

2.008 Quiz 1 Review

Quiz Scope & Logistics

- Quiz 1 will cover HW 1 - 4 and through Lecture 12 (3/13) . Even if content was not explicitly asked about in a HW, if it was discussed in class, it is fair game for the quiz
- You are allowed one double sided, handwritten 8.5" x 11" notes sheet. This is for equations and any other pertinent information
- We will supply you with calculators for the exam
- Show your work, box your answers

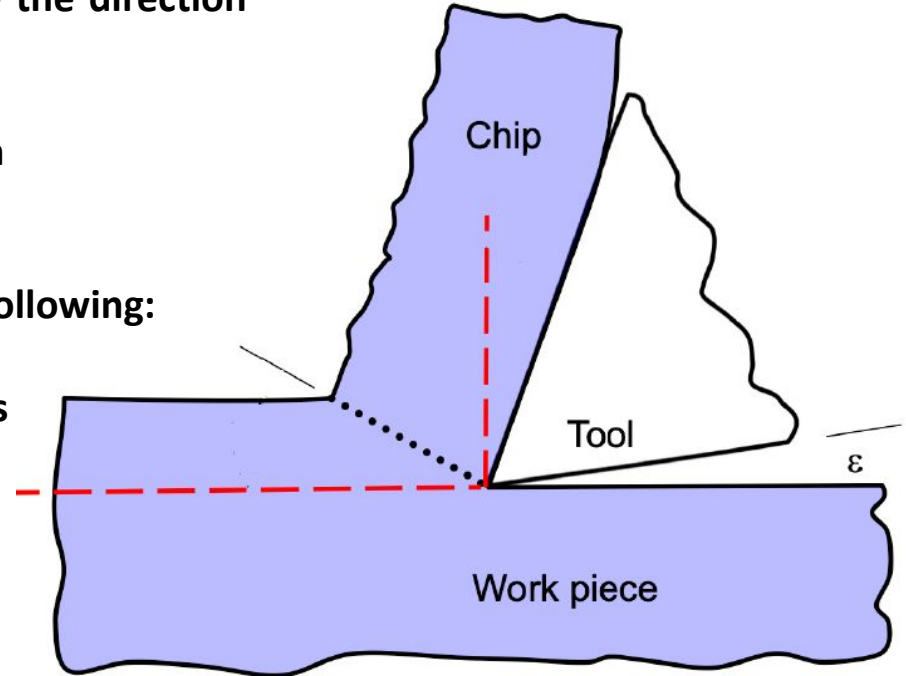
Merchant's Diagram - HW2 Question

Draw and complete Merchant's Diagram with respect to this operation. Your drawing should label, and indicate the direction of

- Each of the forces from part a
- The 3 angles described in Merchant's equation
- The resultant force vector

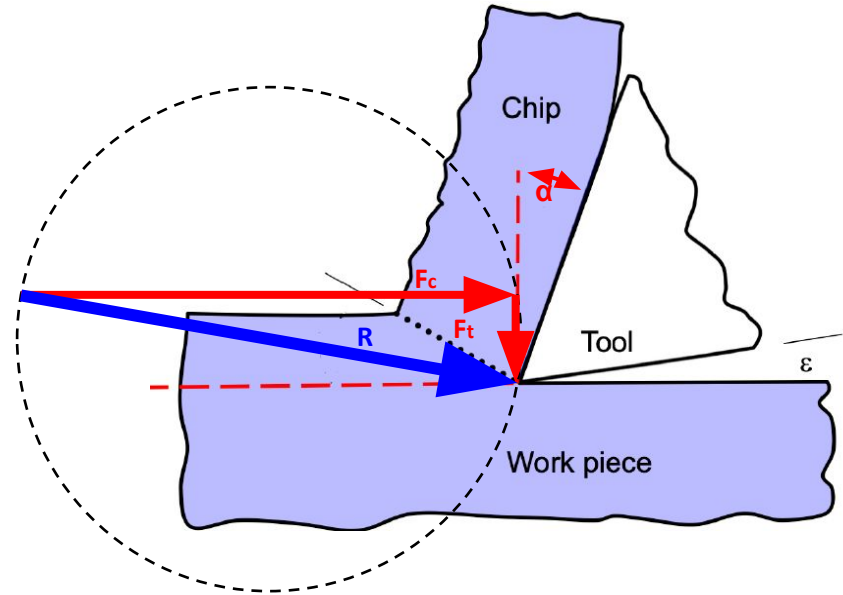
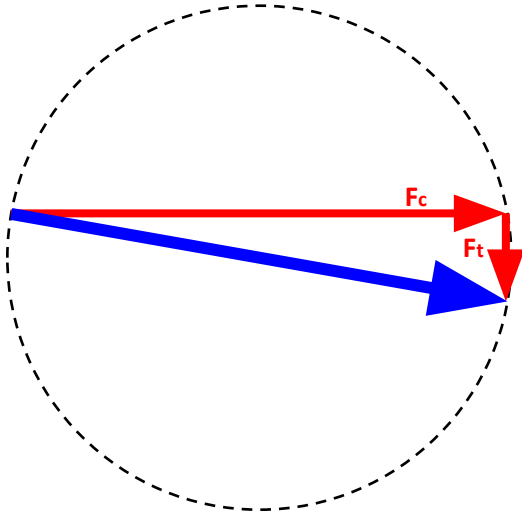
Directions of forces and angles should assume the following:

