
AC 2011-516: USING A SERIES OF ADVERTISING VIDEOS TO ILLUSTRATE SOLID MECHANICS AND MATERIAL-RELATED DESIGN ISSUES IN THE ENGINEERING TECHNOLOGY CURRICULUM

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Using a Series of Advertising Videos to Illustrate Solid Mechanics and Material-Related Design Issues in the Engineering Technology Curriculum

Abstract

Helping students relate what they learn in an engineering technology course to actual physical designs is a worthy goal. Five years ago in an attempt to help students see how knowledge of material properties translates into how materials are used in the design of mechanical parts led me to the use of a series of advertising videos produced by the Ford Motor Company. The videos were on a DVD titled, “The Truth About Trucks” and were distributed through Ford Dealerships. The video was made to promote the newly redesigned Ford F-150 truck. I created an accompanying question worksheet that required the students to watch the series of videos from the DVD and answer questions about specific engineering and material-related items that they observed. This paper will explain how I used these advertising videos in class to help illustrate material selection and solid mechanics topics. It will discuss what aspects of the assignment helped engage the students and how it helped create awareness in the students that their everyday life is surrounded by engineering design.

Introduction

It’s always important to give context to material taught in engineering technology classes. Tying the knowledge to real-world applications improves the learning experience for the students. The experience described in this paper began a few years ago when I was teaching an Industrial Materials course. This course was taken by students in our Mechanical Engineering Technology, Construction Technology, and Manufacturing Technology programs. Various techniques were used to show the students the application of the course material to common mechanical devices they might encounter in their daily experiences and to garner student buy-in to the course. One of these techniques included giving extra credit to students that brought in failed/broken parts so that they could be examined by the class. Another technique that was used was to assign students material-related topics to research and then prepare a presentation on their topic to share with the class. The topic of this paper deals with an approach that came about while I was visiting my local Ford dealership to get an oil change for my car.

This stems from when the Ford Motor Company completed a major redesign of their popular F-150 truck in 2004. As part of their promotional materials for this new vehicle they produced a video series titled, “The Truth About Trucks” on a DVD that could be obtained for free in the dealership sales showroom. I took one of these home and viewed it and realized that this could be a great tool to show students how Ford used different materials in the various mechanical systems for their new truck. The video involved a program host who supervised various workers as they cut open and dissected the Ford F-150 as well as competing trucks from other manufacturers.

As I viewed one of these DVDs I realized that mixed in with the hard-sell-advertising were numerous examples of how the engineers at Ford had solved their design problems by the particular materials that they chose. I created a worksheet of questions for the students that required them to watch the videos and then fill in answers on the sheet. I used this worksheet successfully in the Industrial Materials course that I was teaching.

How the Video Spots were Utilized

During all but the last year that I used this class project I obtained an individual copy of the DVD from local Ford dealers for each of the students. I credited the donor in the introduction of the assignment handout as incentive for the dealerships to provide the large number of copies of the disc required. Although the videos were also available from the Ford internet site - and most students used this approach to access the material - handing out the disc to each student was like giving them a gift and it increased the student buy-in to the assignment. In addition to the disc, each student was given the question worksheet. I ordered the questions in the worksheet so that it followed the presentations of the videos without involving hunting and searching to find the question that matched up with the topic of the video. I wanted this to be a relatively simple assignment so that they would enjoy it and it would hold their interest. In addition to asking the students to copy down some facts from the videos, some questions were designed to make sure the student was paying attention and some of them required the student to draw a conclusion or offer up their opinion as to whether they agreed with what the narrator was presenting or how he was presenting it. After the students turned in their completed worksheets I graded them and then passed them back in a future class. On the day they were returned I reviewed the answers with the class and a lively discussion always ensued.

An Example from the Materials Course

One example of how the videos brought the students knowledge of materials-related topics was the demonstration of a material used in the F-150 known as Quiet Steel®.¹ This product is used in the vehicle to help dampen out road noise. The narrator demonstrates this material by dropping ball-bearings on a sample of regular sheet steel and then on the Quiet Steel® as seen in the screen shot shown below.



