XMP Trigger Pull force Study - TLW 2358

Background

The following analysis relates to a study done to characterize the trigger pull forces as found in a sample of 50 firearms withdrawn from the warehouse using 3 different measurement methods. There were two main questions the study addressed:

1. Did the firearms sampled meet the specifications for trigger pull of 3.5 lb. minimum and 5.5 lb. maximum force?
2. Is there a statistically significant difference between the three methods of measuring the trigger pull force?

The first method evaluated and duplicated the technique and equipment used by the manufacturing plant and used a Chatillon Spring scale, (10 lb. max. range.) Method two used Lyman Digital Scale and method three used the Dvorak Trigger Pull machine currently used by the R&D site in Elizabethtown. All three devices were calibrated using the standard procedure recommended for each individual device.

Prior to the start of the study, an additional question was posed. Was there a detectable difference in trigger pull force that was dependent upon whether the safety was cycled during the operation (SC) or not cycled during the measurement operation (NSC)?

Analysis

At the start of the analysis the data was checked to determine if the distributions could be considered as Normal. See Figure 1. A test for normality, (Anderson-Darling), determined that all six test methods could be assumed to be fairly represented by Normal distributions.

A table of Descriptive Statistics (see Table 1) summarized the data from all six methods. The means for all six methods ranged from 4.2 lb. (labeled as Chatillon SC) to 5.2 lb. (labeled as Lyman SC.) The Minimum valued was 3.0 lb. (labeled as Chatillon SC) and the maximum value was 6.9 lb. (labeled as Lyman NSC.)

The total percentage of firearms that did not meet the specifications for trigger pull force ranged from 8.2% (Chatillon) to 22.4% (Lyman) depending on the method used to measure the force. (See Table 2.)

A comparison of the distributions for all six methods (See Figures 2 & 3) shows an average difference of approximately ½ lb. (i.e. .554 lb.) between the Chatillon SC method and the Dvorak SC method. Standard deviations between these two methods differed by approximately $1/10^{th}$ of a lb.

Table 3 gives the results of an ANOVA (Analysis of Variance) for the six methods and indicates that there is a statistically significant (95% C.I.) difference between the methods used with the largest difference detected between the Chatillon Spring Scale device and the other two measurement devices. The lowest average readings were taken with the Chatillon device and the highest average readings were taken with the Lyman device with the Dvorak device averaging between the other two. The biggest difference in technique (i.e. SC and NSC) was found on the Dvorak device. The other two devices did not appear to be different when comparing the SC and NSC techniques.

Tables 4 &5 and Figures 4 & 5 breaks the analysis down in terms of the two techniques (SC and NSC). Figure 7 looks at the differences between techniques (SC vs. NSC) within each method (Chatillon, Lyman, and Dvorak).

Conclusions:

1. Regardless of the method used, there were trigger pulls that were measured to be out of specifications, either about 8% of the sample or about 20% of the sample depending on the device being used. Whether the forces measured indicated that the trigger pulls were over or under the specification depended (primarily) on the device being used. The Chatillon gauge found pulls that were under the

specification (but not out on the high side.) The Lyman and Dvorak found pulls to be out of specification on both the high and low side of the specification but, generally out on the high side. (See Table 2 for reference.)

2. There appears to be a bias (statistically significant) introduced into the measurement process by the devices being used with the Chatillon gauge measuring the same fire control approximately ½ lb. lower, on average, than the other two devices. Consequently, using the Chatillon gauge will tend to find that trigger pull forces are lower than would be found by the other two devices and would not pick up the higher forces found by the Dvorak or the Lyman.

Supporting data:

Descriptive Statistics: Chatillon SC, Chatillon NSC, Lyman SC, Lyman NSC, Dvorak SC, Dvorak NSC

