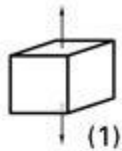
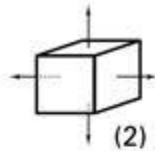


# Fundamentals of Metal Forming

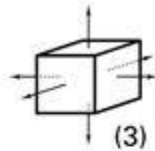
# Classification of States of Stress



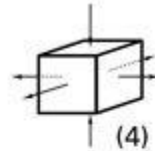
Simple uniaxial tension



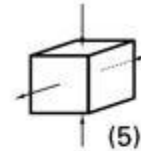
Biaxial tension



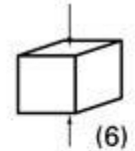
Triaxial tension



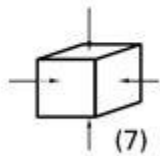
Biaxial tension, compression



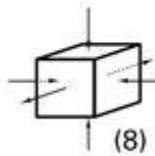
Biaxial tension and compression



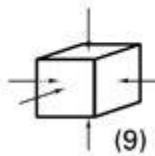
Uniaxial compression



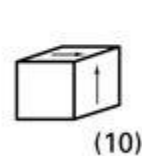
Biaxial compression



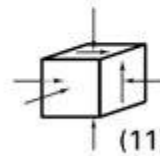
Biaxial compression, tension



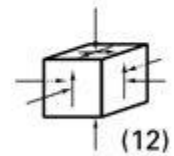
Triaxial compression



Pure shear



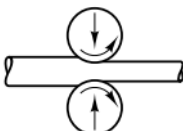
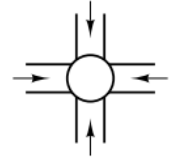
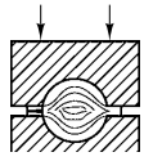
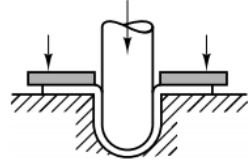
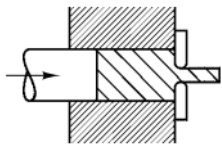
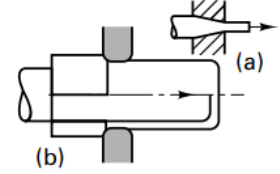
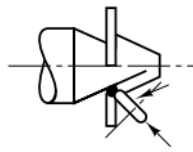
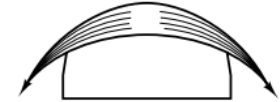
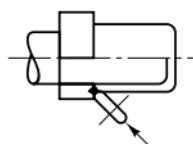

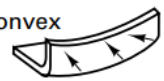

Simple shear with triaxial compression



Biaxial shear with triaxial compression

# Classification of Some Forming Operations

Classification of Some Forming Operations

Process	Schematic Diagram	State of Stress in Main Part During Forming <sup>a</sup>			
Rolling		7	Swaging or kneading		7
Forging		9	Deep drawing		In flange of blank, 5 In wall of cup, 1
Extrusion		9	Wire and tube drawing		8
Shear spinning		12	Stretching		2
Tube spinning		9	Straight bending		At bend, 2 and 7
			Contoured flanging	(a) Convex 	At outer flange, 6 At bend, 2 and 7
				(a) Concave 	At outer flange, 1 At bend, 2 and 7

<sup>a</sup>Numbers correspond to those in parentheses of previous slide's table.

# Independent and Dependent Variables Linked

## Independent variables

Starting material  
Starting geometry  
Tool geometry  
Lubrication  
Starting temperature  
Speed of deformation  
Amount of deformation

