



# Evaluating the benefits of adding interactive elements to traditional print mechanical engineering textbooks

## Ryan Barlow (Lead Content Author - Mechanical Engineering)

Ryan Barlow obtained his Bachelor's Degree in Mechanical Engineering from the University of Utah in 2012, his Master's Degree in Science Education from the University of Maryland in 2016 and his PhD in Engineering Education from Utah State University in 2020. He is currently a Lead Content Author - Mechanical Engineering with zyBooks, a Wiley Brand. His current work centers on transitioning traditional print textbooks to the online interactive zyBooks format, making engineering textbooks more accessible, and developing innovative online engineering assessment.

## Oscar Rios (Engineering Content Developer)

## James Eakins

## Adrian Rodriguez

Adrian Rodriguez is an Engineering Content Developer for zyBooks, a Wiley brand and a Lecturer in Mechanical Engineering at The University of Texas at Austin. His research interests include engineering education, multibody dynamics, contact and impact with friction, electro-mechanical systems, and nonlinear dynamics. He earned his B.S. degree in Mechanical Engineering from The University of Texas at Austin and his M.S. and Ph.D. degrees in Mechanical Engineering from The University of Texas at Arlington.

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## **Abstract**

Even before the COVID-19 pandemic changed the methods of course delivery for many universities to hybrid or online-only classes, engineering students did not tend to read the textbooks. Traditional print engineering textbooks are typically dense and filled with practical information, but it is often difficult to convey complex concepts using static figures. In order to give students a more beneficial experience, several professors began writing interactive online textbooks (zyBooks) from scratch for introductory computer science courses. These zyBooks included minimal text, with emphasis on conciseness balanced with preciseness. Rather than explaining through text, animations and learning questions were created. The purpose of these animations and learning questions was to allow the students to interact with the textbook instead of just reading static text. The company that these professors founded, zyBooks was purchased recently by Wiley, which made it possible to transform the existing print textbooks in the Wiley library, beginning with mechanical engineering textbooks, into the interactive online format instead of starting from scratch. For the first version of these new interactive textbooks (zyVersions), the text from the original print book remains mostly unchanged but interactivity was added in the form of animations and learning questions. The purpose of the animations was to clarify, add to, or replace the existing text, figures, or examples from the print textbook. These animations include dynamic figures, images, equations, and text instead of static visuals with which students cannot interact. The sets of learning questions were added not as a summative assessment, but to promote student learning as a formative assessment. Two of these zyVersions were adopted and used by approximately 1,200 students across 75 courses at over 50 different universities and colleges. Data was obtained on interactive participation activities to understand student usage, student struggle, and student earnestness. This data is in the form of several metrics: the percentage of first time wrong, the number of tries until correct, the time spent, the percentage of students that struggle, and the percentage of students that give up. Preliminary results show that students are engaging with animations and learning questions in the current interactive online engineering textbooks. Qualitative data was also obtained in the form of a student survey and feedback on the effectiveness of the interactive elements from students and professors.

## **Introduction**

Traditional print engineering textbooks have been the main reference source for material in engineering classes. But, the use of online, or electronic, textbooks is slowly gaining more acceptance in place of print textbooks. Print textbooks are limited by static figures and examples to convey complex concepts, whereas technological capabilities enable electronic textbooks to add interactivity, like animations and learning questions. Comparisons between print and electronic textbooks have been studied in the literature to evaluate preferences and student attitudes [1]-[3]. For example, [1] found that student perceptions and attitudes toward technology were higher, or more positive, than print textbooks. It was observed that students completed more learning activities and were engaged in the classroom. Similarly, [3] examined the impact between print and e-textbooks and concluded that students preferred the shorter reading and participation activities in e-textbooks. The data collected on student attitudes yielded a

mixture of positive and negative results, but the authors used it to propose methods for using the e-textbook more effectively in the future.

After gaining acceptance among students, it is key to ensure the quality of electronic textbooks matches or exceeds that of print textbooks. The effectiveness of electronic textbooks is a means for justifying the switch from a print textbook to an electronic textbook. In [4], the authors found that comprehension was the same when comparing the use of hyper-references in electronic resources vs. conventional dictionaries. But, the development of technology capabilities in the last 20 years has expanded the types of learning tools that are available to help improve comprehension. For example, multimedia and learning activities in electronic textbooks offer new and engaging methods of delivering information to students [5]. These methods are simply not available in print materials with static information. Yet, some researchers express doubts that these tools are effective. A multiple year study in higher education found that while usage of e-textbooks has increased, e-textbooks are not always more effective [6]. The authors mention that further study is needed to answer questions regarding the role of the instructor and the availability of digital materials. Even though the literature is not in complete agreement, the results of other studies highlight the potential of electronic textbooks when interactivity is included. For example, it was found that interactivity in an engineering textbook provided students with the opportunity for more practice and led to higher grades [7].

Interactivity is the ability for a textbook to respond to a student's input and show dynamic content. Several works have explored different multimedia tools to engage student learning [2], [8]-[9]. In [2], an extensive set of tools were implemented in an e-textbook, such as demo videos, animations, hyperlinks, and detailed color drawings. The author concluded that these tools helped improve student usability and material visibility, allowing students to interact with content more easily. The interactivity that the present work aims to include in online engineering textbooks comprises two features, namely, animations and learning questions as used in [3], [10]. The animations convert concepts from the text and static figures into dynamic content. The addition of reactive elements in an e-textbook is popular among students and can help develop a visual sense of complex content [11]. The learning questions are designed to create an active reading environment that checks a student's understanding of the text. Each question provides students with an explanation for both correct and wrong answer choices, taking the opportunity to address common misconceptions, simple mistakes, and real-world application examples [12]-[13]. The completion rate for animations (e.g. a student watched all animation steps) and learning questions (e.g. a student attempted all questions until a correct answer is achieved) is recorded by the platform. Additional data about the learning questions, like number of tries and time spent is tracked to draw conclusions about student struggle and give up rates. The details of the content development process are discussed in the next section and followed by the methods used to obtain feedback from students and professors about the interactive content.

### **Adding Interactive Content**

In response to declining student usage of traditional print textbooks, several computer science professors started a company, zyBooks, and began to create online interactive textbooks from scratch for introductory computer science courses. These online textbooks were divided into chapters, sections, and subsections. Each subsection followed a say-show-ask format. The say section is composed of 1-2

paragraphs of short and concise text that introduces the topic of the subsection to the student and generally includes one or two definitions of key concepts and at least one real world example. Following the say section, the show component includes an interactive animation that is used to both visually demonstrate and enhance the main points in the say section. Lastly, the ask component of the subsection allows students to test their knowledge of the concepts via multiple choice, true and false, matching, or short answer questions. Because the questions provide explanations, the ask section can also be used for additional learning. The say-show-ask format has proven to be very effective in teaching computer science and introductory courses, as the company has experienced continued success.

The company that these professors started was later purchased by a larger, well-established publishing company (Wiley) that had a large selection of historically successful traditional print textbooks. This new situation presented the opportunity to use the print textbooks as a starting point, rather than starting from scratch, beginning with adding interactivity to two mechanical engineering textbooks in materials science and control systems. For the first version of these new zyVersions, the say-show-ask pedagogy was implemented to add interactivity to the two books. While the text from the original print books remains mostly unchanged and is used as the say section, interactivity was added in the form of animations and learning questions (e.g. show and ask sections). The animations that were added to the zyVersions are composed of dynamic images, equations, text, and other interactive visual elements. The learning questions that were added are in multiple formats including multiple choice, true/false, short answer, and matching.

The control systems textbook that was converted into the online interactive format was previously available both in print and digitally to users. While the digital format of the controls textbook was available for online viewing, the digital experience, for both student and professor, has been greatly improved through the addition of animations and interactive question sets. The previous digital version of the control systems textbook included links to an outside webpage where student resources required the students to successfully read and follow along with the text that was included. Such resources included appendices with derivations for equations, instructions on using software, and solutions to key exercises throughout the book. While the resources are very useful, they normally require the student to jump through several webpages before getting to the needed document. To ease the process for the student, all appendices have been directly embedded as new chapters in the zyVersion. Therefore, what used to be called appendix A1 and available only via the student resources webpage, is now Chapter 14 in the zyVersion. Solutions to exercises, both at the end of the chapter and within the text, have also been fully integrated, which includes the capability for professors who adopt the book to have control over which solutions the students can view and when.

In addition to integrating the available resources, the say-show-ask pedagogy has been implemented into the text with almost every subsection within the book being modified to follow the say-show-ask pedagogy. Since the textbook was already written, the say section was simply the original text with very minor modifications. To show the student how to apply the concepts just described in the say section, interactive animations and example problems were used. The interactive animations were 5-8 step animations that visually demonstrated the concepts in the say section or demonstrated the procedure to solve a problem. For example, the say section could introduce the root locus sketching techniques, and an animation would show the student exactly how to apply those rules to a given system in a step-by-step

process. Every step in the animation includes a concise caption describing what is occurring in the animation. In addition to the animations, the example problems in the original textbook were also included to further show the student how to apply the concepts. If both an animation and example problem was used in the show section, both were used to solve similar but different problems to increase student exposure to different scenarios. With the animations implemented, the professors who adopt the new interactive textbook are able to see the percentage of students that have gone through all steps of the animation and can assign points to encourage reading before class or exams.