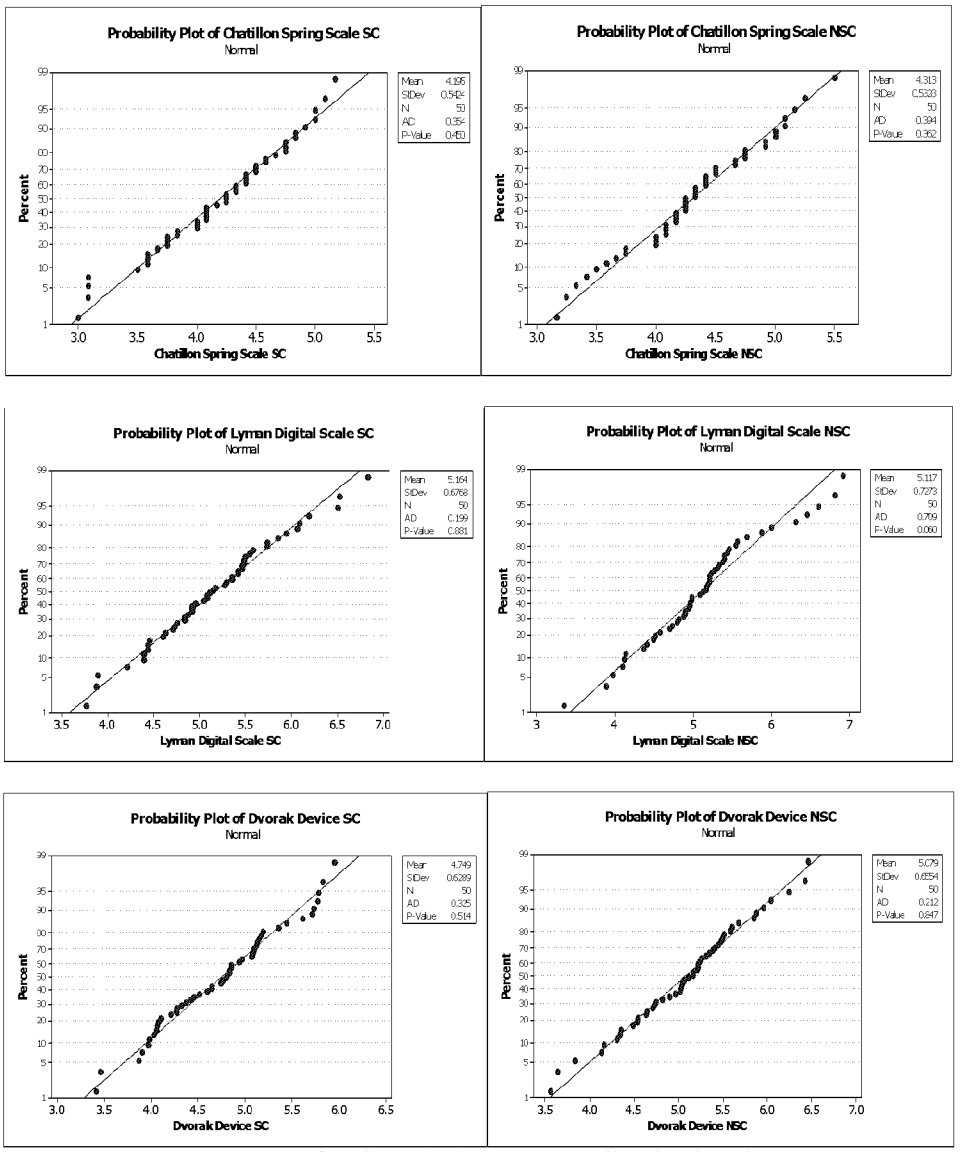
Variable	Mean(lb.)	SE Mean	StDev	Minimum	Maximum	Range
Chatillon SC	4.1949	0.0767	0.5424	3.0000	5.1670	2.1670
Chatillon NSC	4.3134	0.0754	0.5328	3.1670	5.5000	2.3330
Lyman SC	5.1642	0.0957	0.6768	3.7710	6.8330	3.0620
Lyman NSC	5.1170	0.103	0.727	3.354	6.917	3.563
Dvorak SC	4.7491	0.0889	0.6289	3.4150	5.9470	2.5320
Dvorak NSC	5.0785	0.0927	0.6554	3.5620	6.4560	2.8940

Table 1

Method	Number Under Min. Spec.	Percentage Under Min. Spec. N=50	Number Over Max. Spec.	Percentage Over Max. Spec. N=50	Total Number Out of Spec.	Total Percentage Out of Spec.
Chatillon SC	4	8.2%	0	0.0%	4	8.2%
Chatillon NSC	4	8.2%	0	0.0%	4	8.2%
Lyman SC	0	0.0%	11	22.4%	11	22.4%
Lyman NSC	1	2.0%	9	18.4%	10	20.4%
Dvorak SC	2	4.1%	6	12.2%	8	16.3%
Dvorak NSC	0	0.0%	10	20.4%	10	20.4%

Note: Gun # 12 not counted in this table

Table 2



Note: Data for all Methods were Normally Distributed.

