Automotive Technology 6th Edition
Chapter 108 MACHINING BRAKE DRUMS & ROTORS
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain learning objectives to students as listed below: 1. Explain the factors that cause rotor damage. 2. Discuss brake drum distortion. 3. Explain how to machine a brake drum and when a brake drum should be discarded. 4. Discuss disc brake rotors and causes of rotor distortion. 5. Explain the procedure for machining a disc brake rotor.
Establish the Mood or Climate	Provide a ***WELCOME***, Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: Lesson plan is based on 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 108 Chapter Images: From

http://www.jameshalderman.com/automotive_principles.html

NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	Chapter 108 Machining Drum/Rotor

1. SLIDE 1 CH108 MACHINING BRAKE DRUMS & ROTORS

Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/

WEB SITE IS CONSTANTLY UPDATED

http://www.jameshalderman.com/automotive_principles.html

DOWNLOAD

Crossword Puzzle (Microsoft Word) (PDF)

Word Search Puzzle (Microsoft Word) (PDF

Videos

2. **SLIDE 2** EXPLAIN **Figure 108-1** Types of brake drums. Regardless of the design, all types use cast iron as a friction surface.
3. **SLIDE 3** EXPLAIN **Figure 108-2** The airflow through cooling vents helps brakes from overheating.
4. **SLIDE 4** EXPLAIN **Figure 108-3** Scored drums and rotors often result in metal-to-metal contact.

DEMONSTRATION: Show students a brake drum that displays evidence of scoring. Ask students to speculate on causes of scoring. Why are drum brakes more prone to scoring than disc brakes?

DEMONSTRATION: Show students a brake drum that has cracks, and discuss the possible causes of the cracking. Show students how to do the tap test to determine if a brake drum is cracked.

EXPLAIN TECH TIP: *Tap Test.* Using a steel hammer, lightly tap a brake drum or rotor. It should ring if it is not cracked. If a dull thud is heard, drum or rotor is likely cracked and should be replaced.

5. **SLIDE 5** EXPLAIN **Figure 108-4** Cracked drums or rotors must be replaced.
6. **SLIDE 6** EXPLAIN **Figure 108-5** A heat-checked surface of a disc brake rotor.
7. **SLIDE 7** EXPLAIN **Figure 108-6** These dark hard spots are created by heat that actually changes the

metallurgy of cast-iron drum. Most experts recommend replacement of any brake drum that has these hard spots.

DISCUSSION: **Ask students to talk about the issue of heat checking in brake drums. How is it different from cracking and what causes it?**

DEMONSTRATION: **Show students an example of a brake drum that displays evidence of hard, or chill, spots. How are hard spots caused and what problems do they create? Show students an example of a brake drum that displays bellmouth distortion, and discuss what causes it.**

DEMONSTRATION: **Show students an example of a brake drum that has gone out-of-round. Ask students to discuss the causes of out-of-round brake drum distortion and its symptoms. Ask students to talk about eccentric distortion of brake drums. What are the symptoms of eccentric distortion and what problems does it cause? How can it be avoided or resolved? Show students how to perform the parking brake trick to diagnose brake-pedal pulsation.**

DISCUSSION: **Ask students to discuss the issue of drum distortion. How does even the minutest shift in position cause drum damage?**

EXPLAIN TECH TIP: ***Storing Drums and Rotors***
A common cause of distortion in new brake drums and rotors is improper storage. Drums and rotors should always be stored lying flat; they should never be stood on edge. Distortion of new drums and rotors is common, so they should be routinely checked before installation.

8. **SLIDE 8 EXPLAIN Figure 108-7** Bellmouth brake drum distortion.
9. **SLIDE 9 EXPLAIN Figure 108-8** Out-of-round brake drum distortion.
10. **SLIDE 10 EXPLAIN Figure 108-9** Eccentric brake drum distortion.