After the student has progressed through both the say and show sections, the ask section acts as a formative assessment and includes either multiple choice, short answer, true and false, or matching questions. For the controls textbook, most ask sections include short answer questions that walk students through a lengthy problem. With short-answer questions, the student has to type in a solution in the space provided. If the answer is incorrect, the student is given a hint that should lead them to the right answer. If the student can not figure out the solution on their own, the student can click on the “show “answer” button where the answer, along with an explanation, is presented. As an example, following the say-show section of sketching a root locus, the short answer question walks the student through another example by asking for the number real-axis segments, the number of infinite zeros, asymptotes-real intercept and angle.

The materials science and engineering textbook is well established and widely used as both a reference book and teaching text. Because of this wide usage, special care was taken to ensure that the written text itself was not altered in such a way that would change any meaning. One tactic employed was converting descriptions of figures directly into animations. For example, a paragraph may describe a topic, followed by a paragraph used to describe a figure, then the figure is shown with a description, followed by a paragraph with further clarification, then a written follow up or example. In the new interactive textbook, the figure description and clarifications are used as a basis for each step of an animation based on the figure. This shift allows students to visually break down key points of a complicated figure while learning material for the first time, while a quick glance of the final animation step from an experienced user contains a concise description that does not require flipping between different pages or scrolling up and down. In addition to replacing static figures with animations, the example and design problems that were included in the print textbook have been converted to animations. A user learning the material for the first time can have a step-by-step walkthrough for a real world problem to help their learning process, and an experienced user will not be slowed down as all of the information is included in one final image. Additionally, the text often describes very visual systems that do not have figures attached. While the descriptions are excellent for users that can easily form the images in their heads, the extra step of imagining a system while learning for the first time can take longer for the information to sink in, and is even harder for users that struggle with mental imagery. Because the zyVersion allows for the animations to show the systems, learning is made easier. For example, a material's hardness has multiple tests that can be used. An animation showing the general format of each test helps users identify key similarities and differences between each test, while the text and questions solidify more subtle comparisons.

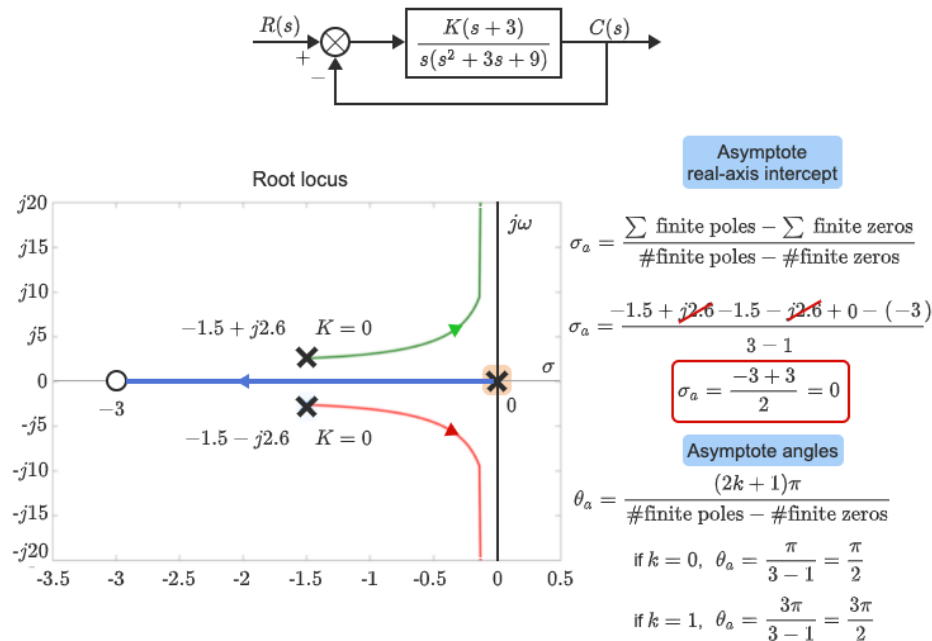
Since the primary goal is to enhance student learning, learning questions were added as a formative assessment that adds to the learning experience rather than a summative assessment to assess the user's current knowledge. Each question was designed to help guide a learner to fully understand key concepts,

and precisely why common misconceptions are incorrect. Each option was created to specifically target these common misconceptions. Incorrect responses include a description that is shown after selection, helping to explain misconceptions and lead learners to a correct response. The correct responses also include an explanation of why the response is correct. These learning questions increase the critical learning of the material, rather than assessing a learner's 'factual knowledge'.

### *Animations*

The purpose of the animations that have been added to the online interactive engineering textbooks is to clearly illustrate concepts where a static image is insufficient to fully describe the concept. The animations emphasize key concepts by allowing the students to go through the animation step by step from beginning to end, after which it is possible to replay parts of the animation. Before a student starts the animation, an image of the animation as it appears after the final step is displayed. This allows the animation to function as a figure if a student is re-reading through a chapter. Furthermore, the final step of the animation should be able to be read on its own and still illustrate the concept. Every step of the animation is supplemented with a text caption. These captions supplement the animation actions with a clear and concise explanation. Each caption is displayed at the bottom of the animation while the relevant step is playing and all captions can be displayed below the animation even before the animation starts so that the captions can also be used as a reference without watching the animation for students who are reviewing the content. When creating the animations, a general layout of the animation is created first, along with creating/editing the necessary graphics. Often the original figures and pictures from the textbook are insufficient, low-quality, or too complex. If that is the case, then the original graphic is replicated. Animations typically try to keep the graphics simple. For example, they have sparse use of colors, are stripped of any extraneous graphics, and animation steps are explicit and performed one at a time. To help students better understand where variables and values are coming from in animations that deal with equations and math, a duplicate of the value or variable moves into the equation from its original location.

The animation below from the Control systems interactive book showcases the process of sketching a root locus. While this information and process is normally presented in a list format by a textbook, the animation below walks the students step by step through the root locus sketching process using an example. The animation provides the students a visual presentation of the same material found in the text, but is able to unveil, highlight, and move elements in a manner that connects the different elements presented. The animation steps involved in the animation below are shown in Appendix A.

Start  2x speed

Captions ^

1. This system has negative unity feedback and gain  $K$ . The effect of  $K$  on the system and the location of poles is determined using a root locus.
2. The open-loop poles and zeros are placed in the  $s$ -plane to start the root locus sketch. The system has a zero at  $s = -3$ , and three poles:  $s = \{0, -1.5 \pm j2.6\}$ .
3. A single pole-zero pair on the real axis implies one real-axis segment, from the pole  $s = 0$  to the zero  $s = -3$ .
4. With one finite zero and three finite poles, the system must have two infinite zeros, and thus two asymptotes pointing towards the infinite zeros. The real-axis intercept of the asymptotes is  $\sigma_a = 0$ .
5. The first asymptote angle  $\theta_a = \pi/2$  comes from setting  $k = 0$  in the formula. The second angle  $\theta_a = 3\pi/2$  for  $k = 1$ .
6. The branches start at open-loop poles  $s = -1/5 \pm j2.6$  when  $K = 0$ , and approach the infinite zeros along the asymptotes as gain  $K$  grows.

Feedback?

Figure 1. Animation static image of a Control Systems animation shown to students prior to pressing start.

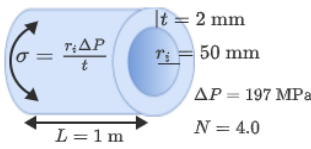
The animation from the Materials science book, whose final static image is shown in Figure 2, showcases a conversion of an example problem to an animation. In-text example problems are designed to show a student how to solve a problem in a linear fashion. However, question statements can be lengthy by nature of needing to completely describe a situation, and somewhat confusing to a student, increasing overall cognitive load. The animation essentially breaks up the original problem statement into three steps to help the student visualize what the situation is, what parameters are involved, and what value is to be solved for. The table utilized for solving the problem is also shown because the table is used for two stages of problem solving (determining first which materials fit the safety parameters, then determining the cost for those materials if used). As the animation progresses, information on the table is highlighted, helping students to visualize exactly how the table is being used in a problem. The second table is created from calculations made during problem solving, with the solution to the overall problem highlighted in the



same color as other solutions in the book for consistency. Similar to other animations, the mathematical process unveils and shows values moving from the image to the equations to reinforce which values are related to each variable in the equations. Rather than having images, tables, and process explanations in different areas of the example solution, the animation shows the process using all three in a clear way, preventing students from being confused between values given, calculated, or inferred from a table. The animation steps involved in the animation below are shown in Appendix B.

**PARTICIPATION ACTIVITY** | 6.12.2: Material selection at lowest cost for a pressurized cylindrical tube (Design Example 6.2 in original text).