Figure 1

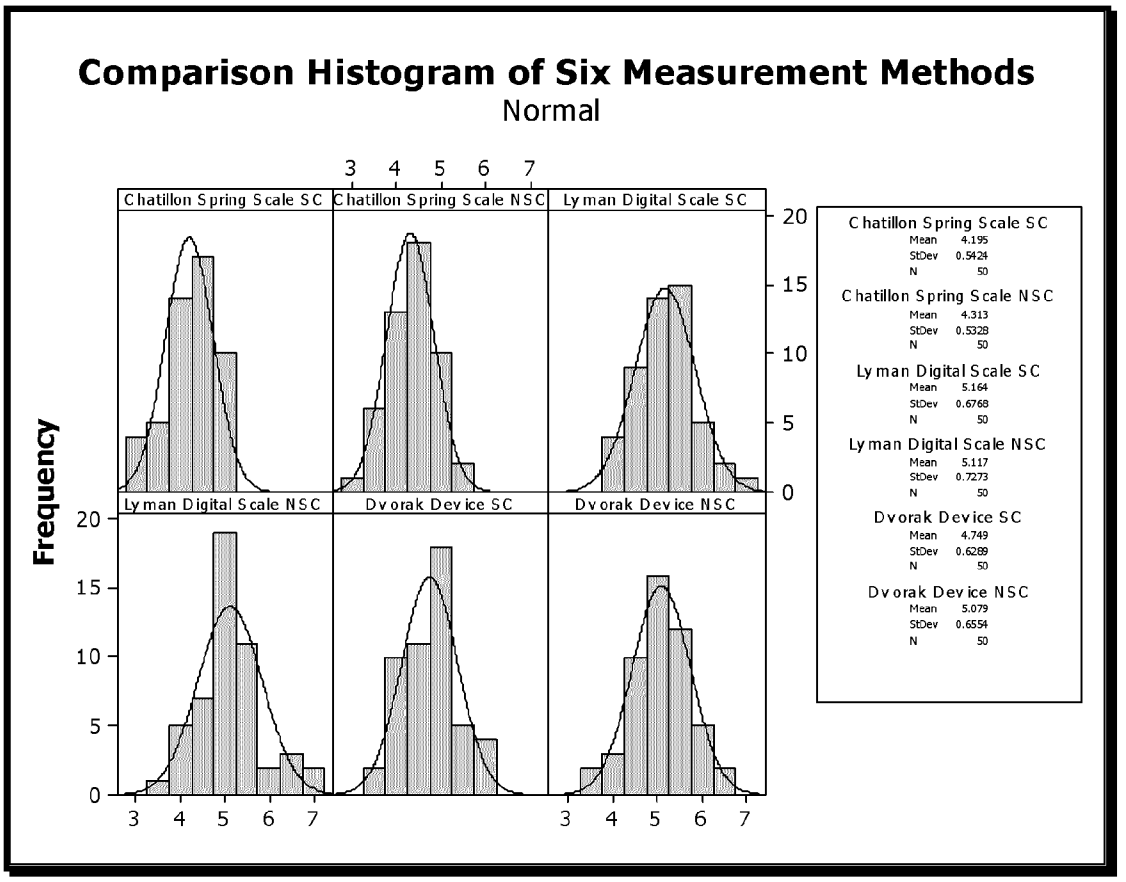

Comparison Histogram of Six Measurement Methods
Normal
Chatillon Spring Scale SC
Chatillon Spring Scale NSC
Lyman Digital Scale SC
Lyman Digital Scale NSC
Dvorak Device SC
Dvorak Device NSC
Frequency
Chatillon Spring Scale SC
Mean 4.195
StDev 0.5424
N 50
Chatillon Spring Scale NSC
Mean 4.313
StDev 0.5328
N 50
Lyman Digital Scale SC
Mean 5.164
StDev 0.6768
N 50
Lyman Digital Scale NSC
Mean 5.117
StDev 0.7273
N 50
Dvorak Device SC
Mean 4.749
StDev 0.6289
N 50
Dvorak Device NSC
Mean 5.079
StDev 0.6554
N 50

