Department of Mechanical Engineering
Massachusetts Institute of Technology

2.830 Control of Manufacturing Processes
Spring 2004

Assignment #2

Out: 2/11/04
Due: 2/19/04

We will use a series of processes to produce simple parts. A sufficient number of parts will be produced to get a measure of the "natural" variation of the processes. In addition, intentional changes will be made to the process to determine the effect on the output.

For each of the processes listed below, there will be at least *four distinct operating conditions as defined by setup, material or input changes*. Our goal is to plot each of these separately to display general variation and then to compare the effect of the different conditions on mean values and variation.

Excel data sheets are attached to this assignment, and will be available in the lab:
Please be sure to fill in all columns of the sheet for every test!

Process:	***Sheet Metal Cutting***
Specifications:	Produce 1" wide pieces from 5" wide strip
Materials:	0.028" Steel
	0.040" Aluminum
Machine Input	Fence position
Output	Part width and taper
Measurements	Width at each end; average and difference (2 outputs)
Operating Conditions	2 Materials (Only 2 for this process)
Assignment:	Plot run chart for average width and for taper for each material This will be 4 charts
	Compare and assess level of process noise
	Hypothesize noise sources

Process	***Brake Bending***
Specifications	Bend blanks to two different depths:
	0.3" depth, 0.6 in depth
Materials	Same as above steel and aluminum
Machine Input	Tailstock rotations
Output	Part angle and radius of bend
Measurement	Part angle
Operating Conditions	2 Materials (Only 2 for this process)
	2 Punch depths
Assignment:	Plot run chart for each case separately: material-depth This will be 4 charts
	Determine effect of forming conditions (material/depth) on process variability

Process:	***CNC Turning***
Specifications	Turn parts from 0.750 to 0.625" diameter
Materials	Aluminum bar
Machine Inputs	CNC tool program (axis positions/speeds) Spindle speed, feed
Output	Part diameter and location on bar (inner, middle outer)
Operating Conditions	2 Spindle Speeds 2 Feeds
Assignments	Plot run chart for each case separately: feedrate-Spindle speed This will be 4 charts Determine effect of machining conditions (material/feed) on process variability

Process:	***Thermo-forming***
Specifications	Form parts to mold shape
Materials	Polystyrene sheet, 0.020" and 0.040" thickness
Machine Inputs	Heater time heater temperature
Output	Part diameter
Operating Conditions	2 Material thicknesses 2 Heater residence times
Assignments	Plot run chart for each case separately: material-time This will be 4 charts Determine effect of forming conditions (material/time) on process variability

Process:	***Injection Molding***
Specifications	Form parts to mold shape
Materials	Polypropylene
Machine Inputs	Barrel temp Injection speed/profile packing pressure hold time
Output	Part diameter
Operating Conditions	2 Hold Times 2 Injection Velocities
Assignments	Plot run chart for each case separately: Hold time - velocity This will be 4 charts Determine effect of machine conditions (hold time - velocity) on process variability

NB: Please do not change the operating conditions unless told to do so by your lab instructor. This will insure that we get a uniform dataset over all 3 shifts

Procedure

1. Form 5 teams

2. Each team should designate operators, measurers and data loggers

Team 1	Sheet Cutting	Injection Molding	Turning
Team 2	Sheet Bending	Thermo Forming	Injection Molding
Team 3	Injection Molding	CNC Turning	Sheet Cutting
Team 4	Thermo Forming	Sheet Cutting	Sheet Bending
Team 5	CNC Turning	Sheet Bending	Thermo Forming

3. Each team will be responsible for collecting *all* data sheets for all three "shifts" for a one of the processes:

Team 1:	Sheet cutting
Team 2:	Sheet bending
Team 3:	CNC turning
Team 4:	Thermo-forming
Team 5	Injection Molding

4. Each team should use the attached Excel sheet for their process and combine data from all three shifts. Again, be sure to have entries in all columns listed.

5. Each team should then send their spreadsheet for the process listed in 3.) to all of the class and to Hardt by the end of lab day (Thursday 2/12).

6. **Each student** will consider only the data for the three processes they worked with. You should write up a short set of observations and conclusions based on the data. In particular, we want you to address:

- The basic variation of the process as reflected in the data (how would you characterize the variation)How the different operating conditions affected the mean value and variation.
- What other factors influenced the mean value and the variation of the output (intentional and otherwise).
- A discussion of the relationship between the input you manipulated and the process output, and other machine outputs.
- An assessment of the "precision " of the process and how it could be improved

Make use of appropriate plots to illustrate your conclusions, but do not use any detailed statistics at this point.