**Start**  2x speed



$\sigma = \frac{r_i \Delta P}{t}$   
 $\Delta P = 197 \text{ MPa}$   
 $L = 1 \text{ m}$   
 $N = 4.0$

$\sigma_w = \frac{r_i \Delta P}{t}$   
 $\sigma_y = N \sigma_w$   
 $\sigma_y = N \frac{r_i \Delta P}{t}$   
 $\sigma_y = (4.0) \frac{(50 \times 10^{-3} \text{ m})(1.97 \text{ MPa})}{2 \times 10^{-3} \text{ m}} = 197 \text{ MPa}$

$V = AL = \pi(r_o^2 - r_i^2)L$   
 $V = \pi((r_i + t)^2 - r_i^2)L$   
 $V = \pi(r_i^2 + 2r_i t + t^2 - r_i^2)L$   
 $V = \pi(2r_i t + t^2)L$   
 $V = \pi[(2)(50 \times 10^{-3} \text{ m})(2 \times 10^{-3} \text{ m}) + (2 \times 10^{-3} \text{ m})^2](1 \text{ m})$   
 $V = 6.28 \times 10^{-4} \text{ m}^3 = 628 \text{ cm}^3$

$Cost = \left( \frac{V \rho}{1000} \right) \bar{c}$   
 $Cost_{(steel)} = \left( \frac{(628 \text{ cm}^3)(7.8 \text{ g/cm}^3)}{1000 \text{ g/kg}} \right) (1.25 \text{ \$US/kg})$   
 $Cost_{(steel)} = \$6.10$

Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$US/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

Alloy	Cost (\$US)
Steel	6.10
Copper	35.00
Brass	40.00
Titanium	113.00

Captions ^

1. A thin-walled cylindrical tube having an inner radius  $r_i = 50 \text{ mm}$  and wall thickness  $t = 2 \text{ mm}$  is to be used to transport pressurized gas.
2. The change in inside to outside pressure is  $\Delta P = 197 \text{ MPa}$ . The hoop stress due to pressure for the tube is  $\sigma = \frac{r_i \Delta P}{t}$ .
3. For a safety factor  $N = 4.0$ , a table of material yield strength, density, and cost per mass can be used to determine a low-cost material to build the tube.
4. To safely transport the gas, the likelihood for plastic deformation must be minimized. So, the working stress,  $\sigma_w$ , is used as the hoop stress.
5. Since the yield strength,  $\sigma_y$ , is related to  $\sigma_w$  and the safety factor, an expression for the yield strength in terms of the safety factor and hoop stress is found.
6. Using the values for  $N$ ,  $r_i$ ,  $\Delta P$ , and  $t$ , the minimum yield strength is  $\sigma_y = 197 \text{ MPa}$ . Steel, copper, brass, and titanium have higher  $\sigma_y$ , and thus meet the functioning criteria.
7. The volume for the tube is needed to determine cost. The tube's cross-sectional area,  $A$ , is found using the difference between the squares for the outer and inner tube radii. The tube volume is  $V = 6.28 \text{ cm}^3$ .
8. The cost to build the tube is equal to the material needed for tube volume,  $V$ , times material's density,  $\rho$ , times the unit mass cost,  $\bar{c}$ . Adjusting for units, steel's cost to build the tube is \$6.10.
9. The cost for making a tube is calculated for each material that meets the design criteria. Comparing the costs, steel is the least expensive material for the design.

[Feedback?](#)

Figure 2. Animation static image of a Materials Science animation shown to students prior to pressing start.

A key topic in Materials Science is the description of crystal structures within a material on the atomic level. Because the structures are three-dimensional, 2-D representations are not always clear as to where atoms are located. In a traditional textbook, these images and descriptions can be confusing to students due to the 2-D limitation. The Virtual Materials Science and Engineering (VMSE) resource below is used to show a 3-D representation of crystal structures that a reader can manipulate. Using the VMSE, readers can get a better physical sense of where atoms are located in a crystal structure. Additionally, the toggle from reduced sphere to full sphere representation helps readers keep track of where atoms are in comparison to various rotations that static images in the traditional text book may not be clear on.

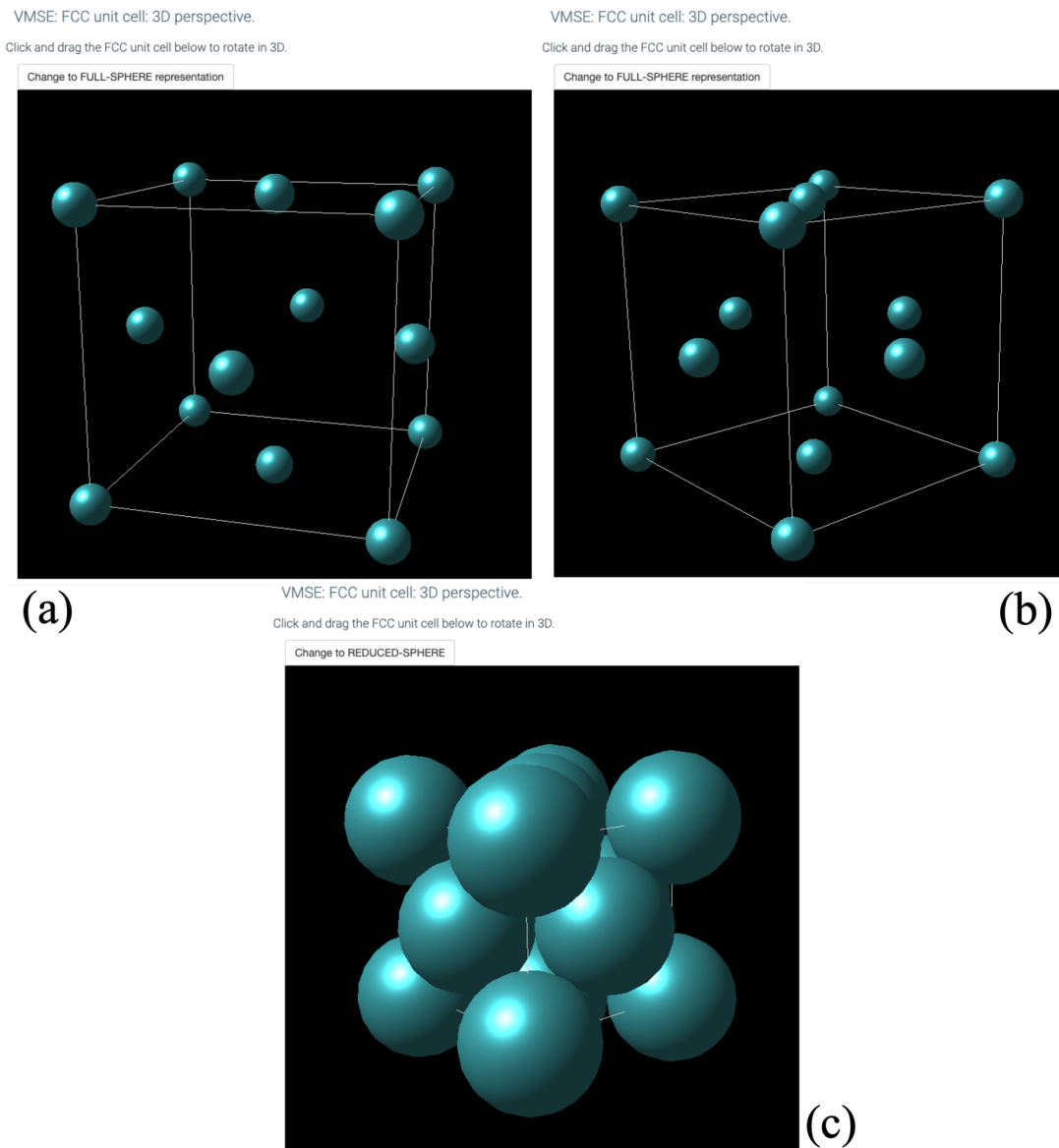


Figure 3. The VMSE resource in the Materials Science book of an FCC unit in a) reduced sphere form b) rotated reduced sphere form, and c) full-sphere form.

## *Question Sets*

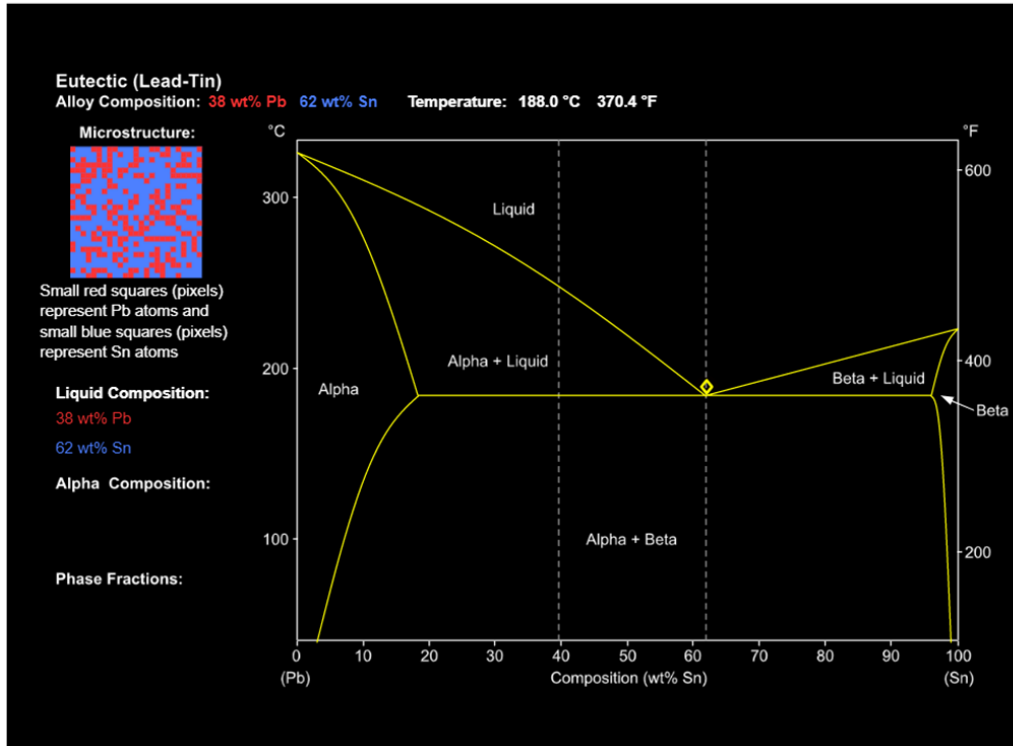
In the first round of converting the traditional print mechanical engineering textbooks into interactive textbooks, question sets were implemented throughout nearly every section in every chapter. The question sets serve as a formative assessment, providing students feedback after reading a section or subsection within a chapter. Three different types of question sets were used throughout the conversion of both the Materials Science and Control Systems books: multiple choice, matching, and short answer questions. Although True/False questions are also an available question type, they do not provide as much feedback to the students and were therefore only used sparingly in the two interactive textbooks. Below are examples of the other three question types and how they were implemented throughout the books.

