SAS/QC® AND SAS/GRAPH® AN EFFICIENT AND EASY MEANS TO ANALYZE PRODUCT CHARACTERISTICS AND CAPABILITIES

Jim R. McHenry

Weirton Steel Corporation

Weirton WV

ABSTRACT

This paper introduces the user to the basic code needed to utilize SAS/QC and SAS/GRAPH to generate histograms and bar charts to analyze product characteristics and process capabilities. The minimal code provides the novice user a better understanding of product and processes involved in their manufacturing. The code is simple and provides the basis for more complex and sophisticated programming and statistical analysis. It is the intent of this paper to demonstrate with simple code and data the potential wealth of information SAS/QC and SAS/GRAPH software can provide.

INTRODUCTION

Weirton Steel Corporation is a fully integrated steel mill with a unique difference. Weirton Steel is the largest employee-owned steel mill in the world, with approximately 8,000 employee-owners. With this situation Weirton Steel became solely responsible for analysis of the characteristics of products produced and the capabilities of the processes.

In this age of major foreign competition in the steel industry product characteristics and process capabilities must be constantly monitored to assure customer satisfaction and market competitiveness. The user with his knowledge of the product and processes has become invaluable. Teaming his knowledge and experience with data collection, input, and analysis has provided our company with a solid basis for knowledge and for growth.

With the use of SAS/QC and SAS/GRAPH, the users were able to quickly and efficiently monitor certain product characteristics and process capabilities in a professional manner, presenting clear and concise graphic and statistical documentation.

The purpose of this paper is to acquaint the user with easy to understand code using SAS/QC to generate histograms and SAS/GRAPH to generate bar charts defining subgroup variables included in the data. This paper will utilize only one basic dimensional characteristics of steel, thickness. The code provides a simple basis upon which to build more complex and sophisticated programs.

This paper will look at a single thickness of 0.0083 inches and the minimal code required by SAS/QC and SAS/GRAPH to generate charts and statistical analysis and some of the conclusions that can be dervied.

OBJECTIVES

With the many thousands of possible ways processes can be monitored in a manufacturing enviroment, certain factors must be considered as primary indicators. First the items must be considered that the consumer of these products consider as major quality factors. In the steel industry one consideration is gauge or thickness and the ability to consistently produce that gauge within the specification limits required. For purpose of demonstration an 0.0083 inch nominal gauge was chosen. In this case the end use of this product would be in the manufacture of tin cans. The thickness requirements his manufacturing process can tolerate and the economics of yield and consistency.

The main objective is to utilize basic data collected and study the statistical indices of this data. For the example hand micrometer readings will be collected at specific locations on the steel sheet. The locations must remain the same to maintain the integrity of the data and derived statistics. After the raw data has been collected the objective is to minimize the time for analysis of the results and possible recommendations.

With the SAS/QC software the cumbersome time that it may have taken in the past to write 200 lines of code or more to generate a histogram has been greatly reduced. Capability indices, normal curve functions, and other statistical tools have been incorporated into the software simply and concisely.

FROM RAW DATA TO QUALITY STATISTICAL RESULTS

In this program, the raw data must first be entered. In this example, the use of a simple input data step utilizing a cards approach is used. The data could have come from other permanent datasets in which the data was entered through screens developed by using SAS/FSP®. To keep it simple, in SECTION A, code variables for edge hand micrometer readings and center hand micrometer readings are intialized. These variables will be referred to as EDGE and CTR and will be located in a dataset called GAUGE.

```
        "SECTION A"
****************************************
**HAND MICROMETER EDGE AND CENTER
  READINGS RECORDED IN DATA GAUGE**
****************************************
DATA GAUGE;
 INPUT EDGE 1-6 CTR 12-17;
 CARDS;
0.0084     0.0085
0.0080     0.0082
0.0079     0.0082
0.0078     0.0080
0.0081     0.0083
0.0082     0.0084
0.0084     0.0085
0.0081     0.0083
0.0082     0.0083
0.0085     0.0086
0.0083     0.0084
0.0083     0.0083
0.0082     0.0083
0.0083     0.0084
0.0082     0.0083
0.0084     0.0085
0.0082     0.0083
0.0084     0.0085
0.0086     0.0087
0.0082     0.0083
0.0081     0.0083
0.0083     0.0084
0.0080     0.0082
0.0079     0.0081
0.0081     0.0083
0.0080     0.0082
0.0081     0.0083
0.0083     0.0084
0.0082     0.0083
0.0081     0.0083
;
```