Figure 2

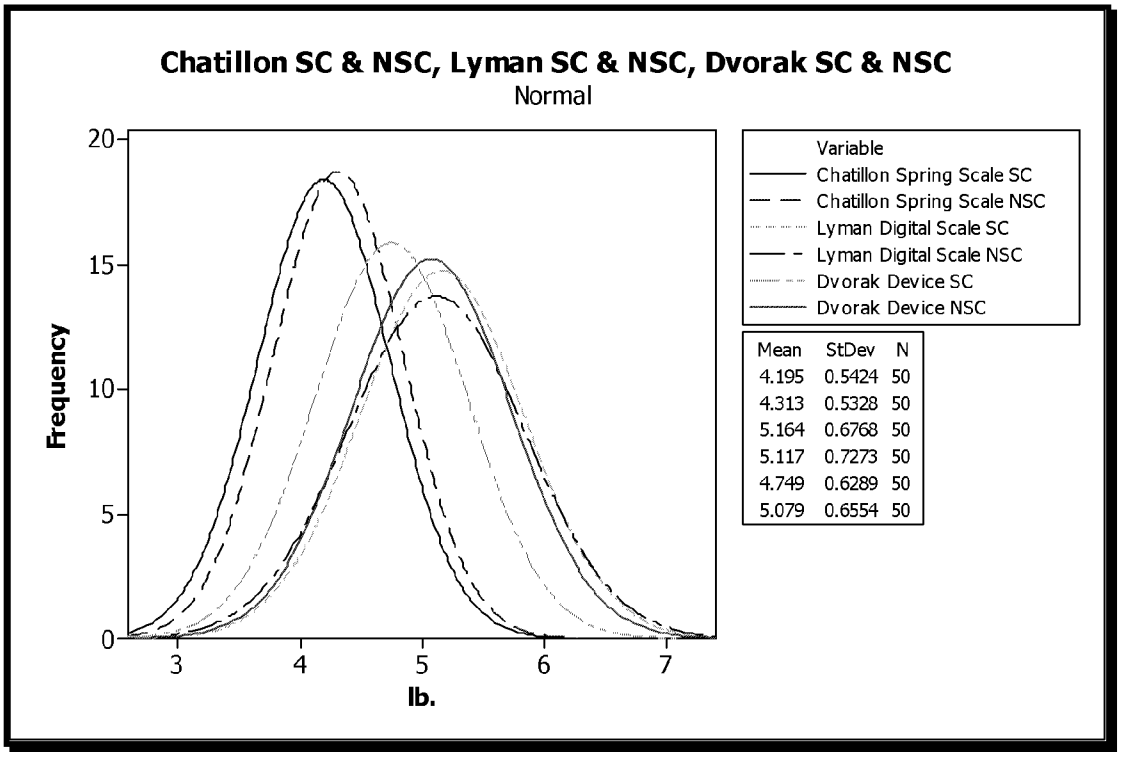


Figure 3

One-way ANOVA: Chatillon SC, Chatillon NSC, Lyman SC, Lyman NSC, Dvorak SC, & Dvorak NSC

Source	DF	SS	MS	F	P
Factor	5	45.537	9.107	22.86	0.000
Error	294	117.113	0.398		
Total	299	162.650			

S = 0.6311 R-Sq = 28.00% R-Sq(adj) = 26.77%

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
Chatillon SC	50	4.1949	0.5424	(----*----)
Chatillon NSC	50	4.3134	0.5328	(----*----)
Lyman SC	50	5.1642	0.6768	(----*----)
Lyman NSC	50	5.1171	0.7273	(----*----)
Dvorak SC	50	4.7491	0.6289	(----*----)
Dvorak NSC	50	5.0785	0.6554	(----*----)

4.20 4.55 4.90 5.25

Pooled StDev = 0.6311

Note: There is a statistically significant difference between the Dvorak SC and the Dvorak NSC methods (in red above.).