The following resource and multiple choice question set are from the Materials Science book in a chapter about phase diagrams. The Virtual Materials Science and Engineering (VMSE) resource below shows an interactive phase diagram. By selecting a point on the graph, the material's microstructure at that composition and equilibrium temperature is shown. Each region on the graph has a defined microstructure, and changing the equilibrium temperature (y-axis) visually shows the microstructure changes. Additionally, the composition for the liquid and alpha phases are given, along with the phase fractions.

VMSE resources can help a student build intuitive understanding for phase diagrams and changes in those diagrams, compared to memorizing points on a static graph without associated changes between points. However, in a standard textbook, the VMSE is disjointed from the physical textbook at a separate website, and doesn't encourage reader use beyond a website link. Here, the resource is integrated into the zyVersion directly, so that there is no question as to which section/information the resource is related to. Additionally, because the resource is interactive, questions can be asked about the resource to reinforce understanding of the material in the chapter and section.

Since this is the first instance of this particular VMSE, questions are designed to help students initially navigate the new tool, while also reinforcing concepts discussed in the section's animations and text. Questions are designed to prevent students from falling into common traps, like conflating primary alpha formation with eutectic formation. Also, not every question is focused on specific numeric values, allowing for general trends in the graphs to be learned that apply universally without adding a numerical load that may not apply to other phase diagrams.

VMSE: Eutectic (Pb-Sn).



PARTICIPATION  
ACTIVITY

9.12.7: Cooling comparison for different eutectic compositions.

Use the VMSE resource above for the following questions for cooling in the lead-tin phase diagram.

1) During cooling from a high temperature liquid phase, the 40 wt% Sn alloy forms \_\_\_\_ before the 62 wt% Sn alloy.

- $\alpha$   
  $\beta$   
 eutectic structure

Correct

The  $\alpha$  begins to form at about 246° C, as the alloy composition lowers to be into a  $\alpha$  + Liquid region.

2) At 181° C, the 40 wt% Sn alloy has \_\_\_\_ amount of eutectic structure compared to the 62 wt% Sn alloy.

- a larger  
 an equal  
 a smaller

Incorrect

While both compositions have formed eutectic structures, the eutectic structure amount is not equal. In the 40 wt% Sn alloy, some liquid has already transformed into primary  $\alpha$  before reaching the eutectic line. Because there is less liquid available, less eutectic structure will form in the 40 wt% Sn alloy compared to the 62 wt% Sn alloy

3) During cooling after a eutectic reaction, the primary  $\alpha$  composition \_\_\_\_, while eutectic  $\alpha$  composition \_\_\_\_.

- changes, stays constant  
 stays constant, changes  
 changes, changes

Incorrect

The primary  $\alpha$  stays constant during a eutectic reaction, and afterwards as cooling continues. If the primary  $\alpha$  grains changed after a eutectic reaction, there would be no advantage in heat treatments to get the grains.

Feedback?

Figure 4. A multiple choice question set taken from the Materials Science interactive book. The multiple choice question set uses the VMSE interactive plot above.

In Materials Science, key terms and jargon vocabulary can quickly overwhelm students. As a way to help students retain information along the way, matching question sets, as shown below, are used to encourage retention of key terms and concepts by chunking the information throughout a chapter. In the matching question set shown in Figure 5, students can match key terms to the term definition and usage. Once a student chooses the correct term that matches a definition, an additional explanation is provided. Unlike with the multiple choice question format, explanations are not provided for incorrect responses. An additional feature of the matching question type allows for students to reset the question to practice matching the terms as many times as wanted.

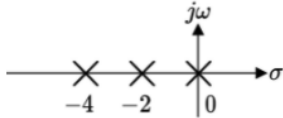
The screenshot shows a web-based interface for a matching activity. At the top, it says 'PARTICIPATION ACTIVITY' and '2.6.10: Primary bonding types.' There are two tabs: 'Bond hybridization' and 'Covalent bonding'. Below the tabs, there are four rows of items to be matched. The first row has 'Ionic bonding' on the left and a definition on the right: 'A valence electron is transferred from a metal atom to a nonmetal atom. An ionic bond is formed when an atom transfers a valence electron to another atom. The resulting oppositely charged ions are bonding by an attracting coulombic force.' This row is marked as 'Correct' with a green vertical bar. The second row has 'Metallic bonds' on the left and a definition: 'Two elements with similar electronegativity share at least one electron each.' This row is marked as 'Incorrect' with a red vertical bar. The third row is empty on the left and has the definition: 'The mixing of two or more atomic orbitals'. The fourth row is empty on the left and has the definition: 'Electrons exist in an electron cloud and are not bound to a single atom'. At the bottom right, there is an orange 'Reset' button and a blue 'Feedback?' link.

Figure 5. A matching question set taken from the Materials Science interactive book.

The question set shown in Figure 6 below showcases a short answer question set. A short answer question set allows the student to input an answer as either a numerical value or variable expression. As shown in Figure 6, to the left of the input box is an example expression (Ex: 4). The example expression allows the authors to indicate to the student the type of answer needed (numerical vs variables) and the number of significant figures expected. After inputting an answer, the student can select "Check" to check if the answer is correct or incorrect. If a student inputs an incorrect answer, as shown in question 1 in Figure 6, the student receives a hint that guides them to the correct answer explanation. If the student inputs the correct answer as shown in question 3 below, the student still gets an explanation and an image as to why the answer is indeed the right choice. If the student is unclear and simply wants to see the answer, the student can select "Show answer". After pressing "Show answer" once, the student will get the message "Press again to show the answer" as shown in question 2 below. After selecting the "Show answer" button a second time, the student receives the correct answer and the correct answer explanation. To receive credit for the question, the student will still need to input the correct answer in the input box.

Given these pole-zero plots for unity feedback systems...

1) The root locus has \_\_\_\_ real-axis segments.



Ex: 4

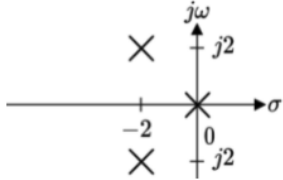
Check

Show answer

**Incorrect**

The real-axis root locus segments lie to the left of odd numbers of poles and/or zeros.

2) The root locus has \_\_\_\_ real-axis segments.



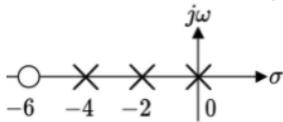
Ex: 4

Check

Show answer

Press again to show the answer.

3) The root locus has \_\_\_\_ real-axis segments.



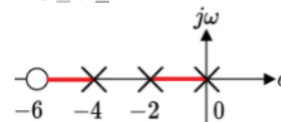
Ex: 4

Check

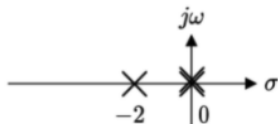
Show answer

**Correct**

The real-axis root locus segments lie to the left of odd numbers of poles and/or zeros. With these three poles and one zero, one segment is  $-2 \leq s \leq 0$ , and another segment is  $-6 \leq s \leq -4$ .



4) The root locus has \_\_\_\_ real-axis segments. The poles below at 0 are repeated.



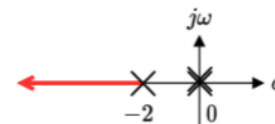
Ex: 4

Check

Show answer

**Answer**

The real-axis root locus segments lie to the left of odd numbers of poles and/or zeros. With two out of three poles repeated, only one real-axis segment is needed from  $-2$  to  $-\infty$ .



Feedback?

Figure 6. A short answer question set taken from the Control Systems interactive book.