Figure 1, Screenshot of Quiet Steel® demonstration.

I was able to verify this demonstration for the students since Ford had placed displays in their dealerships about the new F-150 that allowed you to strike a sample of Quiet Steel® and a sample of regular sheet steel and hear the difference in the sound produced. After the completion of the video assignment the topic of Quiet Steel® was assigned as a research topic and a student prepared a presentation for the class on this material, how it works and how it can be used. During the research of the material the student noticed that this material was not exclusive to the Ford truck but was sold to them by an independent company that also sold the material for use in Chrysler minivans. The sound dampening property of Quiet Steel® is what allows Chrysler to offer their stow-and-go feature without increasing road noise from the thinner structure required to allow the seats to fold into the floor. Because the students had been exposed to this material it caught their attention when they heard of its use in another product and they understood why the engineers selected this particular product.

Another example of the materials-related topics on the DVD involved the demonstration of the control arms on the Ford truck as well as those of the Ford's competitors. The competitor's control arms were manufactured out of steel in various shapes and sizes. The Ford product was made from cast aluminum.



Figure 2, Screenshot of cast aluminum control arm.

The narrator discusses that using cast aluminum allowed Ford to increase the size of their part for greater rigidity of the design without increasing the weight. The narrator also discusses the noise-dampening properties of the aluminum with respect to a comparable steel part. Because the narrator shows all of the competing designs it makes this a great point of discussion with the students.

An Example from the Solid Mechanics Course

Eventually the growth of our student enrollment and faculty members resulted in a change in my assigned classes and I stopped teaching the materials course. At this time I was teaching a solid mechanics course and realized that the video also helped illustrate concepts of stress, strain, torque and other topics applicable to this course. I rewrote my question worksheet and started using the videos in my solid mechanics course. One principle taught in the solid mechanics course that is demonstrated in the videos involves torsion. During the videos the different brands of truck frames are subjected to a torsion load and the resulting deflection is measured. The load being applied to the Ford frame is shown below as Figure 3.



Figure 3, Screenshot of torsion loading of truck frame.

The students use the numbers shown in the video to calculate the torsion load that is applied to the frames and are able to see that an identical load can result in different values of deflection based on the design of the structure. The example shown above is from the 2009 series of videos and shows actual numbers. In an earlier version of the videos this particular demonstration is not included but another video spot showing the practical reason why the torsional rigidity of the frame is important is demonstrated. This is accomplished by observing as each truck is parked on an uneven surface. Then each truck is viewed from behind and the amount that the outer edge of the truck bed drops in relation to the cab is shown. Ideally, both the older practical application approach would be combined with the newer version involving specific numbers so that the calculations could be tied to the application.

Another solid mechanics principle illustrated in the videos involves the size and shape of the truck frame cross-sections. Cross-sections of the frames of the different brands of trucks are shown to the viewer. The narrator mentions that the Ford frame is better because its cross-section is taller and “fully boxed,” meaning that it is a closed shape unlike a couple of the other truck frames that utilize open C-section designs. He doesn’t explain why these are important things to look for but that’s where discussion in the solid mechanics course picks up. The students understand how to calculate the Moment of Inertia and the Polar Moment of Inertia for

various shapes and can apply that knowledge to the different shapes. They understand that the taller shape will generally result in a bigger value for the Moment of Inertia and the Polar Moment of Inertia. They will understand from their class work that this will allow the shape to handle larger bending and torsion loads. They also learn that closed shapes are better able to resist torsion loads and readily see why the closed shape is important to the design. An example of the Toyota truck frame and the Ford cross-sections are shown below in Figure 4.



Figure 4, Screenshot of Toyota and Ford frame cross-sections.