Table 3

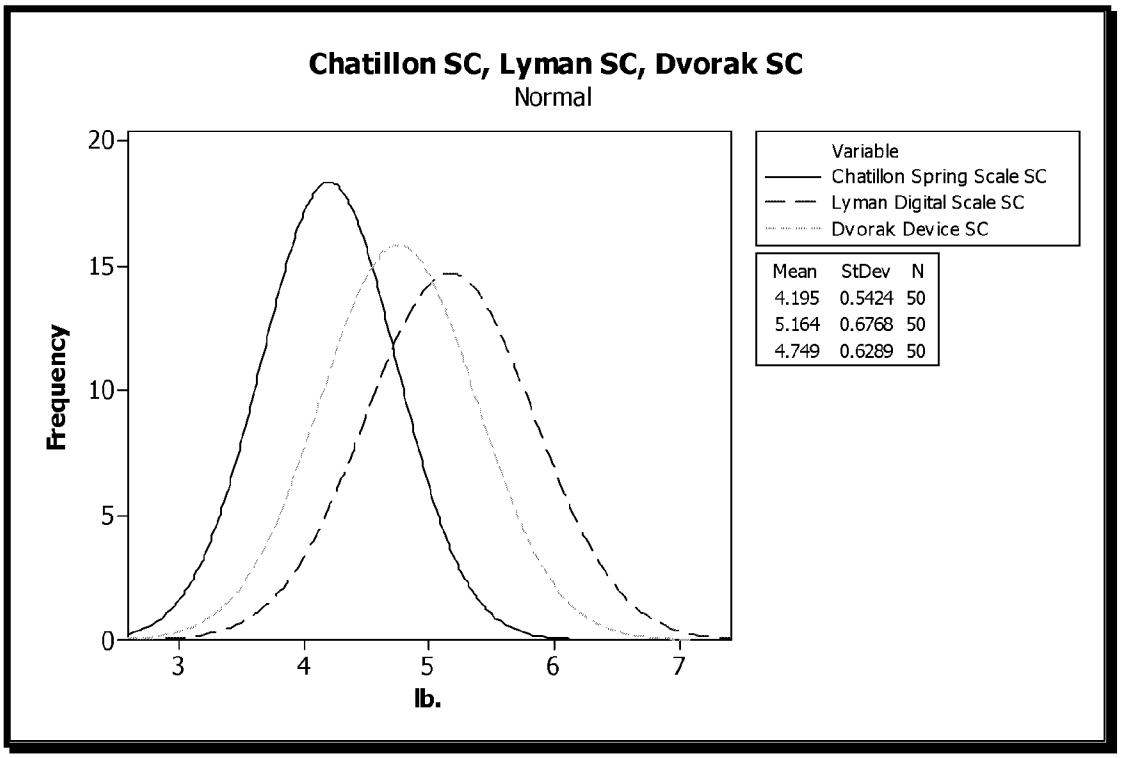


Figure 4

One-way ANOVA: Chatillon SC, Lyman SC, Dvorak SC

```
Source   DF      SS      MS      F      P
Factor    2  23.648  11.824  30.91  0.000
Error   147  56.240   0.383
Total   149  79.888

S = 0.6185   R-Sq = 29.60%   R-Sq(adj) = 28.64%

                                          Individual 95% CIs For Mean Based on
                                          Pooled StDev
Level              N    Mean   StDev  -----+---------+---------+---------+----
Chatillon SC      50  4.1949  0.5424  (----*----)
Lyman     SC      50  5.1642  0.6768                          (----*---)
Dvorak    SC      50  4.7491  0.6289                 (----*----)
                                          -----+---------+---------+---------+----
                                             4.20      4.55      4.90      5.25

Pooled StDev = 0.6185
```