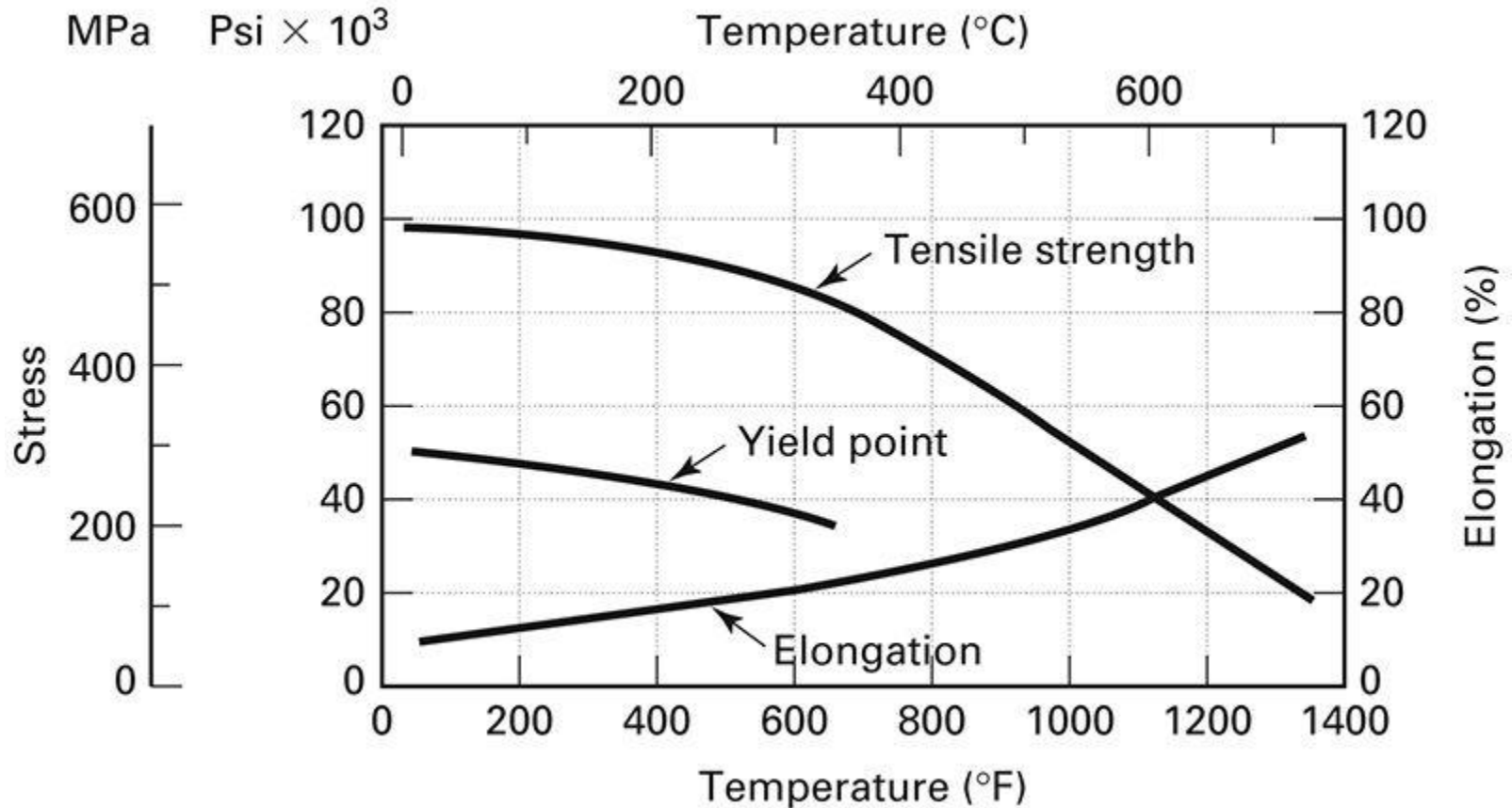
## Links

-Experience-  
-Experiment-  
-Modeling-

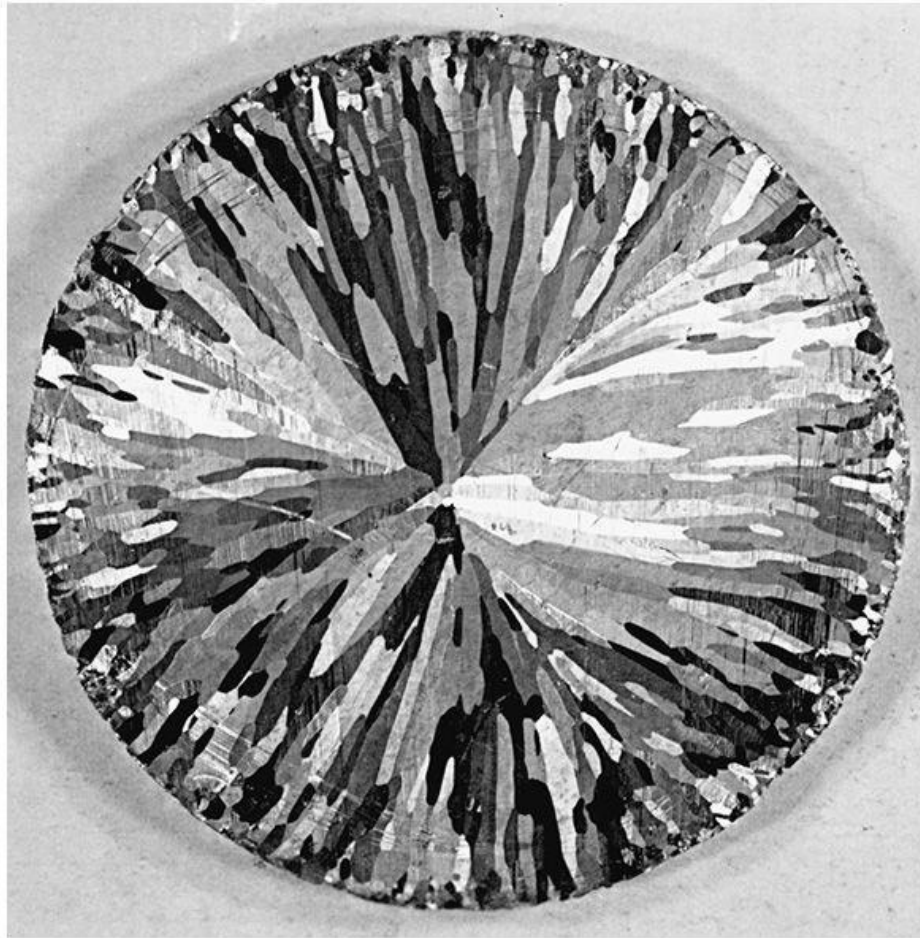
## Dependent variables

Force or power requirements  
Product properties  
Exit temperature  
Surface finish  
Dimensional precision  
Material flow details