- Cutting force is acting on the tool
- The rake angle is positive, as the image implies
- Friction angle is less than the rake angle



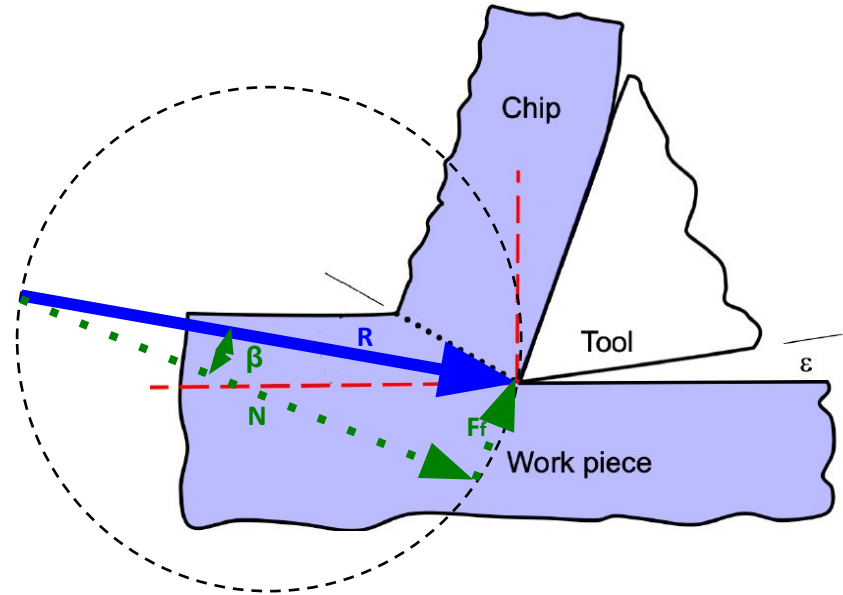
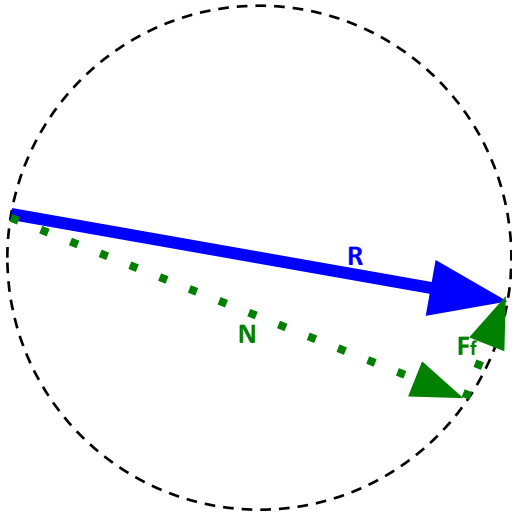
Merchant's Diagram

