictures. Homework and reading assignments were given at the bottom of the last page of each handout. The assignments were as detailed as they had been in the first year of teaching, because questions could fill the width of the page. Announcements of upcoming labs, exams, etc. were placed immediately before the homework assignments, because this is one portion of the handout that students are guaranteed to revisit. Large tables (such as the periodic table of elements, and the AISI steel designation system) were integrated sequentially into the handouts at the appropriate point in the lecture…a feat that is impossible with the standard PP handout format.

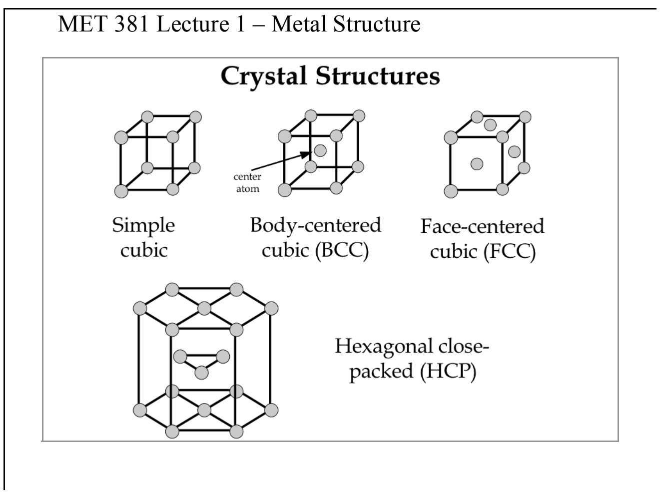


Figure 4: Portion of a handout from the second year of teaching, showing one of six slides on the page. The handout includes the entire content of the slide, but there is little room for annotation by the student.

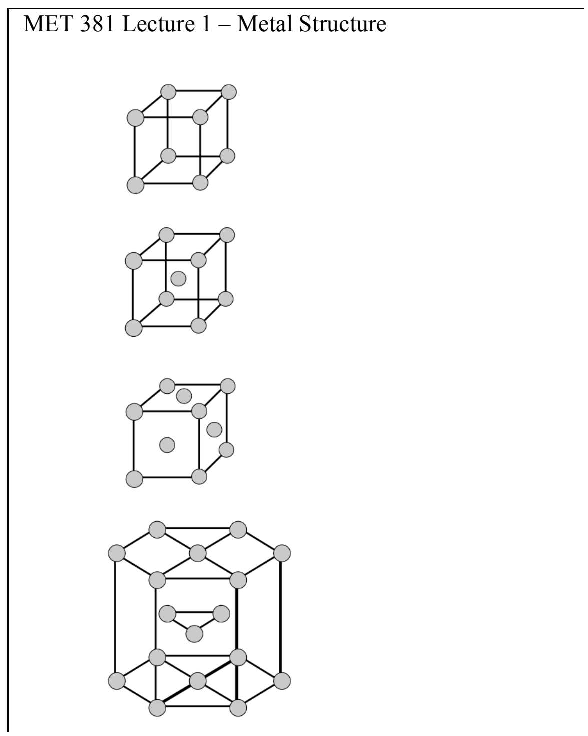
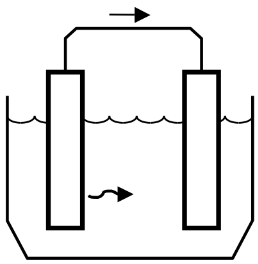


Figure 5: Portion of a handout from the third year of teaching, showing crystal structures in a column, with whitespace at the right for annotation.

MET 381 Lecture 3 – Physical properties

Galvanic Corrosion

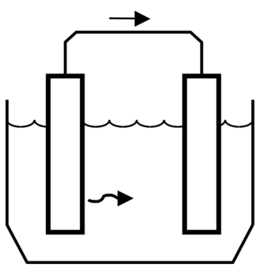


Anode

Cathode

Physical contact

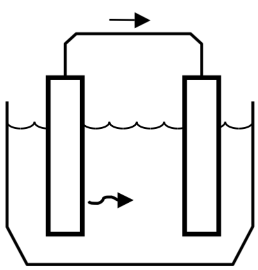
Electrolyte



$M \rightarrow M^{n+} + n\ e-$

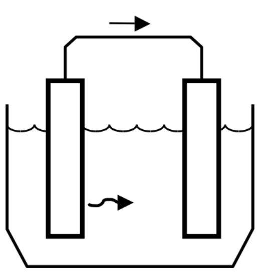
$M^{n+} + n\ e- \rightarrow M$

$2H^{+} + 2e- \rightarrow H_2$
$O_2 + 2H_2O + 4e- \rightarrow 4OH^{-}$
$O_2 + 4H^{+} + 4e- \rightarrow 2H_2O$