DEMONSTRATION: **Show students how to remove a brake drum, and then ask them to inspect it for distortion. Have students use a micrometer to measure the brake drums they removed previously**

ICONS	Chapter 108 Machining Drum/Rotor
	DISCUSSION: Ask students to talk about why brake drums on the same axle should have as close to the same ID as possible. What is indicated when the brake drum chamfer is not visible?
	HANDS-ON TASK: Have students remove a brake drum that is stuck on the hub my using the hammer tape method to release it from the hub.
	DEMONSTRATION: Show students how to remove a brake drum, and then ask them to inspect it for distortion. Have students use a micrometer to measure the brake drums they removed previously
	DISCUSSION: Ask students to talk about why brake drums on the same axle should have as close to the same ID as possible. What is indicated when the brake drum chamfer is not visible?
	HANDS-ON TASK: Have students remove a brake drum that is stuck on the hub my using the hammer tape method to release it from the hub.
	EXPLAIN TECH TIP: ***Parking Brake Trick*** **Whenever attempting to diagnose a brake pedal pulsation, drive to a deserted area or parking lot and try stopping vehicle using parking brake. If a vibration occurs, problem is due to a fault with the rear brakes. If a vibration does not occur except when using the service brakes, problem is most likely due to a fault with front brakes.**
	11. **SLIDE 11 EXPLAIN Figure 108-10** A straightedge can be used to check for brake drum warpage.
	12. **SLIDE 12 EXPLAIN Figure 108-11** Discard diameter and maximum diameter are brake drum machining and wear limits.
	Brake Drum Micrometer (View) (Download)
	EXPLAIN TECH TIP: ***Mark It to Be Sure*** **Most experts recommend that brake rotors, as well as drums and wheels, be marked before removing them for service. Many disc brake rotors are**

directional and will function correctly only if replaced in the original location. A quick-and-easy method is to use correction fluid. This alcohol-based liquid comes in small bottles with a small brush inside, making it easy to mark rotors with an "L" for left and an "R" for right. Correction fluid (also called "white-out" or "liquid paper") can also be used to make marks on wheel studs, wheels, and brake drums to help ensure reinstallation in same location.

EXPLAIN TECH TIP: ***Brake Drum Chamfer***

Look at chamfer on the outer edge of most brake drums. When the chamfer is no longer visible, brake drum is usually at or past its maximum ID. • SEE FIGURE 108–12. Although this chamfer is not an accurate gauge of ID of the brake drum, it still is a helpful indicator to technician.

13. **SLIDE 13** EXPLAIN **Figure 108-12** Most brake drums have a chamfer around the edge
14. **SLIDE 14** EXPLAIN **Figure 108-13** needle-dial brake drum micrometer. Left movable arm is set to approximate drum diameter and the right arm to the more exact drum diameter. The dial indicator (gauge) reads in thousandths of an inch.
15. **SLIDE 15** EXPLAIN **Figure 108-14** (a) A rotor or brake drum with a bearing hub should be installed on a brake lathe using the appropriate size collet that fit bearing cups (races). (b) A hubless rotor or brake drum requires a spring and a tapered centering cone. A faceplate should be used on both sides of rotor or drum to provide support. Always follow operating instructions for specified setup for brake lathe being used.
16. **SLIDE 16** EXPLAIN **Figure 108-15** self-aligning spacer (SAS) should be used between drum or rotor and spindle retaining nut for even clamping force and to prevent adapters and cone from getting into a bind. A silence band should always be installed to prevent turning-tool chatter and to ensure a smooth surface finish.

DEMONSTRATION: **Show students how to use a self-aligning spacer (SAS) to ensure that the spindle nut applies an even force to the drum. Show**

ICONS	Chapter 108 Machining Drum/Rotor
	students the steps involved in using a lathe to machine a drum brake
	DISCUSSION: Have students talk about the micrometer indicator on the feed handle of the brake lathe. How can this micrometer be used for both metric and standard measurements?
	17. **SLIDE 17 EXPLAIN Figure 108-16** After installing a brake drum on the lathe, turn the cutting tool outward until the tool just touches the drum. This is called a scratch cut. 18. **SLIDE 18 EXPLAIN Figure 108-17** After making a scratch cut, loosen the retaining nut, rotate the drum on the lathe, and make another scratch cut. If both cuts are in the same location, the drum is installed correctly on the lathe and drum machining can begin. 19. **SLIDE 19 EXPLAIN Figure 108-18** Set depth of cut indicator to zero just as the turning tool touches the drum. 20. **SLIDE 20 EXPLAIN Figure 108-19** lathe has a dial that is “diameter graduated”. This means that a reading of 0.030 in. indicates a 0.015 in. cut that increases the inside diameter of the brake drum by 0.030 in. 21. **SLIDE 21 EXPLAIN Figure 108-20** Notice chatter marks at edge of friction-area surface of brake drum. These marks were caused by vibration of drum because the technician failed to wrap dampening strap (silencer band) over friction-surface portion of brake drum.
	ON-VEHICLE ASEEDUCATION TASK C2: Remove, clean, and inspect brake drum; measure brake drum diameter; determine serviceability.
	ON-VEHICLE ASEEDUCATION TASK C3: Refinish brake drum and measure final drum diameter; compare with specification.
	ON-VEHICLE ASEEDUCATION TASK D7: Remove and reinstall/replace rotor