Table 4

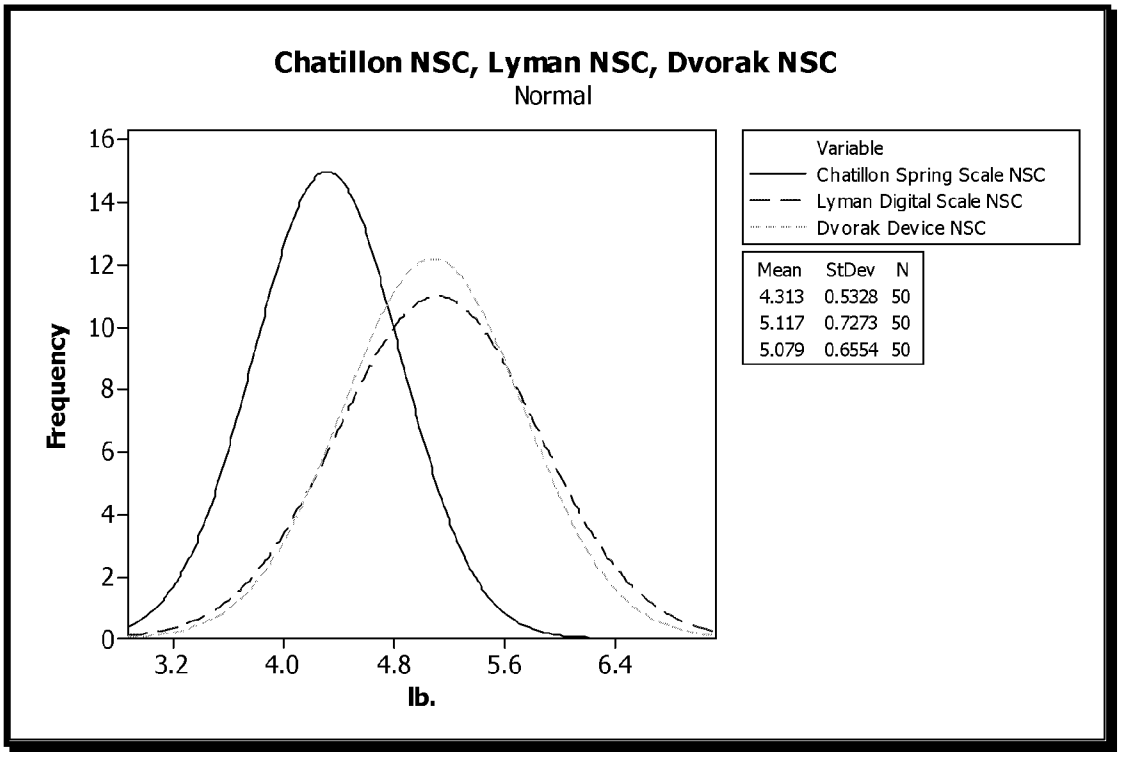


Figure 5

One-way ANOVA: Chatillon NSC, Lyman NSC, Dvorak NSC

Source	DF	SS	MS	F	P
Factor	2	20.550	10.275	24.81	0.000
Error	147	60.873	0.414		
Total	149	81.423			

S = 0.6435 R-Sq = 25.24% R-Sq(adj) = 24.22%

Level	N	Mean	StDev
Chatillon NCS	50	4.3134	0.5328
Lyman NSC	50	5.1171	0.7273
Dvorak NSC	50	5.0785	0.6554

Individual 95% CIs For Mean Based on Pooled StDev

```
--+---------+---------+---------+-------
(-----*-----)
                        (-----*-----)
                      (-----*-----)
--+---------+---------+---------+-------
4.20      4.50      4.80      5.10
```