$Cu \rightarrow Cu^{2+} + 2\ e-$

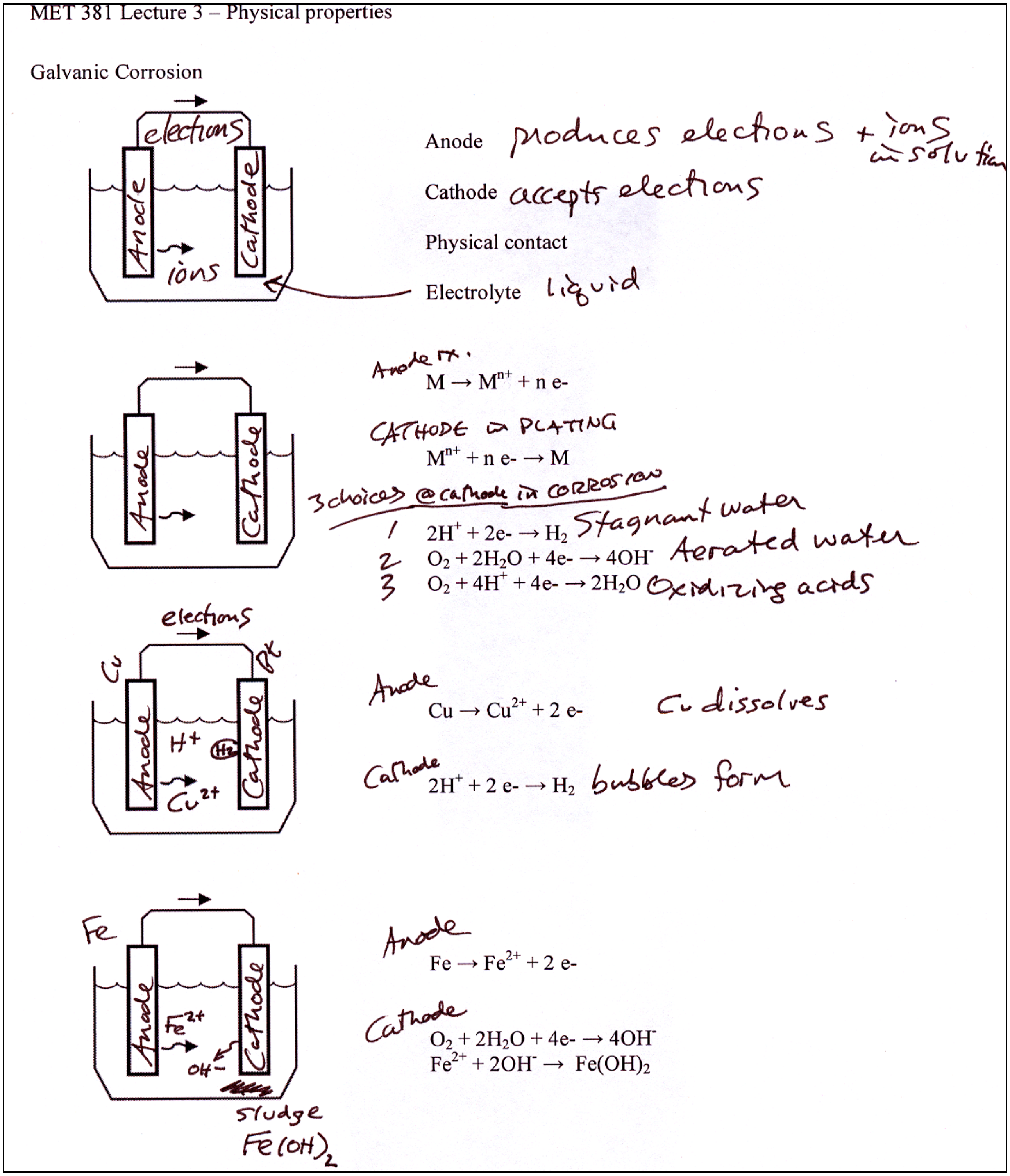
$2H^{+} + 2\ e- \rightarrow H_2$



$Fe \rightarrow Fe^{2+} + 2\ e-$

$O_2 + 2H_2O + 4e- \rightarrow 4OH^{-}$
$Fe^{2+} + 2OH^{-} \rightarrow Fe(OH)_2$

Figure 6: Full page from a 5-page handout from the third year of teaching. Diagrams of galvanic cells are accompanied by electrochemical equations. Students can label the anode, cathode, ions, precipitates, etc. Each diagram is a separate PP slide in the slideshow.