ICONS	Chapter 108 Machining Drum/Rotor

22. **SLIDE 22 EXPLAIN Figure 108-21** This excessively worn (thin) rotor was removed from the vehicle in this condition. It is amazing that the vehicle was able to stop with such a thin rotor.
23. **SLIDE 23 EXPLAIN Figure 108-22** Severely worn vented disc brake rotor. The braking surface has been entirely worn away exposing the cooling fins. The owner brought the vehicle to a repair shop because of a “little noise in the front.” Notice the straight vane design.
24. **SLIDE 24 EXPLAIN Figure 108-23** Directional vane vented disc brake rotors. Note that the fins angle toward the rear of the vehicle. It is important that this type of rotor be reinstalled on correct side of vehicle.
25. **SLIDE 25 EXPLAIN Figure 108-24** Typical composite rotor that uses cast iron friction surfaces and a steel center section

DEMONSTRATION: Show solid and vented disc rotors, and discuss their construction, where they are used, and how they work to dissipate heat.

DISCUSSION: discuss differences between cross-drilled & slotted rotors. How does each aid in dispersing gas and dust particles? Ask students to discuss aluminum metal matrix composite rotors. What are the advantages of this type of rotor construction? How can they be distinguished from conventional cast iron rotors? What are the special servicing requirements for aluminum metal matrix composite rotors?

Rotor Runout & Steering Wheel Shake (View) (Download)
Rotor Runout (View) (Download)
Rotor Thickness Variation & Brake Pedal Pulsation (View) (Download)

DISCUSS FREQUENTLY ASKED QUESTION:

What Does “Cross-Drilled” and “Slotted” Mean?

The terms “cross-drilled” and “slotted” refer to two separate processes. The first procedure involves drilling rows of holes through friction surfaces of rotor. The second procedure refers to milling a series of specially machined grooves from the center of disc toward edge. When friction surfaces of a rotor are smooth

and flat, there is no means of escape for gases and dust, which build up between pad and rotor. This is not a huge problem in normal driving, but is an important consideration in street performance applications.
The drill holes (which are sometimes called "gas relief openings") provide an exit route for the dust and gas. The holes are also commonly labeled "cooling holes" because of the improvements they make in this area. Better cooling means less fade during repeated heavy brake application. They also help dissipate water when driving in poor weather. • SEE FIGURE 108–25. Slotting increases bite of pads and is even more effective than cross-drilling in combating the problem known as "out-gassing." This is when, at very high braking temperatures, the bonding agents used in some brake pads produce a gas. Under extreme conditions, this gas can create a gas cushion between pad and rotor, giving a driver a normal pedal feel but reducing the amount of friction being generated. The slots pump away gas and restore full contact. The "micro-shaving" effect of slots also serves to deglaze the pads and this is why edges of slots are not chamfered or "radiused." It also tends to even out the wear across the brake pad faces, increasing effective contact area.

26. **SLIDE 26 EXPLAIN FIGURE 108-25** This Porsche is equipped with high-performance brakes including cross-drilled brake rotors.
27. **SLIDE 27 EXPLAIN FIGURE 108-26** Brake rotor lateral-runout distortion.
28. **SLIDE 28 EXPLAIN FIGURE 108-27** Before measuring lateral runout with a dial indicator (gauge), remove any wheel bearing end play by tightening the spindle nut to 10 to 20 ft-lb with a torque wrench.

ICONS	Chapter 108 Machining Drum/Rotor

29. **SLIDE 29 EXPLAIN FIGURE 108-28** (a) Rotate the disc brake rotor one complete revolution while observing the dial indicator (gauge). (b) Most OEMS specify a maximum runout of about 0.003 inch (0.08 mm).
30. **SLIDE 30 EXPLAIN Figure 108-29** Brake rotor lack-of-parallelism distortion.
31. **SLIDE 31 EXPLAIN Figure 108-30** (a) Disc brake rotor thickness variation (parallelism). (b) The rotor should be measured with a micrometer at four or more equally spaced locations around the rotor.