In SECTION B, The data is combined into a single variable called READING and individual types of EDGE1 and CENTER. A work dataset is created and called NEW. SAS/QC utilized all the reading as a single variable for analysis. On the other hand , SAS/GRAPH using the subgroup type option can distinguish variables by type codes.

```
        "SECTION B"
****************************************
** GAUGE DATA IS MANIPULATED FOR
       DATA SUBGROUPS**
****************************************
DATA NEW;
  SET GAUGE;
TYPE='EDGE1':
  READING = EDGE;
OUTPUT NEW;
TYPE='CENTER';
  READING = CTR;
OUTPUT NEW;
RUN:
```

In SECTION C of the code, the initial use of the SAS/QC is initiated. The use of a single variable is required for this step, so data NEW1maintains only the single variable READING. The symbol codes allow the user to modify the output into a customized graph with many options available. The generation of the histogram is initiated by the "Proc Capability" statement. The system, given these simple instructions, can compute various statistical indices of the gauge readings. The end result of the code is shown in EXHIBIT 1. The histogram shows the charting of the data values of both edge and center readings combined. Vertical lines are drawn on the chart indicate the LSL (Lower Spec Limit) and USL (Upper Spec Limit). A curve line is also drawn on the chart, this is the Normal Curve as defined in the code as "Normaltest". These lines are noted in the legend portion of the chart.

A quick look at the chart also shows that all the gauge readings are within the specification limits, and the shape of the histogram can be considered as a normal distribution.

Exhibit 2 shows the many capability indices derived from the data. With the use of the "Proc Capability" statement the user is able to generate product capabilities and can determine, when compared to past data, if the product characterisitics are changing.

```
        "SECTION C"
****************************************
** THIS AREA USES SAS/QC FOR ANALYSIS
  OF ALL GAUGE READINGS**
****************************************
DATA NEW1;
  SET NEW;
  KEEP READING; RUN;
SYMBOL1 V=NONE;
SYMBOL2 V=NONE C=RED 1=1 R=2;
SYMBOL4 V=NONE C=RED L=20;
PATTERN1 C=GREEN V=E;
PATTERN2 C=PINK V=S;
TITLE1 F=SWIXX '0.0083 NOMINAL GAUGE'
PROC CAPABILITY NORMALTEST DATA=NEW1
 GRAPHICS;
HISTOGRAM /
  NORMAL(FILL)
MIDPOINTS=0.0070 to 0.0095 by .0001
FONT=XSWISS;
  RUN;
```

.0083 NOMINAL GAUGE

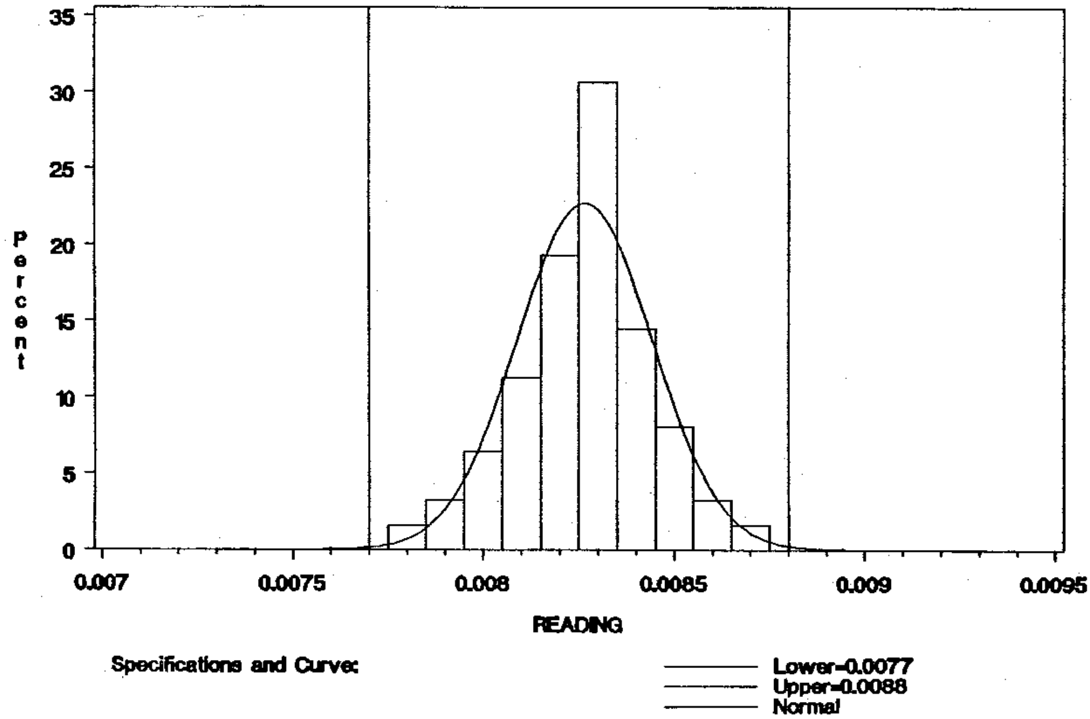

EXHIBIT 1

EXHIBIT 2

.0083 NOMINAL GAUGE

CAPABILITY

VARIABLE=READING

FITTED DISTRIBUTION: NORMAL

PARAMETERS		GOODNESS-OF-FIT	
MEAN (MU)	0.00826452	CHI-SQUARE	3.91521
STD DEV (SIGMA)	.000175646	DF	9
		PR > CHI-SQUARE	0.916904