MET 381 Lecture 3 – Physical properties

Galvanic Corrosion

Anode produces elections + ions in solution

Cathode accepts elections

Physical contact

Electrolyte liquid

Anode rx.
M → M^{n+} + n e-

CATHODE in PLATING
M^{n+} + n e- → M

3 choices @ cathode in CORROSION
1 $2H^+ + 2e^- \rightarrow H_2$ Stagnant water
2 $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ Aerated water
3 $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ Oxidizing acids

Anode
$Cu \rightarrow Cu^{2+} + 2e^-$ Cu dissolves

Cathode
$2H^+ + 2e^- \rightarrow H_2$ bubbles form

Anode
$Fe \rightarrow Fe^{2+} + 2e^-$

Cathode
$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$
$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$

Figure 7: The galvanic corrosion handout from Figure 6 as it might appear after the lecture. The student has annotated the handout in the available whitespace, filling in labels that are present in the slideshow but omitted from the handout.

Figure 6 shows the entire page of a handout, with a series of diagrams requiring annotation. The electrochemical equations are provided, and students are able to add labels and notes to the diagrams as shown in Figure 7.

The chalkboard at the front of my classroom has an aspect ratio of 10:3, but the LCD projector has an aspect ratio of only 4:3. Sequential diagrams that can be drawn across a wide field of view on a chalkboard must either be displayed in quadrants of a screen, or on separate screens. For example, Figure 4 shows a slide for crystal structures. In the new handout format, the crystal structures are shown in a column, with whitespace at the right for notes, as in Figure 5. There is less text on the handout, so students can annotate the figures with labels, and they have room to take notes of the class discussion of calculating the number of atoms per unit cell. Some sequential slides, such as slide “builds”, are best displayed horizontally. A PP “build” sequence on the screen allows the instructor to gradually add lines, images, and text. Placing the intermediate images in a sequence on the handout helps students visualize the build long after they have left the classroom (Dupen 2005).

Converting the handouts from the old to new format took 1-2 hours per lecture. This conversion process also included minor revisions, and it served as a helpful review before the lecture.

Quantitative measures of improvement are difficult to obtain because there is only one semester of control group data for each course (i.e. the chalkboard lecture from the first year). Also, the courses continue to evolve from one semester to the next. However, informal student response has been positive. The last question of the final exam in each course asked students to suggest three course improvements. Almost all comments on slideshows were positive, and students seemed to appreciate the improved handout format.

I found the classroom experience to be much more interactive, after PP was introduced. Without the time pressure to finish writing on the board…and finish writing in notebooks, I had more time to talk *with* students, instead of *at* them. Students seemed to ask more questions in the PP classes than in the chalkboard classes, perhaps because asking questions did not result in the class ending late.

3. CONCLUSIONS

Several principles were followed in developing note-friendly handouts for slideshows:

1. Content is key. Handouts should not be prepared with canned software features that detract from the content (borders, titles, backgrounds, fixed slide sizes, fixed slide arrangements on the page, etc.).

2. Handouts should not be copies of the slides; they should be note-taking aids, with sufficient white space for annotation. Drawings, graphs, and lengthy mathematical formulas should appear on the handout. Labels should be left off, to encourage students to take notes.

3. Handouts should be designed for high-resolution laser printing, with different font sizes and line thicknesses than the slides. Font sizes should be consistent throughout the handout.

4. The time saved with slideshows and note-friendly handouts should be used to improve interactive learning, with Socratic question-and-answer and additional in-class demonstrations.

Slideshow technology does not, by itself, improve the learning process. Instead, it allows for the learning experience to become more interactive, because it frees up time for discussions and demonstrations.

Wisely constructed handouts are more time-consuming to create than the default PP handout format, but these improved handouts can serve as a notetaking aid, not a substitute for notetaking. Once students leave the university, they will be expected to make presentations in industry and government. Hopefully, presentation and handout design methods they are exposed to in school will carry on into their careers.

References

Dupen, Barry (2005). “Teaching Problem-Solving by Storyboard”, 2005 ASEE Conference & Exposition, June 2005. Conference proceedings, session 2568, paper #432.