EXPLAIN TECH TIP: ***Braking Vibration Could Be Due to the Tires.*** **A vibrating condition (roughness) during braking is usually caused by disc brake rotor thickness variation or an out of-round brake drum. Both conditions should be investigated. However, tires and/or road conditions can also cause same vibrations. Tests performed by vehicle and tire-manufacturing engineers have shown that tires, and tires alone, could be cause. If no other problem can be isolated, install a different brand of tire on vehicle and retest. The cause of tire vibration seems to be due to distortion or movement of tire tread. A different brand of tires would have a different tread rubber compound, carcass body ply angles, or other factor that can contribute to a vibration during braking.**

EXPLAIN TECH TIP: ***Think of a Human Hair.*** **Measurements and specifications do not seem to mean much unless you can visualize size compared to something with which you are familiar. The diameter of human hair is from 0.002 to 0.004 inch (2 to 4 thousandths of an inch). The maximum lateral runout of a rotor is usually within this same dimension. The reason a dial indicator has to be used to measure runout, and a micrometer to measure parallelism, is that dimensions involved are less than the diameter of a human hair.**

DEMO

DEMONSTRATION: **Show students a disc rotor that exhibits lack of parallelism. Ask them to talk about what causes lack of parallelism and what problems can result.**

ICONS	Chapter 108 Machining Drum/Rotor
	DISCUSSION: **Ask students to discuss the problem of lateral runout (LRO) of a disc rotor. What causes LRO? What problems result from LRO? Ask students to talk about how distortion can occur in a disc brake rotor. Why are the effects of distortion more pronounced on a disc brake rotor than on a drum brake?**
	DISCUSSION: **Have students talk about how a tire that is not true can cause a vibration that could be confused with a brake problem. Have students talk about how they would determine if the vibration being felt is from the tires or from brakes**
	32. **SLIDE 32** EXPLAIN **FIGURE 108–31** A carbon-ceramic brake (CCB) rotor on a Ferrari. 33. **SLIDE 33** EXPLAIN **Figure 108-32** digital readout rotor micrometer is an accurate tool to use when measuring a rotor. Both fractional inches and metric millimeters are generally available.
	DEMONSTRATION: **Show students where minimum recommended thickness is on a disc rotor, & discuss significance of this measurement.**
	34. **SLIDE 34** EXPLAIN **Figure 108-33** If fingernail catches on a groove in rotor, rotor should be machined. 35. **SLIDE 35** EXPLAIN **Figure 108-34** This rusted rotor should be machined. 36. **SLIDE 36** EXPLAIN **Figure 108-35** Rotors that have deep rust pockets usually cannot be machined.
	Rust is very hard on cutting bits. Remove as much as you can before running cutter over rotor.
	EXPLAIN TECH TIP: ***Ballpoint Pen Test.*** **A smooth friction surface on a drum or rotor is necessary for proper brake operation. To quickly determine if friction surface of a brake drum or rotor is not smooth enough, draw a ballpoint pen across surface. If surface is smooth enough, a solid ink line will be observed. If line drawn by the pen is not solid, then surface is not smooth enough.**

ICONS	Chapter 108 Machining Drum/Rotor
	37. **SLIDE 37 EXPLAIN FIGURE 108-36** Electronic surface finish machine. The reading shows about 140 μ in. This is much too rough for use but is typical for a rough cut surface 38. **SLIDE 38 EXPLAIN FIGURE 108–37** A dial indicator being used to check the arbor for total indicator runout (TIR) brake lathe.
DEMO	**DEMONSTRATION: Show students how to do the ballpoint pen test to determine if the friction surface of a brake drum or disc rotor is smooth enough.**
DEMO	**DEMONSTRATION: Show students the correct procedure for machining a disc brake rotor.**
	39. **SLIDE 39 EXPLAIN Figure 108-38** Most positive brake lathes can cut any depth in one pass, thereby saving time. A typical negative rake lathe uses a three-sided turning tool that can be flipped over, thereby giving six cutting edges. 40. **SLIDE 40 EXPLAIN Figure 108-39** Recommended adapters and location for machining hubbed and hubless rotors. 41. **SLIDE 41 EXPLAIN Figure 108-40** Composite adapter fitted to a rotor. 42. **SLIDE 42 EXPLAIN Figure 108-41** A damper is necessary to reduce cutting-tool vibrations that can cause a rough surface finish. 44. **SLIDE 44 EXPLAIN Figure 108-42** After installing the rotor on the brake lathe, turn the cutting tool in just enough to make a scratch cut. 45. **SLIDE 45 EXPLAIN Figure 108-43** After making a scratch cut, loosen the retaining nut and rotate the rotor on the spindle of the lathe one-half turn. Tighten the nut and make a second scratch cut. The second scratch cut should be side-by-side with the first scratch if the rotor is installed correctly on the brake lathe.
	46. **SLIDE 46 EXPLAIN Figure 108-44 (a)** This technician uses two sanding blocks each equipped with 150-grit aluminum-oxide sandpaper. **(b)** With lathe turned on, technician presses two sanding blocks against the surface of rotor after the rotor has been machined, to achieve a smooth microinch surface finish.