- Workpiece/Tool Interaction



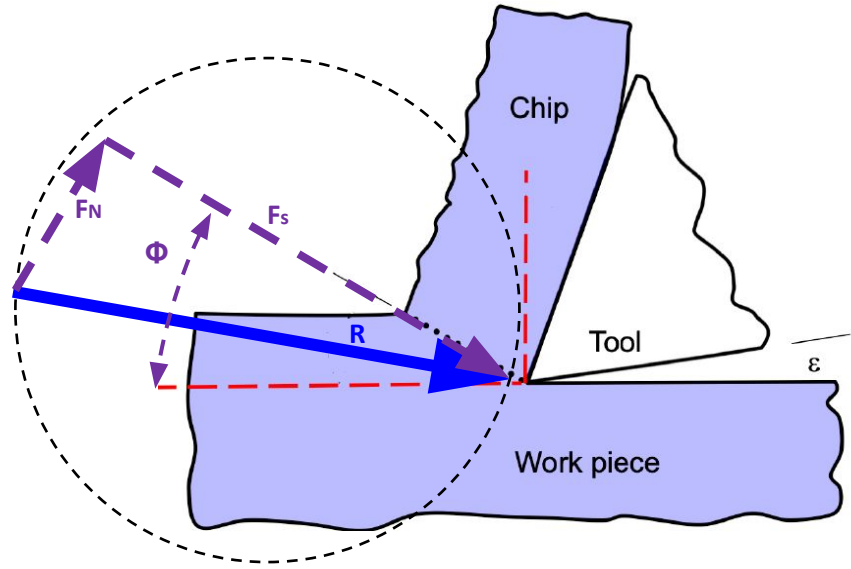
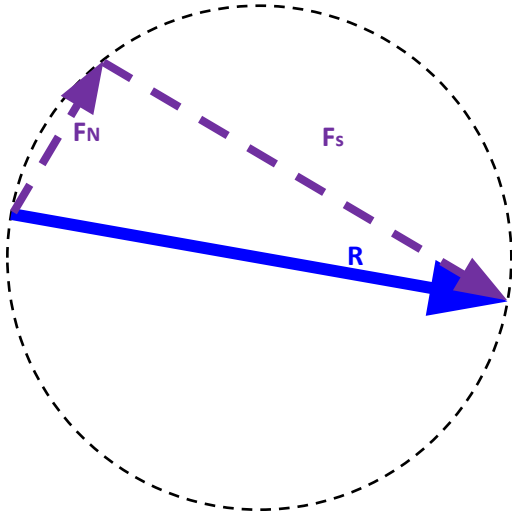
Merchant's Diagram

- Chip/Tool Interaction



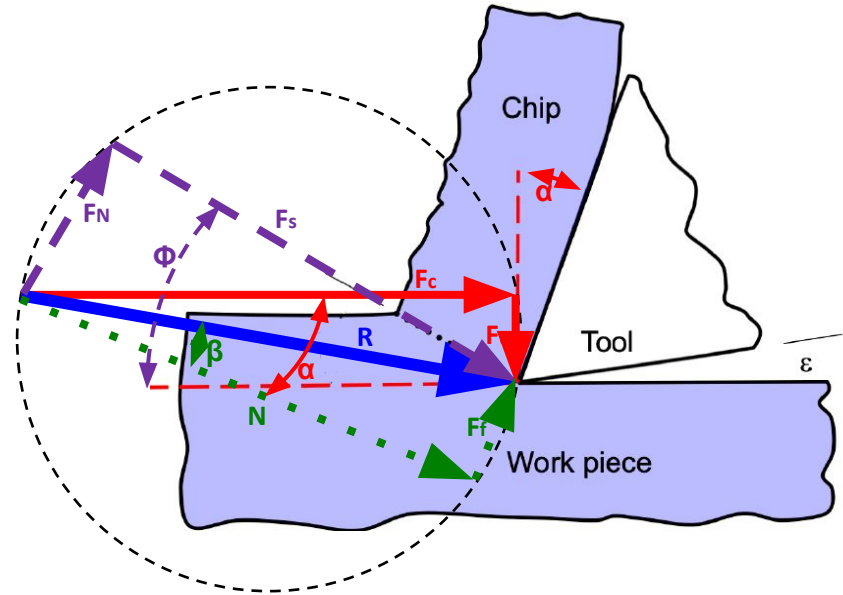
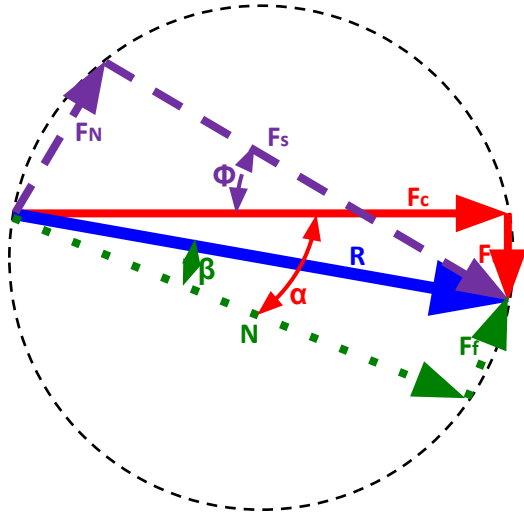
Merchant's Diagram