Pooled StDev = 0.6435

Table 5

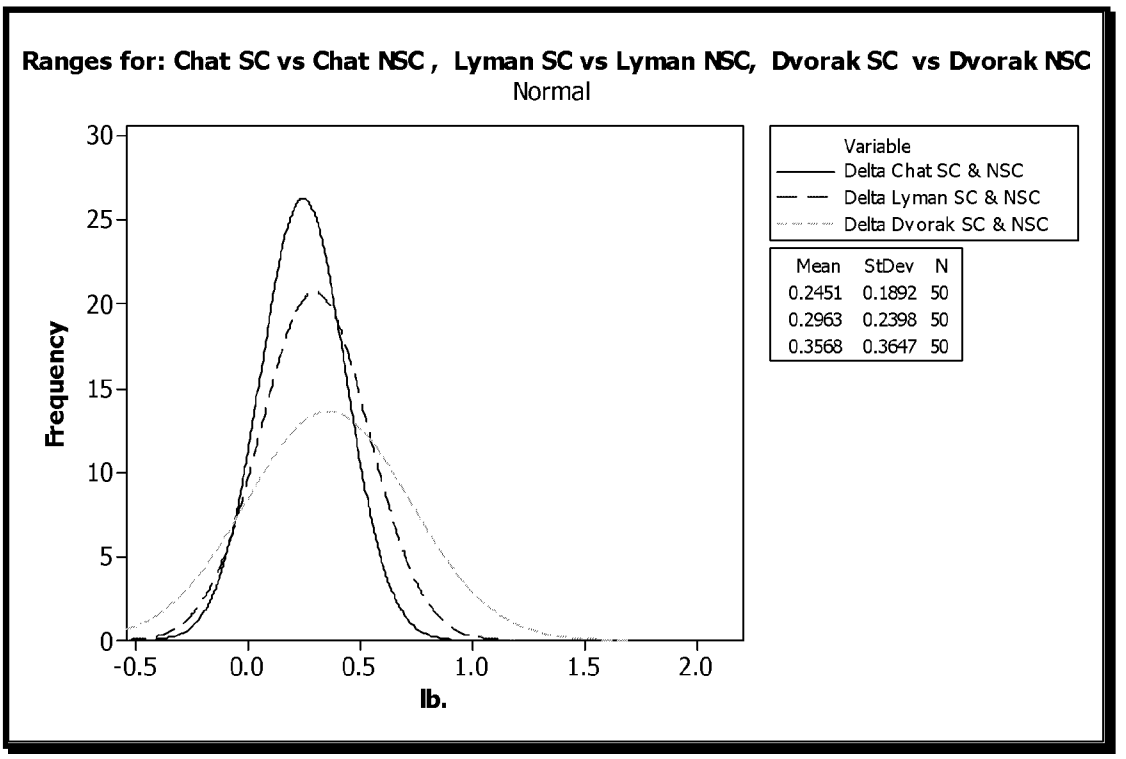


Figure 6

One-way ANOVA: Delta Chat SC & NSC, Delta Lyman SC & NSC, Delta Dvorak SC & NSC

Source	DF	SS	MS	F	P
Factor	2	0.3125	0.1563	2.07	0.130
Error	147	11.0899	0.0754		
Total	149	11.4024			

S = 0.2747 R-Sq = 2.74% R-Sq(adj) = 1.42%

Level	N	Mean	StDev
Delta Chat SC &	50	0.2451	0.1892
Delta Lyman SC &	50	0.2963	0.2398
Delta Dvorak SC	50	0.3568	0.3647

Individual 95% CIs For Mean Based on Pooled StDev

```
------+---------+---------+---------+---
(----------*----------)
       (----------*----------)
                 (----------*----------)
------+---------+---------+---------+---
    0.210     0.280     0.350     0.420
```