ICONS	Chapter 108 Machining Drum/Rotor

47. **SLIDE 47** **EXPLAIN** **Figure 108-45 (a)** After machining and sanding the rotor, it should be cleaned. In this case brake cleaner from an air pressurized spray can is used. **(b)** With the lathe turning, the technician stands back away from the rotor and sprays both sides of the rotor to clean it of any remaining grit from the sanding process. This last step ensures a clean, smooth surface for the disc brake pads and a quality brake repair. Sanding each side of the rotor surface for one minute using a sanding block and 150-grit aluminum-oxide sandpaper after a finish cut gives the rotor the proper smoothness and finish.
48. **SLIDE 48** **EXPLAIN** **Figure 108-46** grinder with sandpaper can be used to give a smooth non-directional surface finish to the disc brake rotor.
49. **SLIDE 49** **EXPLAIN** **Figure 108-47** correct final surface finish should be smooth and non-directional.
49. **SLIDE 49** **EXPLAIN** **Figure 108-48** Rust should always be cleaned from both the rotor and the hub whenever the rotors are machined or replaced. An air-powered die grinder with a sanding disc makes quick work of cleaning this hub.

DISCUSS CHART 108-1 Metric/fractional chart.

DISCUSSION: Ask students to talk about the differences between a rough and finish cut on a lathe. Ask students to discuss the difference between positive and negative rake lathes. Which is preferable for machining brake rotors and why? Ask students to discuss the preconditions for machining a disc rotor.

HANDS-ON TASK: Have students Machine Disc Rotor. Grade students on their ability to complete the task correctly and follow safety procedures. Using a micrometer, have students measure thickness of rotor after they have performed finish cut to determine if it complies with OEM specs

ICONS	Chapter 108 Machining Drum/Rotor
	ON-VEHICLE ASEEDUCATION TASK D8: Refinish rotor on vehicle; measure final rotor thickness and compare with specification.
	ON-VEHICLE ASEEDUCATION TASK D9: Refinish rotor off vehicle; measure final rotor thickness and compare with specification.
	50. SLIDE 50 EXPLAIN **Figure 108-49** typical hub-mount on-the-vehicle lathe. This particular lathe oscillates while machining the rotor, thereby providing a smooth and non-directional finish at the same time
	EXPLAIN TECH TIP: ***Turn or Machine?*** **When asked about what was done to their vehicle, a common response of customers is "They rotated my rotors." Many customers do not understand terms that are commonly used in service industry. Try to use terms that are technically correct and avoid slang when talking to customers. For example, expression machined rotors indicates an operation, whereas expression turned rotors may be misinterpreted by some customers as simply meaning using your hand and moving (rotating) rotor. Resurfacing, refinishing, and reconditioning are other terms that could be used to describe a drum or rotor machining operation.**
	DEMONSTRATION: Show students the correct procedure for on-the-vehicle rotor machining
	HANDS-ON TASK: Have students follow the steps to machine a rotor while it's on the vehicle. Grade them on their ability to complete the task correctly and follow safety procedures.
	EXPLAIN TECH TIP: ***Always Check the Wheel Studs*** **Before installing wheel after brake service, check condition of wheel studs and lug nuts. Check for stripped threads, rust, or cracks. If necessary, replace stud. Most studs are replaced by driving**

ICONS	Chapter 108 Machining Drum/Rotor
	them out using a large hammer and then using washers and a lug nut to draw serrated shoulder of lug stud into rotor stud hole. • SEE FIGURE 108–50. Always use a torque wrench when installing lug nuts to ensure proper and even torque on all lug nuts. This helps to prevent rotor distortion, which can lead to vibration in the steering and/or pedal pulsation during braking.
	51. **SLIDE 51 EXPLAIN FIGURE 108-50** A wheel stud was replaced on rotor hub assembly when it was discovered to be stripped 52. **SLIDES 52-166 EXPLAIN OPTIONAL DRUM & ROTOR ON&OFF CAR MACHINING**
	**SEARCH INTERNET: Have students research process of convection and how it plays a role in absorption of heat within a drum or disc brake system.**