- Chip/Workpiece Interaction



Merchant's Diagram

- All Forces shown together



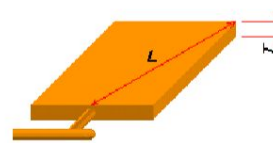
Problem 1 - Injection Molding

Your injection molding machine has a fixed maximum injection pressure. If you are producing two parts of equivalent volume, a _____ (small, thick part / large, thin part) has the greatest risk of a short-shot defect.

Problem 1 - Injection Molding

Your injection molding machine has a fixed maximum injection pressure. If you are producing two parts of equivalent volume, a _____ (small, thick part / large, thin part) has the greatest risk of a short-shot defect.

Flow Path Ratio = L/T



Rule of thumb

Polyethylene (PE)	$L/T = 280-100$
Polypropylene (PP)	$L/T = 280-150$
Polyvinyl chloride (PVC)	$L/T = 280-70$
Polystyrene (PS)	$L/T = 300-220$
Polycarbonate (PC)	$L/T = 160-90$
Acrylonitrile butadienestyrene (ABS)	$L/T = 280-120$
Polyamide (PA)	$L/T = 320-200$

Problem 1 - Injection Molding

Using a _____ (higher/lower) viscosity material would reduce the clamp force.

Problem 1 - Injection Molding

Using a _____ (higher, lower) viscosity material would reduce the clamp force.

Clamp force is the amount of force, (tonnage in english units) required to keep the mold closed

$$F_{\text{clamp}} = A_{\text{proj}} * P_{\text{injection}}$$

What is viscosity? Does a high or low viscosity translate to a high or low injection pressure?

Problem 1 - Injection Molding

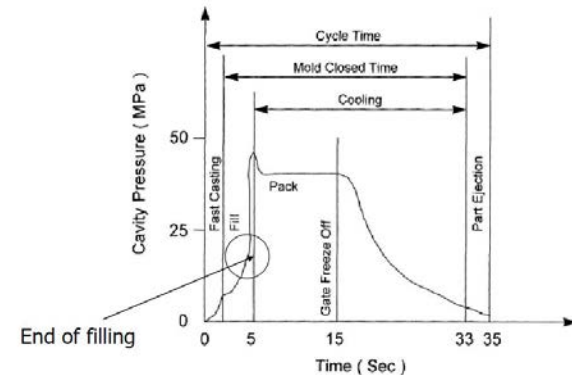
The packing pressure is usually _____
(higher/lower) than the injection
pressure.

Problem 1 - Injection Molding

The packing pressure is usually _____
(higher/lower) than the injection
pressure.

What happens as a molten plastic part cools in a mold? How might we compensate for that with our process parameter?

PRESSURE HISTORY IN AN INJECTION MOLDED PART



Problem 1 - Thermoforming

Draft angles are needed on both thermoformed and injection molded parts. ☒ True / False

What does a draft angle assist with? Is this a common need for both processes?

Problem 1 - Cutting

You mill a pocket with a given set of parameters (depth of cut, width of cut, feed rate, etc.)

If you double the spindle speed (while holding all other parameters the same), the cutting force _____ (stays the same / doubles)

Problem 1 - Cutting

You mill a pocket with a given set of parameters (depth of cut, width of cut, feed rate, etc.)

If you double the spindle speed (while holding all other parameters the same), the cutting force _____ (stays the same / doubles)

simplified estimate of cutting force on a lathe

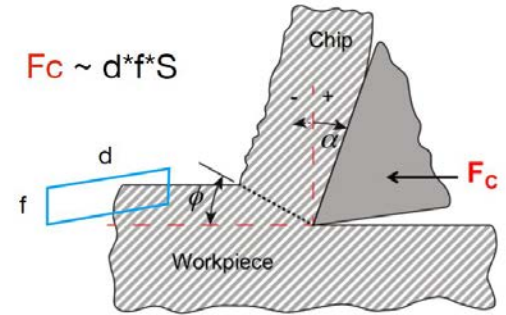
d: depth of cut (in)

f: feed (in/rev)

S: shear strength (Pa or psi)

Material	UTS* (MPa)
Wax	0.86
Aluminum	110
Aluminum 6061-T6	310
Steel (high strength alloy) ASTM A-514	760
Titanium alloys	900

*UTS = Ultimate Tensile Strength
Shear strength $\sim 0.5 \cdot \text{UTS}$



Question to ask yourself: How does this change the amount of material removed?