Changes through the Years

For the first couple of years the video spots were mostly unchanged. After that the videos had some dramatic changes in content and format each year. The original video spots, while not technical in language, took a technical approach by showing the details of the design aspects of the truck and emphasizing the mechanical parts of the vehicle. A few years later the emphasis seemed to move more towards the many available options for the truck as well as the comfort and amenities in the cab. A few years ago Ford did a major redesign on their Super Duty line of trucks and included that on the DVD along with the F-150 videos. More recently, the F-150 had

some minor changes to the design and Ford took a different approach to its marketing. Instead of the overt distribution of these “Truth About Trucks” videos and the technical approach they took, they, instead, hired Mike Rowe from the television program “Dirty Jobs” and created commercials of people doing some pretty crazy things with their F-150s in a setting reminiscent of the program “Junkyard Wars”. At this time the displays in the Ford dealerships focusing on the F-150 seemed to lose their prominence on the showroom floor and the one I visited didn’t have any DVDs available to take home. I assumed that they had abandoned “The Truth About Trucks” product. I later found the latest version of this series posted by Ford Trucks on the YouTube website (the heading to the assignment given in the appendix describes how to find these on the website). The final year this exercise was utilized (Spring 2010) the students were not given individual DVD’s and they were directed entirely to the internet to access the videos. This required a little coaching before turning the students loose. Various individuals had posted segments of these videos all over YouTube so I had to make sure to direct them to the complete set that was posted by the Ford Motor Company.

Student Response

The students don’t show any more excitement when this assignment is passed out in class than with any other homework assignment. However, as they begin the assignment the students realize that the emphasis of this exercise isn’t strongly focused on math and calculations so they realize it shouldn’t be too difficult to complete. While completing the assignment the students form various opinions about the marketing statement made by the Ford program narrator. As mentioned previously, after the assignments are graded and passed back they are reviewed with the students. This is one of the most enjoyable days during the course. One of the reasons for this is that it introduces an increasingly computer-raised generation to mechanical parts used in working machines. Our institution is typical in that we are seeing a decrease in the number of students that come from rural farming backgrounds and have experience in using and maintaining mechanical equipment. Many of the vehicle components are not familiar to many students that came to the engineering technology program from an increasingly serviced-oriented society.² An automobile or truck is a familiar mechanical device and so the students can relate to this as they see the various parts that make it function.

Another reason that the review day is enjoyable is because this is the time when students that have very passionate connections to a specific automobile brand become very vocal and they participate in the class discussion with great gusto. Those that are loyal to a brand other than Ford were ready to pick apart any and all of the claims made by this marketing video. This made for some great in-class discussions. The fact that the videos are an advertising product forces these individuals to dig in and fight for their favorite truck brand more fervently than if this had simply been a generic educational video discussing the design of trucks without referencing a particular brand. Also, since this is a marketing video the language used is often steeped in emotional terms and leaves room for a more factual analysis. The pointed attacks by Ford on their competitors draws out these students’ emotions. In order to draw out some of the more reserved students some of the questions in the worksheet ask the students for their opinion on whether they agree with some specific item mentioned by the narrator of the videos. Other discussion topics arise from what the videos don’t choose to emphasize. The discussion proceeds in an almost Socratic method as I ask leading questions and see what the students offer

up. It can easily be stated that this day in class often shows more student involvement and the students are more likely to offer up their ideas and thoughts.

The changes in the videos through the years also provided a great opportunity to see how other manufacturers had either incorporated some of the touted design elements from the F-150 or started to offer other alternatives to achieve the same results. Some of these were made obvious by deliberate responses in advertisements put out by the rival companies. As an example, the Toyota frame cross-section shown above in Figure 4 definitely caught the eyes of the Toyota Corporation. They placed ads in popular car magazines including one in the May 2007 edition of *Car and Driver* magazine.³ This advertisement states why there are three different profiles for the frame in the Toyota Tundra including a portion that is “fully boxed” and why it was designed to be this way. The August 2008 edition of *Car and Driver* has an advertisement about the Chevy Silverado truck also discussing the portions of the frame that are boxed and those that have a C-channel profile.⁴ I used these ads in class to show that manufacturers are very aware of what their competitors are designing. Over the following years these advertisements indicated areas where competitors had adopted design aspects of the F-150 as shown in the videos. One example of this occurred when Dodge redesigned their Ram pickup truck. Dodge presented their redesigned Ram truck with an advertisement in the December 2008 edition of *Car and Driver* magazine that touted their, “. . .all new fully boxed frame made of Advanced High-Strength Steel.”⁵ This is the type of frame design used in the Ford truck and it is presented in almost the exact same language as used in the original Ford videos. These advertisements are presented to the students during the assignment review and serve as an additional source of discussion. Another indicator of the importance of these videos comes from the independent car evaluation website CarData.⁶ They do independent research and demonstrations of automotive claims and they have evaluated a number of the claims made in the Ford videos.

