HOMEWORK 7

1) Most control charts choose 3 sigma 𝜎 levels for CLs:

    a) If narrower limits are chosen, what happens to type I and type II error?

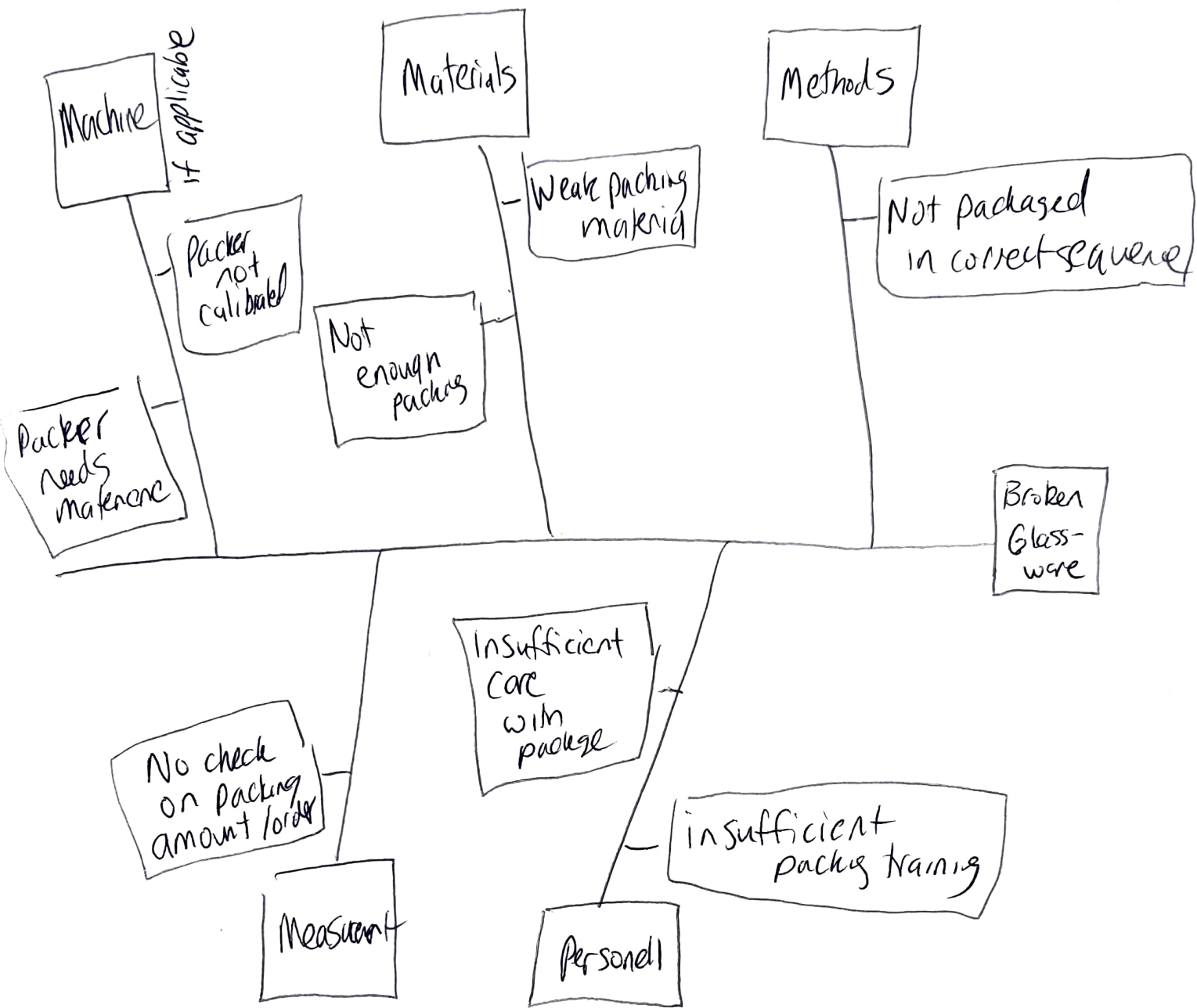Type I error (α): concluding the process is out of control when it is not

If the limits are decreased, type I error will increase.

Type II error: claiming the process is in control when it is really not

If the limits are decreased, Type II error will decrease.

    b) Type I can be controlled via sigma level or α (higher sigma = lower α)

This is a fishbone (Ishikawa) diagram.