Problem 1 - Cutting

If you double the feed rate, the cutting force _____ (stays the same / doubles)

Problem 1 - Cutting

If you double the feed rate, the cutting force _____ (stays the same / **doubles**)

simplified estimate of cutting force on a lathe

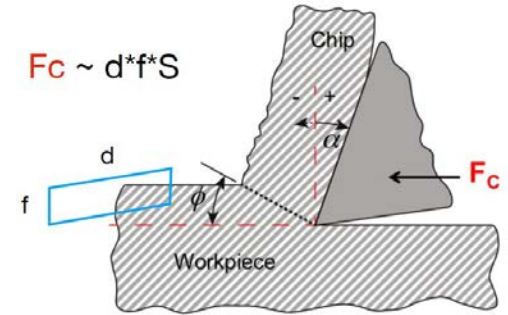
d: depth of cut (in)

f: feed (in/rev)

S: shear strength (Pa or psi)

Material	UTS* (MPa)
Wax	0.86
Aluminum	110
Aluminum 6061-T6	310
Steel (high strength alloy) ASTMA-514	760
Titanium alloys	900

*UTS = Ultimate Tensile Strength
Shear strength $\sim 0.5 \cdot \text{UTS}$



$$F_c \sim d \cdot f \cdot S$$

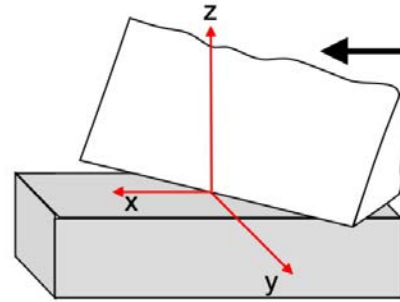
Question to ask yourself: How does this change the amount of material removed?

Problem 1 - Cutting

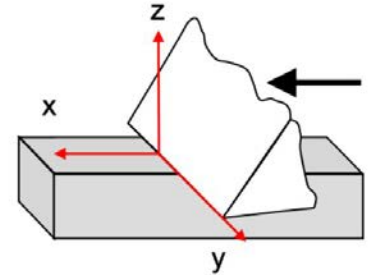
A major assumption to simplify the geometry for analysis is _____
(orthogonal/oblique) cutting.

Problem 1 - Cutting

A major assumption to simplify the geometry for analysis is _____
(orthogonal/oblique) cutting.



Oblique (3D)



Orthogonal (2D)

Problem 1 - Cutting

You can have a negative rake angle.

True / False

Problem 1 - Cutting

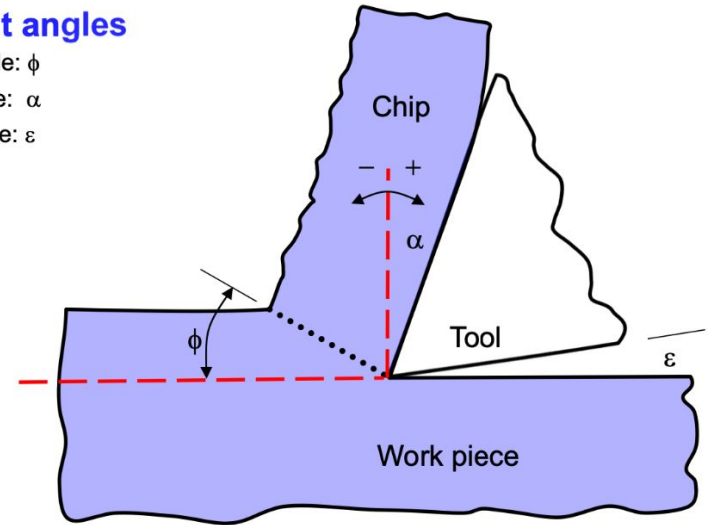
You can have a negative rake angle.