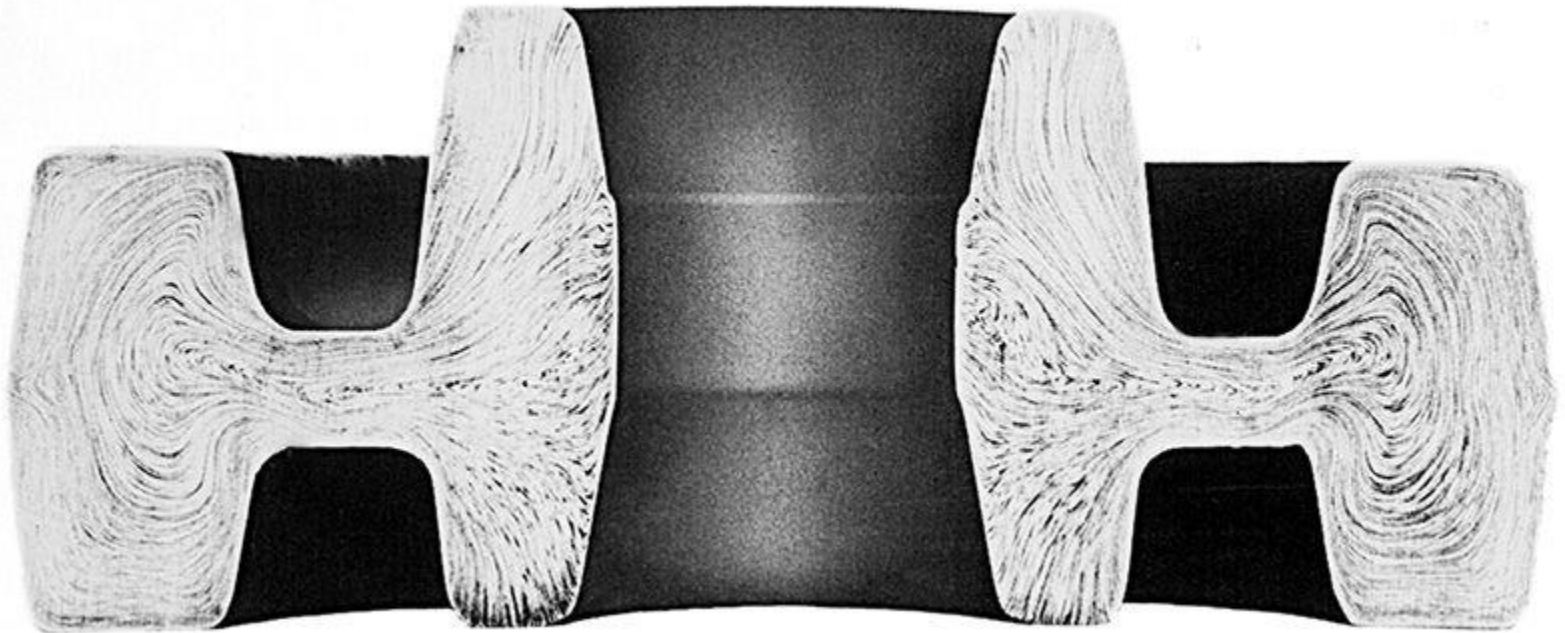
# Effects of Temperature



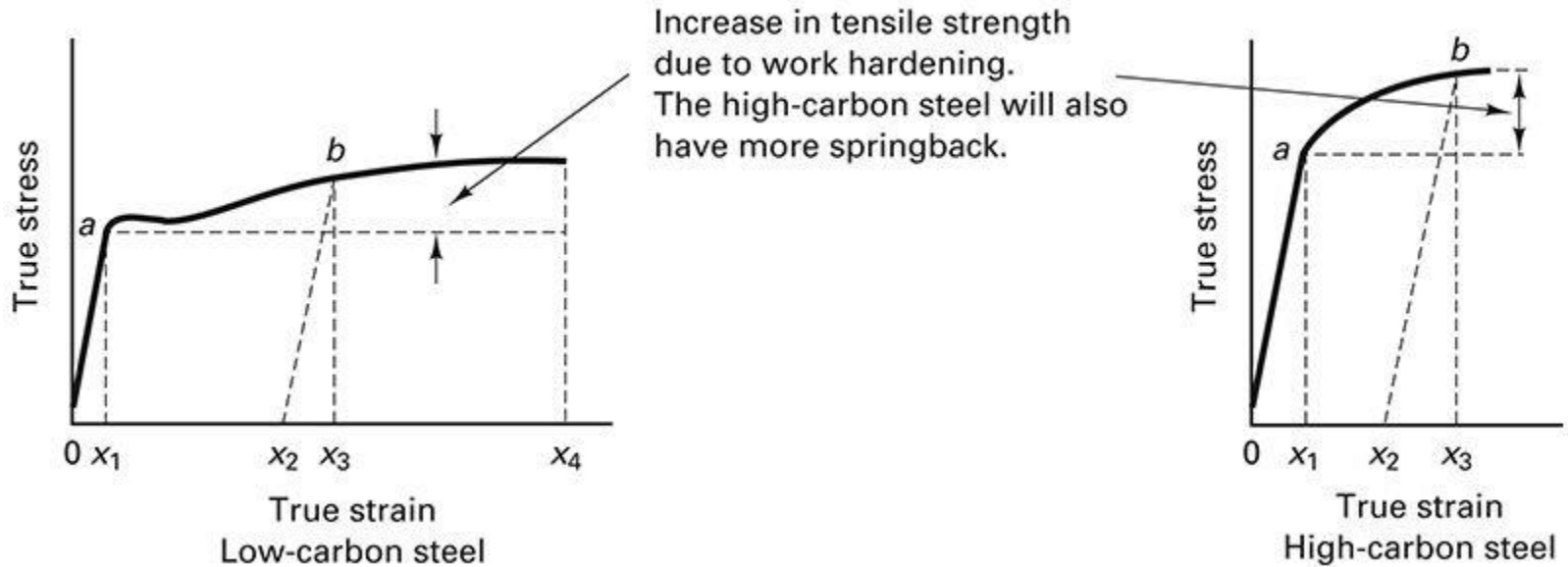
# Cast Structure



# Flow Structure