## Data Collection Methods

In order to evaluate the two new online interactive engineering textbooks, particularly the added interactive elements, data was collected in three different ways. Each interactive element, in addition to the static figures, includes a feedback button, which allows students and professors to provide feedback, including reporting bugs. This feedback is sent to the support team and occasionally to the content developers to address. Any urgent bugs are fixed immediately and pushed into the active book. Other less urgent feedback is still addressed, but is not added to the live book until the subsequent release, which occurs every six months.

In addition to the feedback buttons on interactive elements, data was obtained on the usage of the interactive elements, in particular the learning question sets. The data from the learning questions includes:

- Number of users: The number of students who completed the exercise.
- Average number of tries (until correct): Of students who completed the exercise, the sum of each student's number of tries until they answered the question correctly divided by the total number of students.
- Average time spent: Of students who completed the exercise, the sum of each student's time spent in seconds divided by the total number of students.
- Average first time wrong: Of students who worked on the exercise, the sum of the students who answered a given level of the exercise wrong, divided by the total number of students.
- Strugglers rate: The percentage of struggling students. A struggling student is a student who:
  - Spends more than 15 minutes on a single level of the exercise, or
  - Spends more than 5 minutes on a single level, spends more than at least twice as much time as the top 20% students, tries more than 3 times in a single level, and tries at least twice as many times as the top 20% students in a single level.
- Gave up rate: The percentage of students who gave up on that specific exercise. These are students who have some activity recorded in that exercise, but they never successfully completed the activity.

This data was used to measure student usage, student struggle, and student earnestness for the purpose of evaluating how the students interacted with the question sets that have been added to the two engineering textbooks and to better understand the effectiveness of the interactive question sets.

Feedback was also collected from a survey that was sent after the end of the Fall 2021 Semester to professors and students who used either the online interactive control systems textbook or the online interactive materials science and engineering book. The survey for professors included questions comparing the online interactive versions of the textbook to other versions of the book, rating the quality and quantity of the new interactive elements of the zyVersion, and whether professors would continue using the online interactive version of the textbook. Professors were also asked to write things they like and disliked about the online interactive version of the textbook and any recommendations to include in the online interactive version. The survey for students included asking how the zyVersion compared to

other digital learning systems, whether they would recommend the zyVersion to other students, and what could be improved in the zyVersion.

## Results and Discussion

The first release of the two zyVersions had coverage of all chapters for question sets and priority chapters for animations. Additional animations and question sets were recently released, but will not be used by professors and students until the Summer or Fall of 2022. The data obtained from the professors and students was for the first release. The first release of the control systems interactive book had a total of 67 animations and 218 question sets with a total of 750 questions. The first release of the materials science and engineering interactive book had a total of 186 animations and 339 question sets with a total of 880 questions. The materials science and engineering interactive book also included over 100 VMSE resources embedded in the text.

Rather than presenting the usage data for each question, Table 1 below shows the average of each of the metrics for all questions included in the first release of the control systems interactive textbook and the materials science and engineering interactive textbook.

Table 1. Student Usage Data for Question Sets in the Control Systems and Materials Science and Engineering zyVersions

Data type	Control Systems	Materials Science and Engineering
Number of users	95.9	119.5
Number of tries until correct	1.60	2.1
Average time spent	17.69	10.6
Average first time wrong	32.21%	57.6%
Strugglers rate	0.43%	0.06%
Gave up rate	0.14%	0.04%

The average number of users for each book seems low compared to the total number of students who used each textbook because, particularly in the materials science and engineering textbook, some chapters are used more frequently than others, some professors did not require the students to purchase the interactive version of the textbook, and even professors who did require the students to purchase the interactive version of the textbook may not have included the use of the interactive elements (animations and question sets) in the students' final grades. However, the students who did use the interactive version of both textbooks clearly interacted with the question sets. Even though the average number of tries for the question sets in both books was greater than 1 and the percentage of first time wrong answers was relatively high for both books, less than 1% of students who used each book struggled on average for all questions and less than 0.2% of students gave up on average for all questions. This data shows that even



though students tried multiple times to get correct answers, they did not tend to give up after getting the question wrong.

For the control systems interactive textbook, 11 instructors and 67 students responded to the survey. Figures 7-10 below show a summary of the instructor responses. Out of the 11 professors who completed the survey for the control systems interactive textbook, 6 said they either strongly agree or agree that the interactive version of the book is more effective than other versions in getting students to read before class, 10 said the interactive version is more effective in getting students more engaged, 9 said the interactive version is more effective in helping students understand concepts better, and all 11 said the interactive version is more user friendly as shown below in Figure 7. Figure 8 shows that only 1 professor said that the learning questions did not contribute to student success, but all 11 said that the animations contributed to student success with 6 out of the 11 saying that the animations were excellent. The professors did not have any negative responses about the quantity or quality of the animations and learning questions. As can be seen in Figure 9, only 1 professor said that the interactive version did not help students prepare for class. All other professors either agreed or were neutral for all other questions shown in Figure 9. Figure 10 shows that 100% of the professors who completed the survey said that the interactive version of the book is either better or significantly better than other textbook formats that they have adopted for the course. Out of the 11 professors who completed the survey, 9 either strongly agree or agree that they will continue to use the interactive version of the textbook for the course. The other two professors responded with 'neutral'.

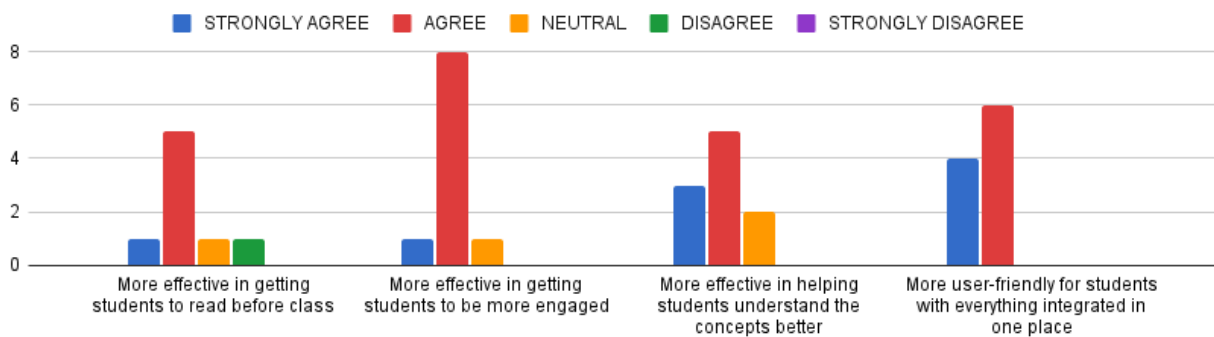


Figure 7. Instructor responses for the control systems book to the question prompt, "Please rate the statements below about the effectiveness of the online interactive version compared to other versions of the text."

Please rate the following statements:

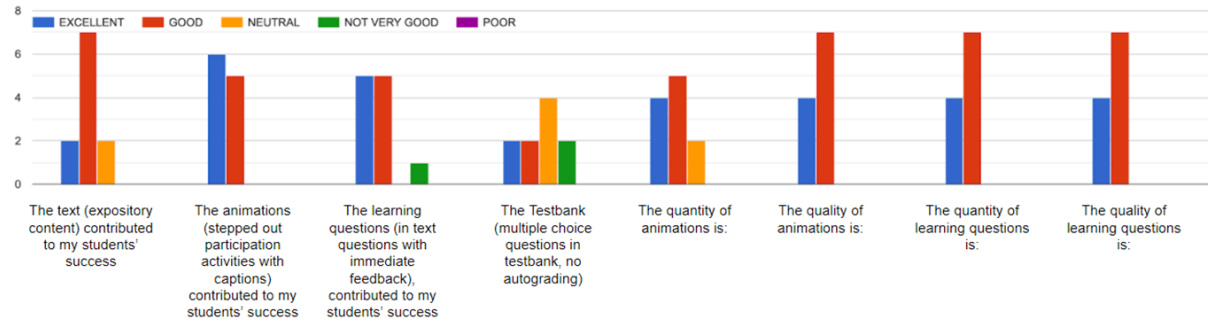


Figure 8. Instructor responses for the control systems book to the question prompt, "Please rate the following statements."

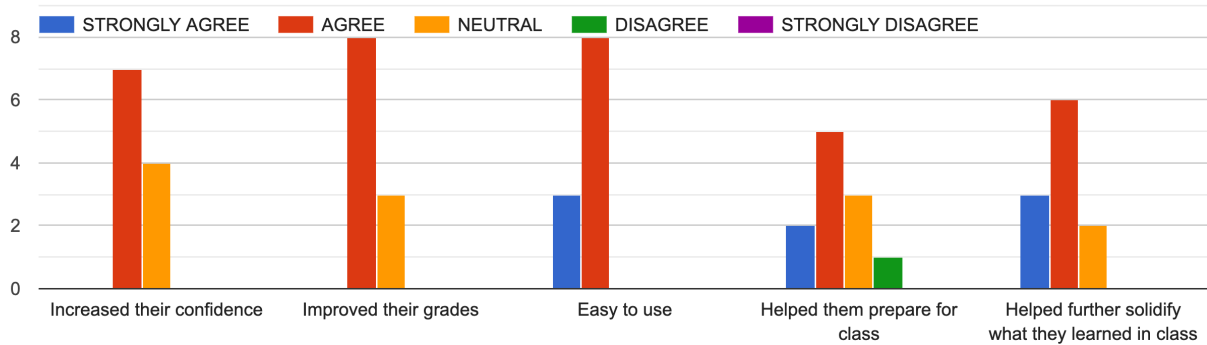


Figure 9. Instructor responses for the control systems book to the question prompt, "How well do the following statements apply to your students' experiences with the online interactive version?"

