Stat 235

Lab 2

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Lab EL12

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# 1 Normal Density

## 1.a

As $\sigma$ increases, there is more variation in the tensile strength (makes sense, since $\sigma^2 = V(x)$). This is seen visually as the curve flattening as a result of the frequency count of the mean being lowered, and the frequency counts at the more extreme ends being increased. In terms of tensile strength, an increase in $\sigma$ does not change the mean but it increases the variation in tensile strength. This means that less of the alloy produced will be around the mean tensile strength, and simultaneously, the fraction of alloy slabs with unacceptable tensile strength will increase.

## 1.b

With lower $\mu$ ($\mu = 280$ for example), the graph appears left-skewed. This increases the fraction of unacceptable alloys with $TS < 275$. At $\mu = 285$, the graph appears to be symmetric, and at higher $\mu$ ($\mu = 290$ for example), the graph appears right-skewed. This increases the fraction of unacceptable alloys with $TS > 295$. Overall, as $\mu$ increases, the tensile strength of the alloys increase, which causes the fraction of unacceptable alloys below 275 to decrease and the fraction above 295 to increase.

# 2 Changes in the Mean and Std. Deviation

| | Parameters | Problem | Answer |
|---|---|---|---|
| a) | $\mu = 285$ and $\sigma = 5$ | Fraction of unacceptable | 0.045500264 |
| | $\mu = 283$ and $\sigma = 5$ | Fraction of unacceptable | 0.062996828 |
| b) | $\mu = 285$ and $\sigma = 6$ | Fraction of unacceptable | 0.095580705 |
| c) | $\mu = 285$ and $\sigma = 5$ | Within 1 std. deviation | 0.6827 |
| | | Within 2 std. deviations | 0.9545 |
| d) | $\mu = 285$ and $\sigma = 5$ | Strength exceeded by 95% | 276.78 |
| | | Strength exceeded by 99% | 273.37 |
| e) | $\mu = 285$ | $\sigma$ so that 1% have $TS < 275$ or $TS > 295$ | 3.88 |

Table 1: How changes in the Mean and Std. Deviation affect the fraction of alloy slabs that do not meet the TS Specifications

# 3 Random Number Generator

## 3.a

From the randomly generated data, the number of unacceptable slabs is 10.

$$fraction\ unacceptable = \frac{10}{200} = 0.05$$

0.05 is reasonably close to the value 0.045500264, obtained from 2 a) in Table 1, so it is consistent with the theoretical value.

### 3.b

| k | Within k Std. Deviations of the mean $\mu = 285$ | Frequency | Relative Frequency |
|---|---|---|---|
| 1 | (280, 290) | 130 | 0.65 |
| 2 | (275, 295) | 190 | 0.95 |
| 3 | (270, 300) | 199 | 0.995 |

Table 2: Acceptable slabs within certain standard deviations

With relative frequencies of 65%, 95%, and 99.5%, we clearly see that the data above is consistent with the 68-95-99.7 rule.

### 3.c

According to the theory, standardizing the values should result in a standard normal distribution. In practice, we observe a distribution that approximates a standard normal distribution.

### 3.d

Using the *Descriptive Statistics Tool*, we find the following from the standardized values:

$$\mu = -0.0546$$

$$\sigma = 1.0221$$

In theory, a standard normal distibution has $\mu = 0$, and $\sigma = 1$. The values obtained here are quite close to the expected distribution parameters of a standard normal distribution, so these values are consistent with the theory.

## 4 Changes in Manufacturing Process

### 4.a Summary Statistics

Using the *Desctiptive Statistics Tool, we find that*

$$\mu = 284.6889205$$

$$\sigma = 5.82582628$$

This is consistent with the target parameters $\mu = 285$ and $\sigma = 5$, as the values are fairly close, being off by less than a value of 1.

### 4.b Histogram

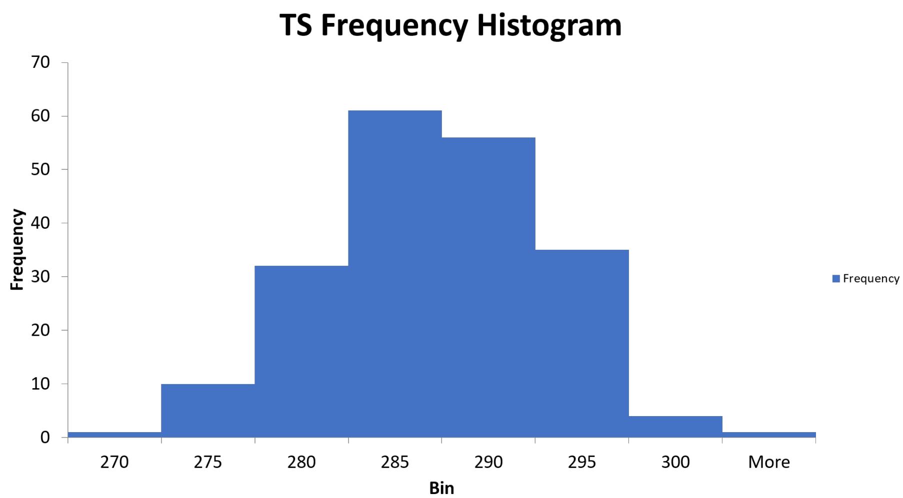


Figure 1: Tensile strengths for a sample of 200

The histogram above appears to be an approximately symmetric, normal distribution. There are no glaring indicators which would point to the data not following a normal distribution.

### 4.c

No. Assuming normality and large sample size, with $\mu = 284.6889205$ and $\sigma = 5.82582628$, we find that 8.65% of the slabs produced are unacceptable, which is above the 5% limit of unacceptable slabs.

### 4.d

The new manufacturing process has slightly lowered the mean tensile strength. Also, the standard deviation has increased a bit, which may suggest that the new manufacturing process is slightly less consistent. These changes did not seem to affect the normality of the distribution in any significant way.

## 5 Binomial Probabilities

### 5.a

Using the *Binomial Probabilities* worksheet, we obtain the following:

| | |
|---|---|
| n | 200 |
| x | 15 |
| p | 0.05 |
| $P(X > x)$ | 0.0444 |

## 5.b

Using the *Binomial Probabilities* worksheet, and the *Normal Probabilities* worksheet to find $p$ we obtain the following:

| | |
|---|---|
| n | 200 |
| x | 15 |
| p | $1 - 0.9545 = 0.0455$ |
| $P(X > x)$ | 0.0213 |