One other important aspect of this assignment is that as a whole the students enjoy it. There are numerous studies that indicate that learning and comprehension greatly improve when the students are happy. The National Association of School Psychologists has published a large number of studies showing that when students enjoy the school experience they definitely gain more from the class.⁷ The entire review and discussion day is fun and exciting, but as a final fun experience I announce the winners of The Truth About Trucks narrator look-and-sound-alike contest. Students submit names of who they think the narrator most reminds them of and the results are announced in class.



Figure 5, Narrator of “The Truth About Trucks” videos.

Conclusions

This assignment generated more in-class discussion, excitement and participation than just about any other method I’ve used. It was great in that it showed how engineers at one company solved a design problem in some great detail. It also introduced an increasingly book-educated student populace to some real-world machinery. It draws the students in with its flashy marketing style. As one example, when the cross-sections for the various trucks are displayed the narrator walks by the side of a Chevy truck while underneath a mechanic is using a cutting torch to remove the frame section. The sparks are flying and then the section of the frame drops to the floor with a “clang”. You can see some of the sparks in the background of Figure 4. The narrator picks up the piece with locking pliers and plunges it into a bucket of water that gives off a steamy vapor as the hot metal cools with a “whoosh”. It is staging like this that keeps the students’ interest.

The fact that the assignment was fairly non-threatening and any student could complete it correctly also added to the success of the experience. It provided some great discussions about the veracity of the approach and claims made by the narrator. It also helped promote life-long learning among the students by showing them how they can encounter engineering and design in day-to-day encounters. It showed them that they had the knowledge to evaluate the claims made by marketing and advertising products. If I were to continue teaching a solid mechanics or materials course and if Ford were to continue to make these videos I would definitely continue to use them. Individuals wishing to utilize an experience similar to this are not tied to the Ford

videos as there are other products out there that could be used. Many of these are easily accessible on YouTube. Ford wisely saw that their next venue for distribution was on the popular YouTube website and there are more and diverse examples of products like “The Truth About Trucks” available there.

Bibliography

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4. Car and Driver magazine, August 2008, pages 70.
5. Car and Driver magazine, December 2008, page 55.
6. CarDataVideo, <http://www.MyCarData.com>, also, see *Ford F-150 vs Toyota Tundra – Frame Strength* on <http://www.YouTube.com>.
7. See, for example, Huebner, S. *Students and Their Schooling: Does Happiness Matter?*, National Association of School Psychologists *Communique*, Vol 39, #2, www.nasponline.org.

Appendix I
Assignment Handout used for “The Truth About Trucks”

“THE TRUTH ABOUT TRUCKS” WORKSHEET (Spring 2010):

1. This Worksheet has a series of questions for you to answer as you view the program, “The Truth About Trucks” about the 2009 Ford F-150 pickup truck. This program can be accessed via YouTube at <http://www.youtube.com>. On the YouTube website type, “The Truth About Trucks” in the search box. Many people have posted pieces and parts of this multi-part video on YouTube. You want to choose the entire selection of these videos that were posted by “fordtruck”. A screen shot of this is shown below:

Playlist Results for the truth about trucks



Truth About Trucks 21 videos

- The Truth About F-150? You Decide (0:26)
- F-150, Competition Get the Truth Test (1:03)
- 09 F-150: Refined Driving Is in the Details (0:48)

Playlist [play all 21 videos](#) [fordtrucks](#)

You'll want to access all 21

Posted by “fordtrucks”