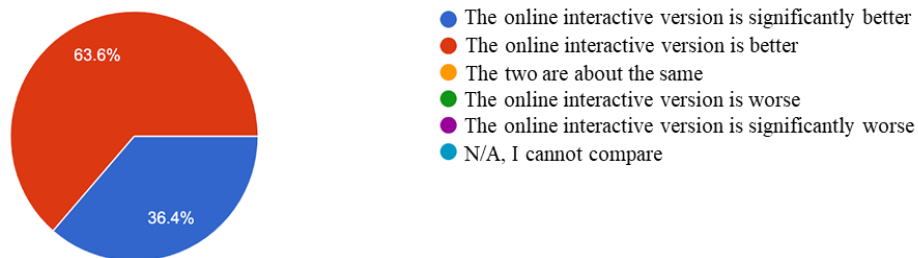


Figure 10. Instructor responses for the control systems book to the question prompt, "How does the online interactive version compare to other textbook formats that you have adopted for this course?"

Professors were also asked to list things they liked and disliked about the interactive version and provide recommendations to improve the interactive version of the control systems textbook. Animations and participation activities (both animation and question sets are considered participation activities) were both listed as likes. Some of the things the professors disliked included problems with the end-of-chapter questions, the lack of a testbank, and a negative browser experience for a particular section that wouldn't

load. Recommendations for the control systems book included adding the ability to export to a high-quality pdf for viewing offline, integrating software, and adding more problems.

Students were asked how the experience of using the interactive version of the control systems book compared to other digital learning systems. Out of the 67 students who completed the survey, 24 responded with 'much better', 24 responded with 'better', 8 students responded with 'about the same' and only 3 students said the interactive version was worse than other digital learning systems. Students were also asked about their likelihood of recommending the interactive version. Of the 61 students who responded to this question, 51 gave a likelihood greater than 5 (10=16 students, 9=12 students, 8=11 students, 7=7 students, 6=5 students). The 10 students who gave a likelihood less than 6 were asked what could be improved. The responses included adding videos and improving the user interface. Some students also preferred having a PDF or a print version of the textbook.

For the materials science and engineering interactive textbook, 13 instructors and 66 students responded to the survey. Figures 11-14 below show a summary of the instructor responses. Out of the 13 professors who completed the survey for the materials science and engineering book, 8 said they either strongly agree or agree that the interactive version of the book is more effective than other versions in getting students to read before class, 9 said the interactive version is more effective in getting students more engaged, 9 said the interactive version is more effective in helping students understand concepts better, and 10 said the interactive version is more user friendly as shown below in Figure 11. Figure 12 shows that all of the professors who answered the questions either strongly agreed, agreed, or were neutral about the student experience using the interactive version of the materials science and engineering textbook. Figure 13 shows that 10 out of 13 professors said that the interactive version of the textbook is either better or significantly better than other textbook formats. Also, 9 out of 13 professors said that they either agree or strongly agree that they will continue to use the interactive version of the textbook, with the other 4 professors responding with 'neutral'.

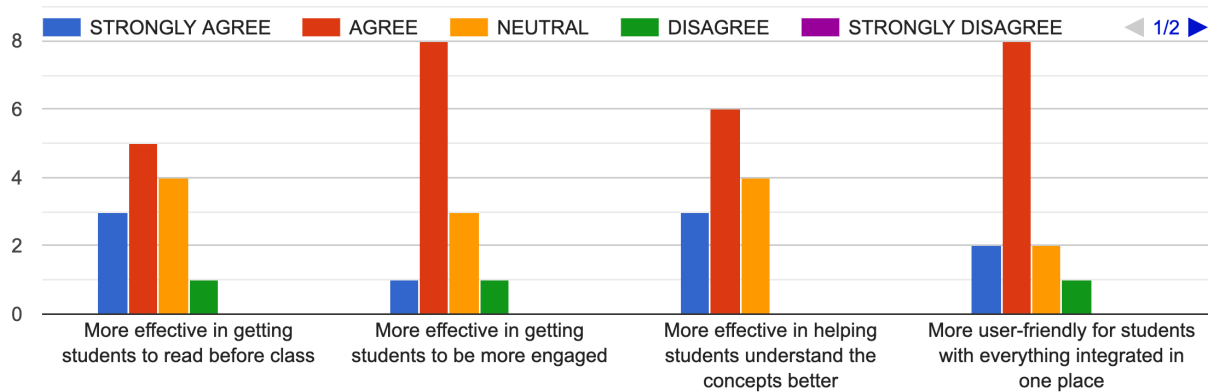


Figure 11. Instructor responses for the materials science and engineering book to the question prompt, "Please rate the statements below about the effectiveness of the online interactive version compared to other versions of the text."

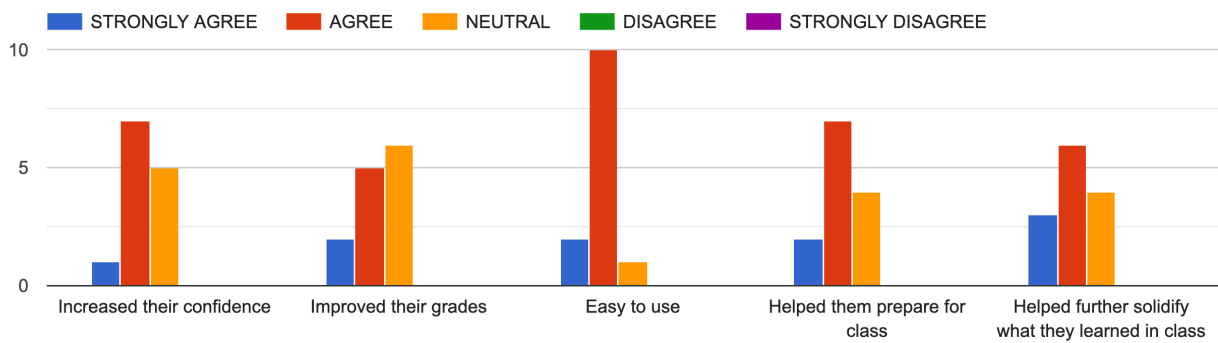


Figure 12. Instructor responses for the materials science and engineering book to the question prompt, "How well do the following statements apply to your students' experiences with the online interactive version?"

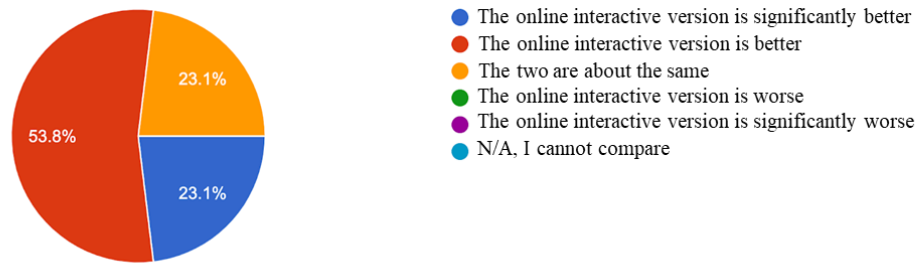


Figure 13. Instructor responses for the materials science and engineering book to the question prompt, "How does the online interactive version compare to other textbook formats that you have adopted for this course?"

Professors who completed the survey about the interactive version of the materials science and engineering textbook were also asked to list likes and dislikes about the interactive version of the book and any recommendations to improve the book. Likes included the animations (and participation activities in general), the low cost, and the continuous publishing model. Dislikes included the presence of auto-grading when multiple answers could be correct, inconsistency with the print copy, and that there weren't enough questions. Recommendations included more consistency, more problems, adding short videos and instructor slides, and including assignment reminders for students.

The students who completed the survey for the materials science and engineering interactive textbook were asked how the experience of using the interactive version of the book compared to other digital learning systems. Of the 66 students who completed the survey, 23 responded with 'much better', 26 responded with 'better', 10 students responded with 'about the same' and only 2 students said the interactive version was either worse or much worse than other digital learning systems. Students were also asked about their likelihood of recommending the interactive version. Of the 58 students who responded to this question, 52 gave a likelihood greater than 5 (10=13 students, 9=11 students, 8=15 students, 7=9 students, 6=4 students). The 6 students who gave a likelihood less than 6 were asked what

could be improved. Responses included adding more participation activities, improving the user interface, exercise examples are hard to complete without links to the text, and the content takes too long to load.

## Conclusions and Future Work

Overall, the usage data, the professor feedback through the survey, and the student feedback through the survey were all overwhelmingly positive. Students interacted with the existing animations and question sets. Professors liked the content and felt that it improved the student experience compared to other versions of the textbook (and other textbooks used in the courses). Students thought the interactive versions of the control systems and the materials science and engineering textbooks were better than other digital learning systems and most were likely to recommend the interactive versions of the books to other students.