True / False

Rake angle is the angle between the tool and a reference plane that is normal to the applied cutting force

Important angles

- Shear angle: ϕ
- Rake angle: α
- Relief angle: ϵ



Problem 1 - Cutting

When the shear angle increases, the shear strain _____ (increases / decreases).

Problem 1 - Cutting

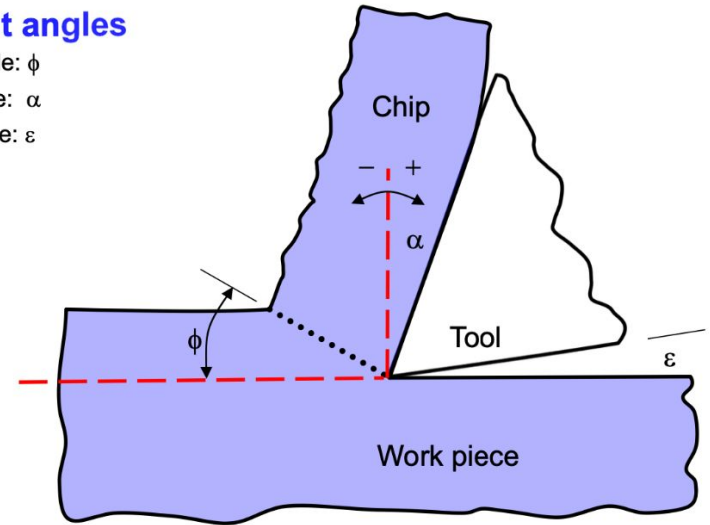
When the shear angle increases, the shear strain _____ (increases / decreases).

Shear angle is the angle between the workpiece and a shear plane

$$\gamma = \cot \phi + \tan(\phi - \alpha)$$

Important angles

- Shear angle: ϕ
- Rake angle: α
- Relief angle: ε



Problem 1 - Variation/Quality Control

If you set the tolerance of a shaft/stem diameter as $0.50'' \pm 0.01''$, it is the _____ (UCL / USL).

Problem 1 - Variation/Quality Control

If you set the tolerance of a shaft/stem diameter as $0.50'' \pm 0.01''$, it is the _____ (UCL / USL).

Control limit = what the process is capable of achieving

Specification limit = desires of the designer

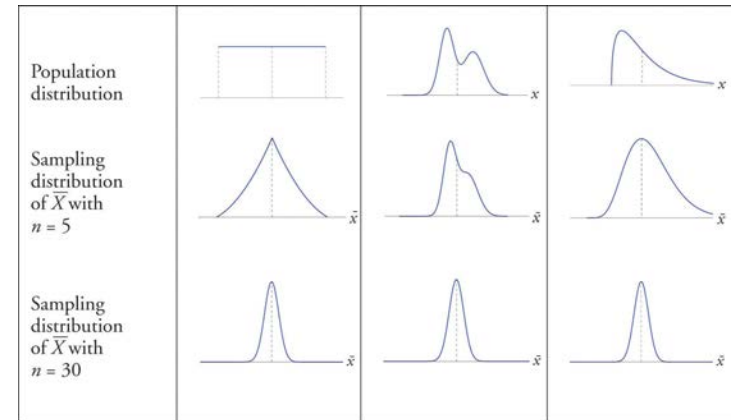
Problem 1 - Variation/Quality Control

According to the central limit theorem,
_____ (more/less) samples increase the
precision of the estimate of the average.

Problem 1 - Variation/Quality Control

According to the central limit theorem,
_____ (more/less) samples increase the
precision of the estimate of the average.

Central Limit Theorem: If random samples of size n are selected from a distribution, the distribution of sample means approach a normal distribution as sample size increases.



*Even if you don't remember what CLT is, you know that more samples, i.e., more data is good

Problem 1 - Variation/Quality Control

As the subgroup size decreases, the
UCL and LCL move _____
(closer/further) to the center line,
making the control chart _____
(more/less) sensitive to shifts in the
mean.

Problem 1 - Variation/Quality Control

As the subgroup size decreases, the
UCL and LCL move _____
(closer/further) to the center line,
making the control chart _____
(more/less) sensitive to shifts in the
mean.

MIT OpenCourseWare
<https://ocw.mit.edu>

2.008 Design and Manufacturing II

Spring 2025

For information about citing these materials or our Terms of Use, visit: <https://ocw.mit.edu/terms>.