2. I would recommend that you read through the questions first before you view the program so that you know what information you are looking for. The questions are in 21 groups that correspond to the 21 different videos.
3. Each of the questions is designed to focus your attention on how Ford used industrial materials to meet requirements or solve problems in the design of their re-designed F-150 truck. A few of the questions are designed to make sure you are paying attention. Note that some of the answers come from what the narrator says, some come from information bars that pop up across the screen, and some require a little thinking or researching.
4. I recognize that this is an advertisement for Ford. The reason I decided to use this commercialized product is because it has some very good information, pictures and explanations of how the engineers at a particular company decided to solve the engineering design problem of how to build a truck. Let me state that I am not endorsing Ford or any other particular automobile. You won't get a better grade in the class if you buy yourself a Ford F-150.
5. Due Date for this assignment is: Beginning of Class, Tuesday, May 11th.

Questions:

1-The Truth about F-150 (0:26):

1. This video is numbered first on the website. If you ran the world would you keep this video at the beginning or where would you put it? _____

2-High Strength Steel (1:50):

2. What kind of steel is used in the B-pillars of the Super Crew model of the F-150?

3. What was the name of the “laminated steel panel” used in the F-150 that helped reduce noise?

3-Leadership in Truck Game Starts Up Front (2:25):

4. The narrator states that the up-front structure can do a number of things for the truck:
 - a. Stiffens up the _____.
 - b. Makes it more _____
 - c. _____ the cab.
 - d. Helps win at the _____ game.
5. The F-150 received a 5-star frontal crash rating from _____ and a “Top Safety Pick” rating from _____

4-Truck Competition Makes Hollow Attempt At Roof Rails (1:51/1:52):

6. Ford uses a manufacturing technique called “hydroforming” to make the roof rails for the F-150. This involves filling the structure with pressurized liquid to get the part to expand into the shape of a mold. Which of the following competitor’s trucks also used hydroforming to make their roof rails?

Chevy (yes/no) Toyota (yes/no) Dodge (yes/no)

7. What type of steel does Ford use in the Roof Rails of the F-150? _____

5-F-150 Gets the Nod When it Comes to Safety (2:01):

8. How many airbags are standard on the F-150? _____
9. One of the airbags was shaped like a letter of the alphabet. It is known as a ____-bag.
10. The side curtain airbag used a technology that unrolls and thus moves the occupants head away from the window. This was called _____ technology.
11. What was the name of the foam piece inside the door that is designed to push your pelvis away from the door in the event of a side impact? “_____”

6-F-150s Got A Handle on Safety Technology (1:52/1:53):

12. The narrator used the phrase “ability to brake and steer” when he referred to what system on board the F-150? _____
13. What does “EBD” stand for? _____
14. Roll Stability Control uses what inputs? _____.
15. What is the purpose for having Roll Stability Control?

7-09 F-150: Refined Driving Is in the Details (0:48):

16. Ford installed a device called a Steering Snubber in order to eliminate the side-to-side oscillations that you can feel in the steering wheel at higher speeds. These oscillations are known as _____.

8-09 F-150 Thinking Outside and Inside the Box (3:23):

17. What is the cargo capacity of the F-150? _____
18. Because the tailgate in the F-150 is so large and heavy, Ford installed a torsion spring to make it easier to open and close. This was referred to as “_____.”
19. The F-150 can handle 600 pounds per cleat. What’s a cleat? _____

9-Experts Test the Get Up and Go of 09 F-150 (0:46):

20. The narrator first states that “A long-standing advertising myth is that The World Lives From _____ to _____.” Then he corrects that by saying that when you’re towing the speeds that are really important are _____ to _____.

21. The F-150 has a 6-speed transmission. What does that mean?

22. How many speeds does the Dodge transmission have? _____

10-One Bolt Tells a Lot About a Truck (1:58/1:59):

23. Which truck manufacturer had a bed bolt similar to the Ford F-150? _____

24. When looking at the bracing underneath the bed of the F-150 the narrator says that the cross-members have a “_____” structure, and are “_____” welded.

11-Towing Confidence Comes Standard on 09 F-150 (2:46/2:47):

25. The F-150 has a Trailer Sway Control as standard equipment. This system senses yaw inputs and then applies the brakes _____ of the sway side of the truck.