Machine (if applicable)
- Packer not calibrated
- Packer needs maintenance

Materials
- Weak packing material
- Not enough packing

Methods
- Not packaged in correct sequence
- Broken Glassware

Measurement
- No check on packing amount /order

Personell
- Insufficient care with package
- Insufficient packing training

3) Sketch out diagrams and explain why it is important to control both process mean and variability

If a process is controlled at μ_0 and σ_0, and most of the output is within spec, it would look like this:

σ_0

μ_0

Lower
Spec

Upper
Spec
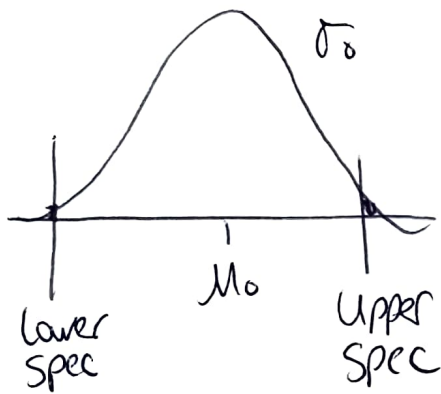
But if the process ~~mean has~~ mean has shifted to say $\mu_1 > \mu_0$ a ~~greater~~ greater fraction of output will be out of spec (for the same σ_0)

σ_0
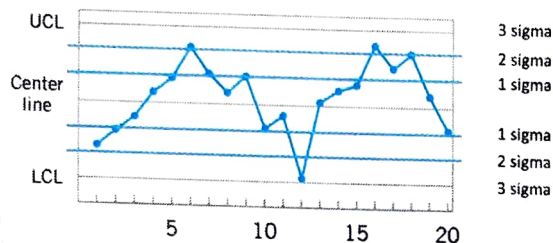
out of spec

μ_0 μ_1

Upper
spec

Lower
spec
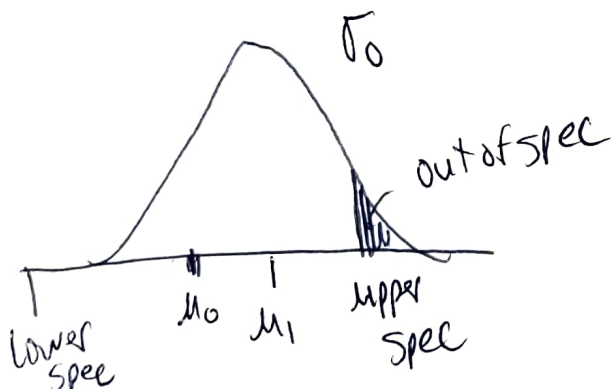
Also, if the standard deviation has shifted to $\sigma_1 > \sigma_0$ the output will also have a greater amount of out-of-spec material
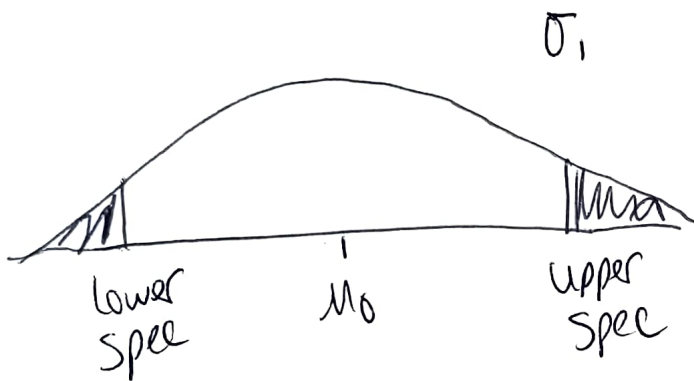
4) Problem 5.19

The plot shown appears to have a pattern, so no it in not random (appears somewhat cyclic)

5.22 Sketch the warning limts on the control
chart in 5.19 → yes - investigate or get more
samples
(look at action plan)

Sensitizing Rules:

✓ 5) 6 points in a row steadly
increasing or decreasing (yes)

6) 15 points in zone C in a row (no)

7) 14 points alternate up and down (no)

8) 8 points in a row on both sides of
centerline but none in zone C

✓ 9) non random patten

✓ 10) one or more points near
a CL

5.23 Are any of the following true?

1) One or more points is outside of the
control limit (no)

2) Two of 3 consecuative points out side
of 2-sigma ~~CL~~ WL but still in CL (no)

3) Four of Five consecuative points outside
of one-sigma ~~covered~~ WLs (no)

4) A run of 8 consecuative points ~~covered~~ on
one side of center line (no)

0.1 $\quad m=20 \quad n=4 \quad \sum_{i=1}^{20} \bar{x}_i = 10.275$

$$\sum_{i=1}^{20} R_i = 1.012$$

a) $\quad \bar{\bar{x}} = \dfrac{\sum_{i=1}^{20} \bar{x}_i}{20} = \dfrac{10.275}{20} = 0.51375$

$$\bar{R} = \dfrac{\sum_{i=1}^{20} R_i}{20} = \dfrac{1.012}{20} = 0.0506$$

For $\bar{x}$ chart:

$UCL = \bar{\bar{x}} + A_2 \bar{R} \implies 0.51375 + (0.729)(0.0506) = \boxed{0.5506}$

$LCL = \bar{\bar{x}} \ominus A_2 \bar{R} \implies 0.51375 - (0.729)(0.0506) = \boxed{0.4769}$

$A_2 = 0.729$

↗
From Table
in book

For R chart:

$UCL = D_4 \bar{R} = 2.282(0.0506) = \boxed{0.1155}$

$LCL = D_3 \bar{R} = 0(0.0506) = \boxed{0}$

$D_4 = 2.282 \quad D_3 = 0$

, Process mean is $\bar{\bar{x}} = \boxed{0.5138}$

Process standard deviation

$$\hat{\sigma} = \frac{\bar{R}}{d_2} = \frac{0.0506}{2.059} = \boxed{0.0246}$$

d_2 from back of book $\Rightarrow$ 2.059

6) ~~Problem~~ Problem 6.5 $n=2$

a) $\bar{\bar{x}} = \sum\limits_{i=1}^{20} \bar{x}_i = 7.57 \Rightarrow \dfrac{151.4}{20}$

$\bar{R} = \sum\limits_{i=1}^{20} R_i = 3.15 \Rightarrow \dfrac{63}{20}$

$\underline{\bar{x} \text{ bar}}$ $A_2 = 1.880$

$LCL = \bar{\bar{x}} - A_2 \bar{R} = 7.57 - (1.880)(3.15) = 1.648$

$UCL = \bar{\bar{x}} + A_2 \bar{R} = 7.57 + (1.880)(3.15) = 13.49$

$\underline{R}$ $D_3 = 0$ $D_4 = 3.267$

$LCL = D_3 \bar{R} = 0(3.15) = 0$

$UCL = D_4 \bar{R} = 3.267(3.15) = 10.29$

Yes! It looks like it is. In control

Rbar	R UCL	R LCL	Xbar UCL	Xbar LCL	Xdbar	Subgroup	Xbar	R
3.15	10.29105	0	13.492	1.648	7.57	1	8.3	2
3.15	10.29105	0	13.492	1.648	7.57	2	8.1	3
3.15	10.29105	0	13.492	1.648	7.57	3	7.9	1
3.15	10.29105	0	13.492	1.648	7.57	4	6.3	5
3.15	10.29105	0	13.492	1.648	7.57	5	8.5	3
3.15	10.29105	0	13.492	1.648	7.57	6	7.5	4
3.15	10.29105	0	13.492	1.648	7.57	7	8	3
3.15	10.29105	0	13.492	1.648	7.57	8	7.4	2
3.15	10.29105	0	13.492	1.648	7.57	9	6.4	2
3.15	10.29105	0	13.492	1.648	7.57	10	7.5	4
3.15	10.29105	0	13.492	1.648	7.57	11	8.8	3
3.15	10.29105	0	13.492	1.648	7.57	12	9.1	5
3.15	10.29105	0	13.492	1.648	7.57	13	5.9	3
3.15	10.29105	0	13.492	1.648	7.57	14	9	6
3.15	10.29105	0	13.492	1.648	7.57	15	6.4	3
3.15	10.29105	0	13.492	1.648	7.57	16	7.3	3
3.15	10.29105	0	13.492	1.648	7.57	17	5.3	2
3.15	10.29105	0	13.492	1.648	7.57	18	7.6	4
3.15	10.29105	0	13.492	1.648	7.57	19	8.1	3
3.15	10.29105	0	13.492	1.648	7.57	20	8	2

Xbar chart

R chart

■ TABLE 6E.1
Hospital Admission Time Data for Exercise 6.5

Subgroup	$\bar{x}$	R	Subgroup	$\bar{x}$	R
1	8.3	2	11	8.8	3
2	8.1	3	12	9.1	5
3	7.9	1	13	5.9	3
4	6.3	5	14	9.0	6
5	8.5	3	15	6.4	3
6	7.5	4	16	7.3	3
7	8.0	3	17	5.3	2
8	7.4	2	18	7.6	4
9	6.4	2	19	8.1	3
10	7.5	4	20	8.0	2

Sum of xbar	151.4	G3 sum of R
X double bar	7.57	3.15 Rbar

R	LCL	0	X	LCL	1.648
	UCL	10.29105		UCL	13.492
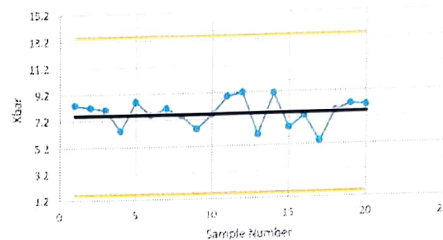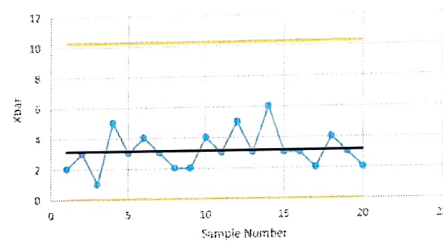
Problem 6.8a   If you check the rules
            - none are violated so
              the process appears in control

Xbar Chart of X1, ..., X4

- UCL=14.538
- +2SL=13.134
- +1SL=11.729
- $\bar{\bar{X}}$=10.325
- -1SL=8.921
- -2SL=7.516
- LCL=6.112

(y-axis: Sample Mean, values 6–15; x-axis: Sample, 1–19)

R Chart of X1, ..., X4

- UCL=14.26
- $\bar{R}$=6.25
- LCL=0

(y-axis: Sample Range, values 0–16; x-axis: Sample, 1–19)