One of the major recommendations from both professors and students was that more participation activities needed to be added. For the most recent release of both the control systems interactive textbook and the materials science and engineering interactive textbook, additional question sets and additional animations have been added. The survey will be administered again after the most recent versions that include additional interactive content have been used in classes.

Another recommendation from both professors and students was that the print to pdf feature needed to be improved. This recommendation is currently being addressed and will be included in a future release of both textbooks. Because of the overwhelmingly positive feedback from both professors and students for both of the existing zyVersions, more textbooks are currently being converted to the online interactive format and more titles are being added to the list of books that will be converted in the near future.


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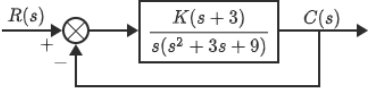
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## Appendix A

Figures A1-A7 demonstrate the animation steps for the animation pictured in Figure 1.

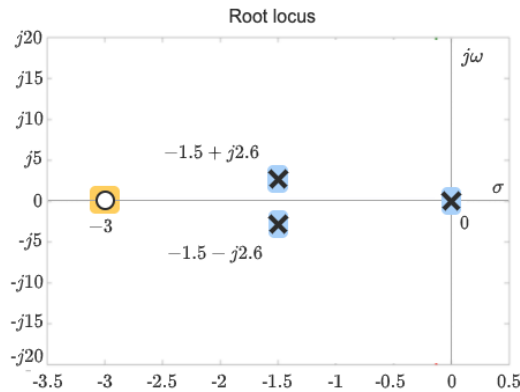
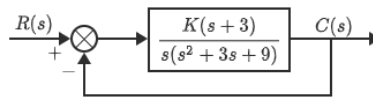
PARTICIPATION ACTIVITY | 8.4.4: Applying the five rules to sketch the root locus. 

1 2 3 4 5 6   2x speed



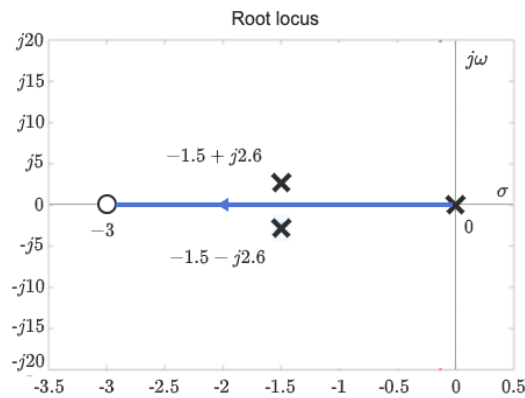
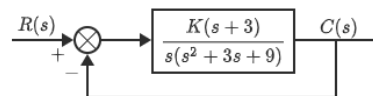
This system has negative unity feedback and gain  $K$ . The effect of  $K$  on the system and the location of poles is determined using a root locus.

Figure A1. Step 1 of an animation in the Control Systems interactive book.

1 2 3 4 5 6  2x speed

The open-loop poles and zeros are placed in the  $s$ -plane to start the root locus sketch.  
The system has a zero at  $s = -3$ , and three poles:  $s = \{0, -1.5 \pm j2.6\}$ .

Figure A2. Step 2 of an animation in the Control Systems interactive book.

1 2 3 4 5 6  2x speed

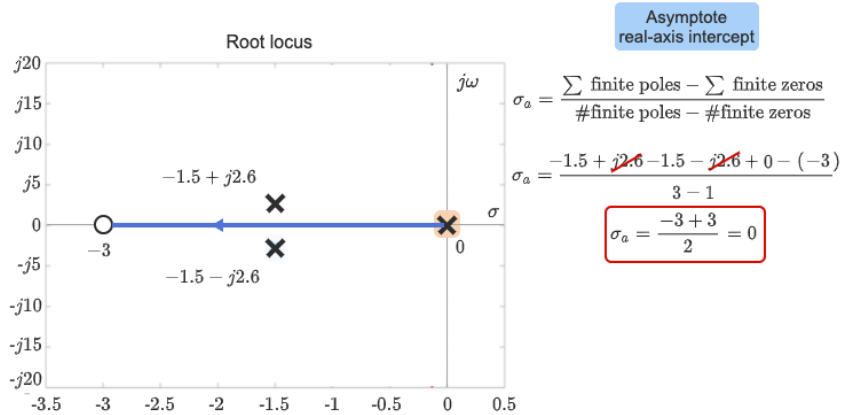
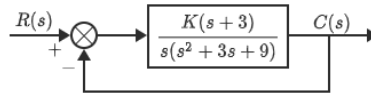
A single pole-zero pair on the real axis implies one real-axis segment,  
from the pole  $s = 0$  to the zero  $s = -3$ .

Figure A3. Step 3 of an animation in the Control Systems interactive book.





1 2 3 4 5 6  2x speed

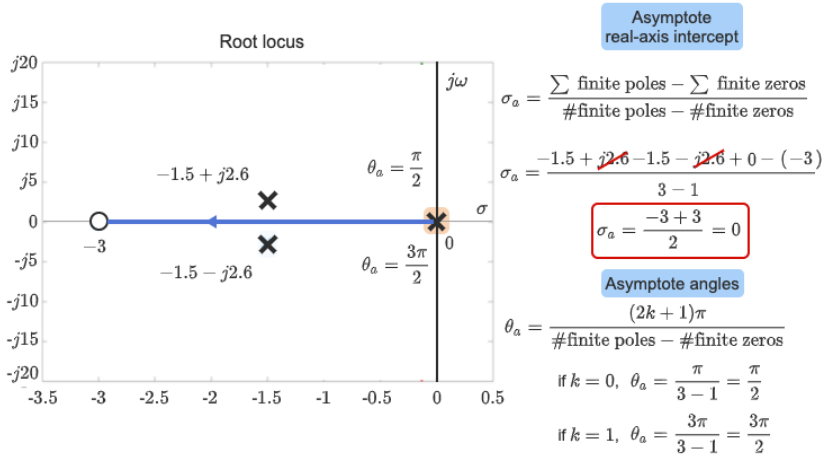
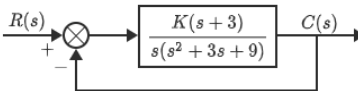


With one finite zero and three finite poles, the system must have two infinite zeros, and thus two asymptotes pointing towards the infinite zeros. The real-axis intercept of the asymptotes is  $\sigma_a = 0$ .

Figure A5. Step 4 of an animation in the Control Systems interactive book.



1 2 3 4 5 6  2x speed

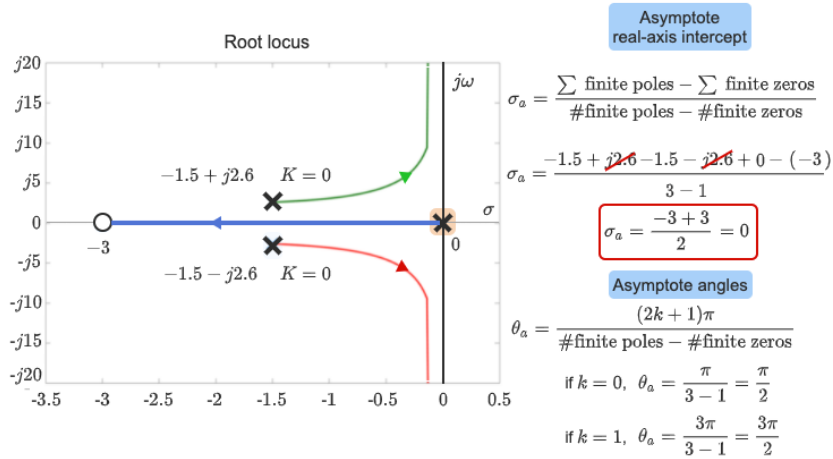
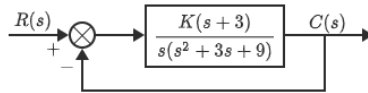


The first asymptote angle  $\theta_a = \pi/2$  comes from setting  $k = 0$  in the formula.  
The second angle  $\theta_a = 3\pi/2$  for  $k = 1$ .

Figure A6. Step 5 of an animation in the Control Systems interactive book.



1 2 3 4 5 6 ◀ 2x speed



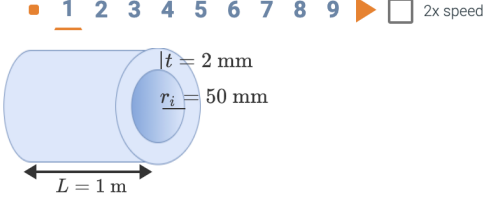
The branches start at open-loop poles  $s = -1/5 \pm j2.6$  when  $K = 0$ , and approach the infinite zeros along the asymptotes as gain  $K$  grows.

Figure A7. Step 6 of an animation in the Control Systems interactive book.

## Appendix B

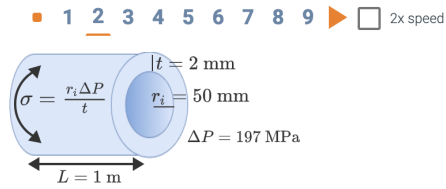
Figures B1-B9 demonstrate the animation steps for the animation pictured in Figure 2.

PARTICIPATION ACTIVITY | 6.12.2: Material selection at lowest cost for a pressurized cylindrical tube (Design Example 6.2 in original text).