12-F-150 Fuel Economy Measured in Layers (1:59/2:00):

26. What are 3 factors the narrator mentions that impact fuel efficiency?

- a. _____
- b. _____
- c. _____

27. The new rear end ratio of the F-150 is _____ to 1.

28. Which gear(s) are considered Overdrive gear(s) on the F-150? _____

29. What can you do to the front axles on a 4x4 F-150 in order to improve fuel mileage?

13-F-150 Aerodynamics: where Art meets Science (2:03/2:04):

30. Besides increasing Fuel Economy, improving the Aerodynamics provides what other benefit? _____
31. True or False: Putting the tailgate down on the F-150 will improve its fuel efficiency.

14-F-150 Makes Every Gallon Count (1:21/1:22):

32. Where did Ford perform their fuel efficiency test? _____
33. How much fuel did each truck have to use for the efficiency test? _____
34. The highest fuel rated model of the F-150 gets ____ mpg city and _____ mpg highway.
35. When does the Fuel Shutoff System activate in the F-150?

36. How many valves does each cylinder have in the F-150's 4.6 Liter engine? _____
37. What's the maximum horsepower of the 4.6 Liter engine? _____
38. What is the torque rating of the engine? _____

15-F-150 Sets Bar High on Rear Suspension (2:19):

39. What was the big change that Dodge made to the rear suspension of the Ram pickup?

40. Why did the narrator think that this change was not a good idea for a truck?

41. How many Leaves are in the F-150 Leaf Spring? _____
42. Where did Ford mount the shock absorbers in order to improve stability?

16-Strength of F-150 Backbone gets Tested (4:54/4:55):

43. What is the Backbone of a truck? _____
44. What method involving the use of a pressurized liquid was used to make the frame members of the F-150? _____

45. All four of the tested trucks had the same general cross-section shape for their frames. Draw the general shape of the truck frame cross-sections:
46. Use the information given in the video to calculate the amount of Torque being applied to the truck frames. Use appropriate units: _____
47. What were the deflection values when the frames were subjected to a twisting load:
- a. Ford _____
 - b. Chevy _____
 - c. Dodge _____
 - d. Toyota _____
48. What method was used to attach the cross members on the Toyota truck that made the narrator worried that it might experience squeaks and rattles? _____

17-F-150 Leaves Competition Spinning Its Wheels (1:48):

49. The narrator discusses the benefits of an electronic locking differential but at the very beginning of the discussion he mentions that it only comes standard on one of the F-150 models. Which model does he mention? (hint: it's a couple of letters followed by a number) _____
50. The F-150 locking differential is supposed to be better than the locking differentials on the other brands because it does what? _____

18-Experts Dissect F-150 Powertrain (2:53/2:54):

51. What was the location name of the test track? _____
52. What happened to the Dodge Ram gas cap door during the bumpy ride?

53. What happened to the bed of the Toyota Truck when it was going over the bumps?

54. During the Tear-down, which truck's engine mount had a torn Dust Cover along with metal shavings? _____
55. What material is put in the engine mounts to help isolate the engine from the truck and reduce noise? _____

19-F-150 Goes Head-to-Head in Whoa Factor Test (2:12):

56. Why does the narrator say that disc brakes are better than drum brakes?

57. The purpose of brakes is “taking motion and reducing it to _____.”

58. Which vehicle has rear drum brakes? _____

20-F-150, Competition Get the Truth Test (1:02/1:03):

59. What is the name of the narrator of this program? _____

21-Ford F-Series Best Selling Trucks (0:31):

60. How many years has Ford’s F-series been the best selling truck? _____

61. Bonus point: Who is narrating this advertisement?

- a. Dennis Miller
- b. Toby Keith
- c. Denis Leary
- d. Timothy Leary

Final Questions:

62. In past years this program had been recorded on DVD’s which were then available at Ford Dealerships. Why do you think Ford decided to post the video on YouTube this time instead?

63. One more Bonus: Who does the narrator look and sound a bit like?