Pooled StDev = 0.2747

Table 6

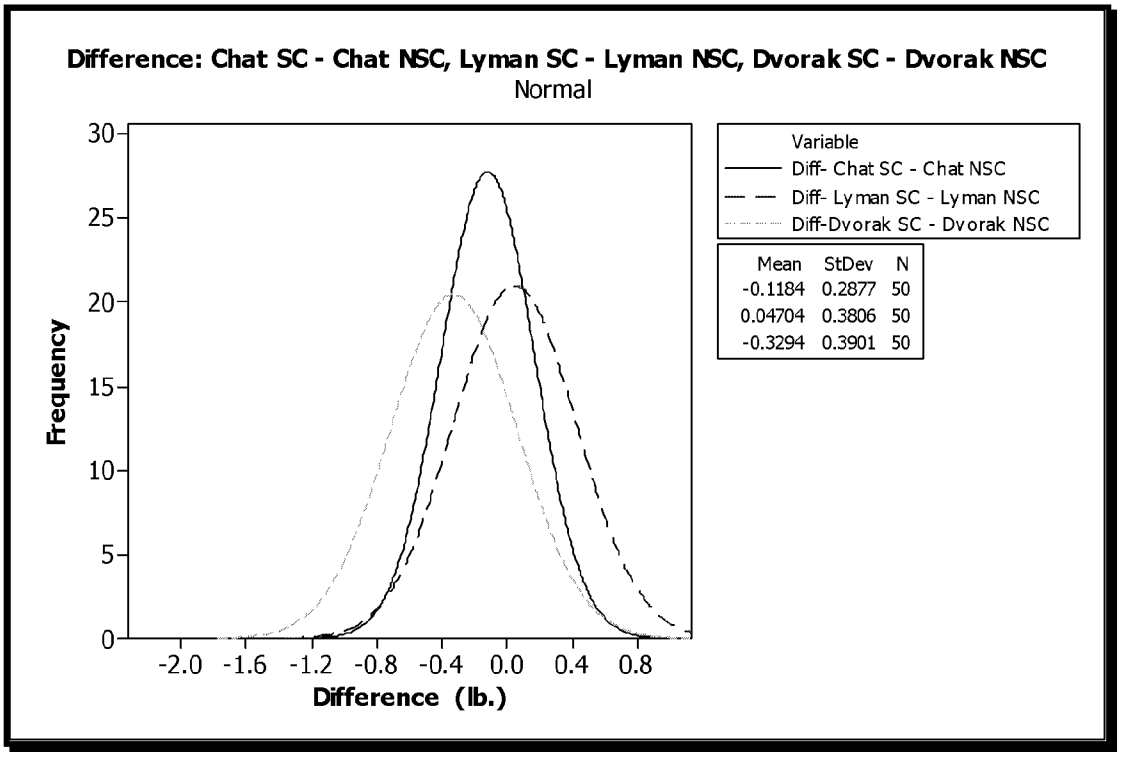


Figure 7

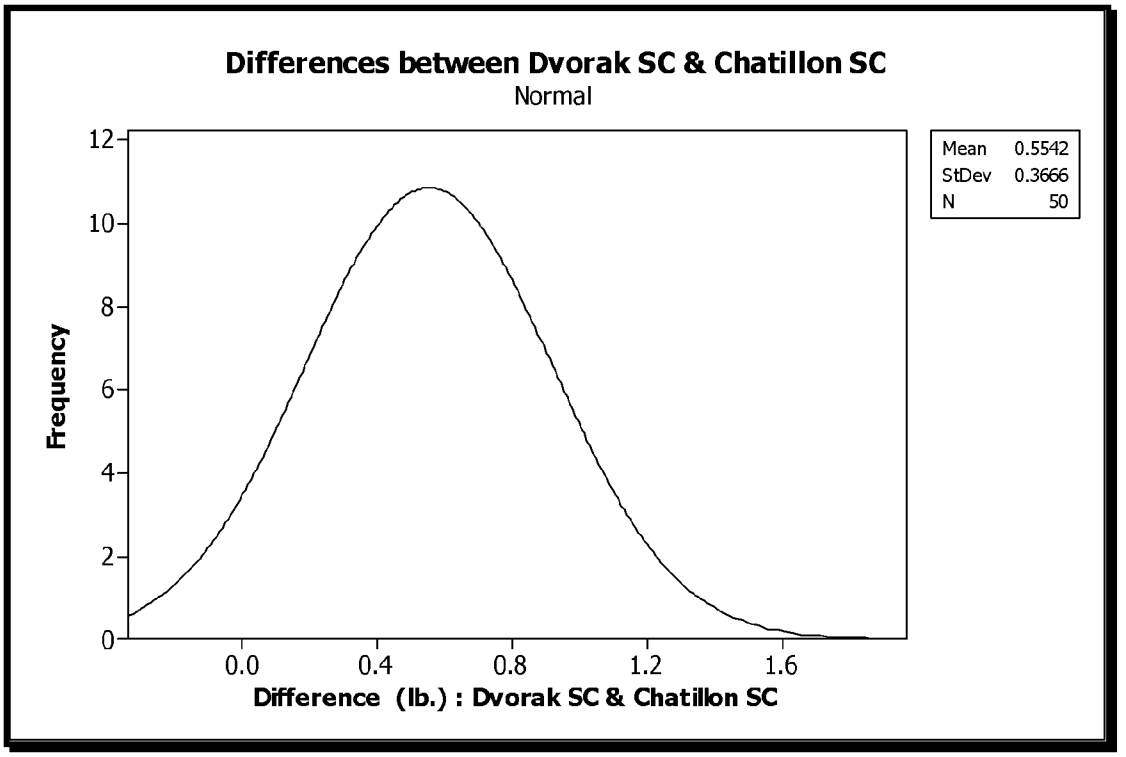


Figure 8