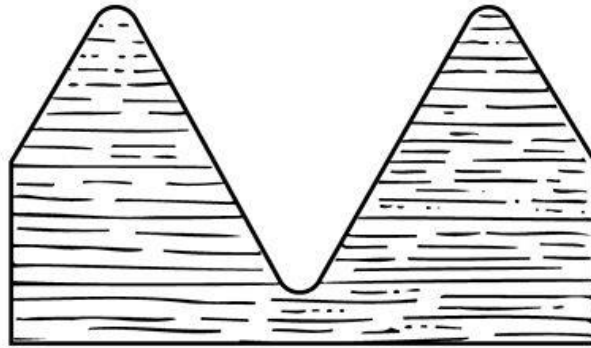


# Springback

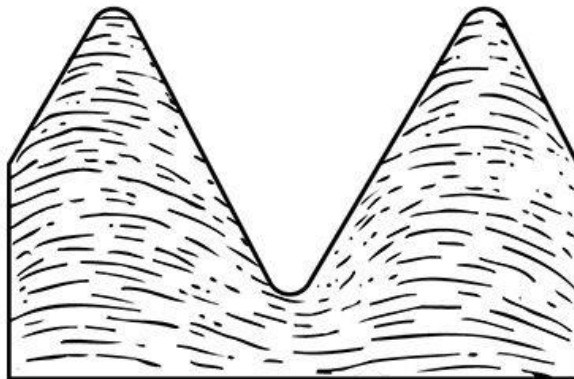




# Machined vs. Rolled Threads

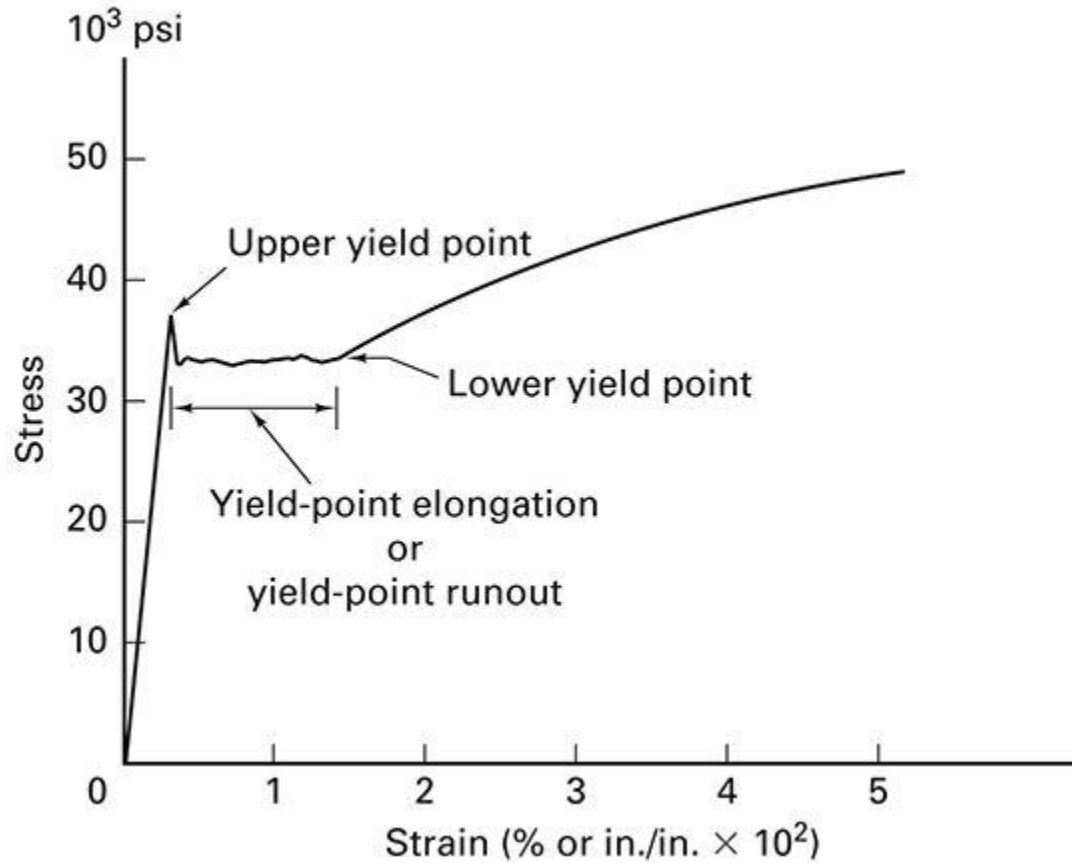