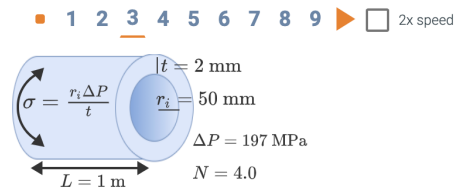
A thin-walled cylindrical tube having an inner radius  $r_i = 50 \text{ mm}$  and wall thickness  $t = 2 \text{ mm}$  is to be used to transport pressurized gas.

Figure B1. Step 1 of an animation in the Materials Science and Engineering interactive book.



The change in inside to outside pressure is  $\Delta P = 197 \text{ MPa}$ . The hoop stress due to pressure for the tube is  $\sigma = \frac{r_i \Delta P}{t}$ .

Figure B2. Step 2 of an animation in the Materials Science and Engineering interactive book.

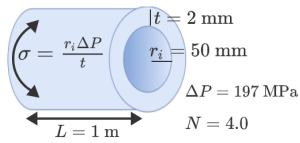


Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$/US/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

For a safety factor  $N = 4.0$ , a table of material yield strength, density, and cost per mass can be used to determine a low-cost material to build the tube.

Figure B3. Step 3 of an animation in the Materials Science and Engineering interactive book.

1 2 3 4 5 6 7 8 9 ▶  2x speed



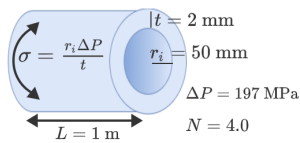
$$\sigma_w = \frac{r_i \Delta P}{t}$$

Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$/US/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

To safely transport the gas, the likelihood for plastic deformation must be minimized. So, the working stress,  $\sigma_w$ , is used as the hoop stress.

Figure B4. Step 4 of an animation in the Materials Science and Engineering interactive book.

1 2 3 4 5 6 7 8 9 ▶  2x speed



$$\sigma_w = \frac{r_i \Delta P}{t}$$

$$\sigma_y = N \sigma_w$$

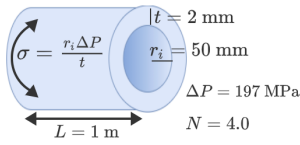
$$\sigma_y = N \frac{r_i \Delta P}{t}$$

Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$/US/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

Since the yield strength,  $\sigma_y$ , is related to  $\sigma_w$  and the safety factor, an expression for the yield strength in terms of the safety factor and hoop stress is found.

Figure B5. Step 5 of an animation in the Materials Science and Engineering interactive book.

1 2 3 4 5 **6** 7 8 9 ▶  2x speed



$$\sigma_w = \frac{r_i \Delta P}{t}$$

$$\sigma_y = N \sigma_w$$

$$\sigma_y = N \frac{r_i \Delta P}{t}$$

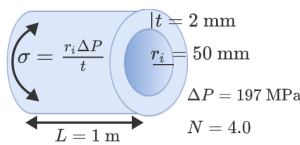
$$\sigma_y = (4.0) \frac{(50 \times 10^{-3} \text{ m})(1.97 \text{ MPa})}{2 \times 10^{-3} \text{ m}} = 197 \text{ MPa}$$

Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

Using the values for  $N$ ,  $r_i$ ,  $\Delta P$ , and  $t$ , the minimum yield strength is  $\sigma_y = 197 \text{ MPa}$ . Steel, copper, brass, and titanium have higher  $\sigma_y$ , and thus meet the functioning criteria.

Figure B6. Step 6 of an animation in the Materials Science and Engineering interactive book.

1 2 3 4 5 6 **7** 8 9 ▶  2x speed



$$\sigma_w = \frac{r_i \Delta P}{t}$$

$$\sigma_y = N \sigma_w$$

$$\sigma_y = N \frac{r_i \Delta P}{t}$$

$$\sigma_y = (4.0) \frac{(50 \times 10^{-3} \text{ m})(1.97 \text{ MPa})}{2 \times 10^{-3} \text{ m}} = 197 \text{ MPa}$$

Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

The volume for the tube is needed to determine cost. The tube's cross-sectional area,  $A$ , is found using the difference between the squares for the outer and inner tube radii. The tube volume is  $V = 6.28 \text{ cm}^3$ .

$$V = AL = \pi(r_o^2 - r_i^2)L$$

$$V = \pi((r_i + t)^2 - r_i^2)L$$

$$V = \pi(r_i^2 + 2r_i t + t^2 - r_i^2)L$$

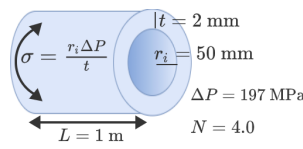
$$V = \pi(2r_i t + t^2)L$$

$$V = \pi[(2)(50 \times 10^{-3} \text{ m})(2 \times 10^{-3} \text{ m}) + (2 \times 10^{-3} \text{ m})^2](1 \text{ m})$$

$$V = 6.28 \times 10^{-4} \text{ m}^3 = 628 \text{ cm}^3$$

Figure B7. Step 7 of an animation in the Materials Science and Engineering interactive book.

■ 1 2 3 4 5 6 7 **8** 9 ▶  2x speed



$$\sigma = \frac{r_i \Delta P}{t}$$

$$\sigma_w = \frac{r_i \Delta P}{t}$$

$$\sigma_y = N \sigma_w$$

$$\sigma_y = N \frac{r_i \Delta P}{t}$$

$$\sigma_y = (4.0) \frac{(50 \times 10^{-3} \text{ m})(1.97 \text{ MPa})}{2 \times 10^{-3} \text{ m}} = 197 \text{ MPa}$$

$$V = AL = \pi(r_o^2 - r_i^2)L$$

$$V = \pi((r_i + t)^2 - r_i^2)L$$

$$V = \pi(r_i^2 + 2r_i t + t^2 - r_i^2)L$$

$$V = \pi(2r_i t + t^2)L$$

$$V = \pi[(2)(50 \times 10^{-3} \text{ m})(2 \times 10^{-3} \text{ m}) + (2 \times 10^{-3} \text{ m})^2](1 \text{ m})$$

$$V = 6.28 \times 10^{-4} \text{ m}^3 = 628 \text{ cm}^3$$

$$Cost = \left( \frac{V \rho}{1000} \right) \bar{c}$$

$$Cost_{(steel)} = \left( \frac{(628 \text{ cm}^3)(7.8 \text{ g/cm}^3)}{1000 \text{ g/kg}} \right) (1.25 \text{ \$US/kg})$$

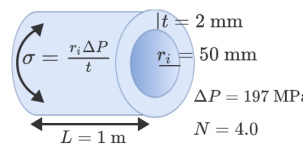
$$Cost_{(steel)} = \$6.10$$

Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$US/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

The cost to build the tube is equal to the material needed for tube volume,  $V$ , times material's density,  $\rho$ , times the unit mass cost,  $\bar{c}$ . Adjusting for units, steel's cost to build the tube is \$6.10.

Figure B8. Step 8 of an animation in the Materials Science and Engineering interactive book.

■ 1 2 3 4 5 6 7 8 **9** ◀  2x speed



$$\sigma = \frac{r_i \Delta P}{t}$$

$$\sigma_w = \frac{r_i \Delta P}{t}$$

$$\sigma_y = N \sigma_w$$

$$\sigma_y = N \frac{r_i \Delta P}{t}$$

$$\sigma_y = (4.0) \frac{(50 \times 10^{-3} \text{ m})(1.97 \text{ MPa})}{2 \times 10^{-3} \text{ m}} = 197 \text{ MPa}$$

$$V = AL = \pi(r_o^2 - r_i^2)L$$

$$V = \pi((r_i + t)^2 - r_i^2)L$$

$$V = \pi(r_i^2 + 2r_i t + t^2 - r_i^2)L$$

$$V = \pi(2r_i t + t^2)L$$

$$V = \pi[(2)(50 \times 10^{-3} \text{ m})(2 \times 10^{-3} \text{ m}) + (2 \times 10^{-3} \text{ m})^2](1 \text{ m})$$

$$V = 6.28 \times 10^{-4} \text{ m}^3 = 628 \text{ cm}^3$$

$$Cost = \left( \frac{V \rho}{1000} \right) \bar{c}$$

$$Cost_{(steel)} = \left( \frac{(628 \text{ cm}^3)(7.8 \text{ g/cm}^3)}{1000 \text{ g/kg}} \right) (1.25 \text{ \$US/kg})$$

$$Cost_{(steel)} = \$6.10$$

Alloy	Yield Strength, $\sigma_y$ (MPa)	Density, $\rho$ (g/cm <sup>3</sup> )	Unit mass cost, $\bar{c}$ (\$US/kg)
Steel	325	7.8	1.25
Aluminum	125	2.7	3.50
Copper	225	8.9	6.25
Brass	275	8.5	7.50
Magnesium	175	1.8	14.00
Titanium	700	4.5	40.00

Alloy	Cost (\$US)
Steel	6.10
Copper	35.00
Brass	40.00
Titanium	113.00

The cost for making a tube is calculated for each material that meets the design criteria. Comparing the costs, steel is the least expensive material for the design.

Figure B9. Step 9 of an animation in the Materials Science and Engineering interactive book.