(a)

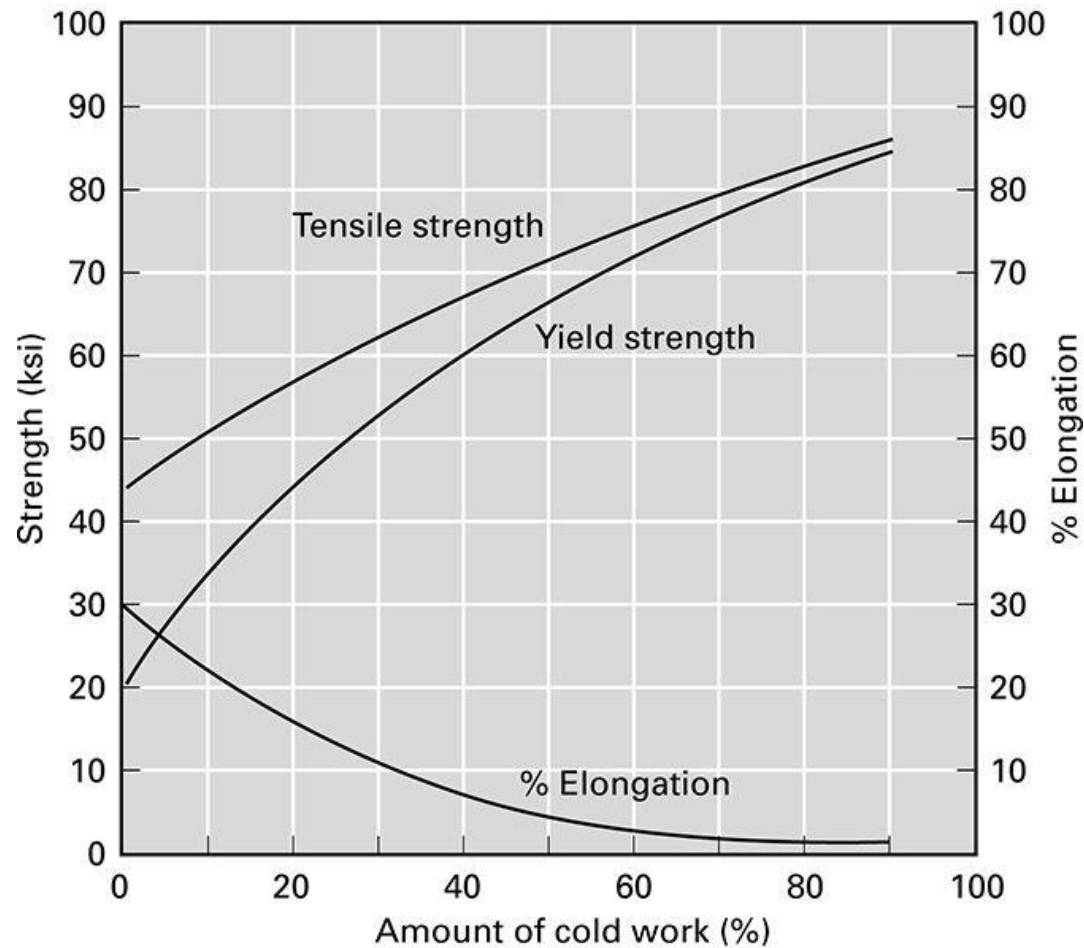


(b)

# Luders Bands



# Mechanical Properties vs. Cold Work



# Yield Strength vs. Temperature