SPECIFICATIONS

LSL	0.0077	USL	0.0088
OBS PCT < LSL	0	OBS PCT > USL	0
EST PCT < LSL	0.0654616	EST PCT > USL	0.114932

LSL	0.0077	% < LSL	0
		% BETWEEN	100
USL	0.0088	% > USL	0

INDICES

CPL	1.07132	CPU	1.01622
CP	1.04377	CPK	1.01622
K	0.026393		

In SECTION D of the code the interrelation of edge and center micrometer readings are analyzed. The use of SAS/GRAPH enables the user to see the data of the histogram segregated by type of micrometer reading. The shape of the histogram is the same but the ability to see how the gauge readings compose the histogram gives the user a concept of how his process is performing. The use of the statement"Proc Gchart" enables the user to define his variable types in a VBAR (Vertical Bar Chart) with pattern statements. In EXHIBIT 3, with the ability of SAS/GRAPH to distinguish subgroup type, a clear view of edge and center gauge readings within the histogram is made apparent. The range and dispersement can readily be seen because of the segregated bar patterns.

Normal production of steel shows that the gauge readings are normally lighter, or thinner, at the edge when compared to center gauge readings. Being able to see the total spread of the gauge variation between edge and center is particularly important when monitoring product characteristics and maintaining specifications. If a shift is noted in the data two possible conditions may exist. One, the process is rolling lighter or heavier thickness at the edge; or two, possibly the edge is thicker than the center.

```
          "SECTION D"
****************************************
** THIS AREA USES SAS/GRAPH FOR ANALYSIS
  OF ALL GAUGE READINGS BY TYPE**
****************************************
PROC GCHART:
LABEL READING="HAND MICROMETER CENTER AND
     EDGE (1" IN)';
   VBAR READING/SUBGROUP=TYPE MIDPOINTS=
      0.0070 TO 0.0095 by .0001;
PATTERN1 C=RED V=L4;
PATTERN2 C=BLUE V=X4;
RUN:
```

In SECTION E of the code the variation between the edge and center gauge is analyzed. Since normal processing requires the center to be thicker than the edge, there are limitations as to the maximum variations the process can tolerate. The consumer of this product may also require a maximum variation due to their equipment constraints and process characteristics. This variation is referred to as "CROWN", center gauge minus the edge gauge readings. Too much or too little crown can affect the process and produce undesirable results. In order to analyze this variation, SAS/QC provides an easy means of capability analysis.

First the data must be developed into the proper format for SAS/QC to manipulate. The calculation of the crown variable is done in the work dataset CRN. For each data entry or observation a calculation of a new variable, CROWN, is performed. Specification limitations are entered into the code as LSL and USL. The "Proc Capability" statement is used to generate a histogram of the variable CROWN, using the "Normaltest" function.

EXHIBIT 4 shows the histogram generated. Once again the vertical lines for specification limits are drawn as well as normal curve.

EXHIBIT 5 shows the generated statistical capability indices of the variable CROWN. This analysis shows any increase or decrease in the process crown readings. It also shows the expected crown charateristics of the product. The analysis also indicated the ability ofthe process to maintain the specified crown requirements.

```
          "SECTION E"
****************************************
** THIS AREA USES SAS/GRAPH FOR ANALYSIS
OF VARIATION BETWEEN CNETER AND EDGE
GAUGE READINGS**
****************************************
DATA CRN;
  SET GAUGE;
CROWN=CTR-EDGE;
KEEP CROWN; RUN;
SYMBOL1 V=NONE;
SYMBOL2 V=NONE C=RED L=1 R=2;
SYMBOL4 V=NONE C=RED L=20;
PATTERN1 C=GREEN V=E;
PATTERN2 C=PINK V=S;
TITLE1 F=SWISS '0.0083 NOMINAL GAUGE';
TITLE2 F=SWISS 'VARIATION BETWEEN CENTER
      AND EDGE GAUGE';
PROC CAPABILITY NORMALTEST DATA=CRN
             GRAPHICS;
SPEC SLS =0.0000 USL=0.0003;
HISTOGRAM /
  NORMAL(FILL)
  MIDPOINTS=-0.0003 to 0.0005 by 0.0001
  FONT=XSWISS;
RUN;
```

.0083 NOMINAL GAUGE

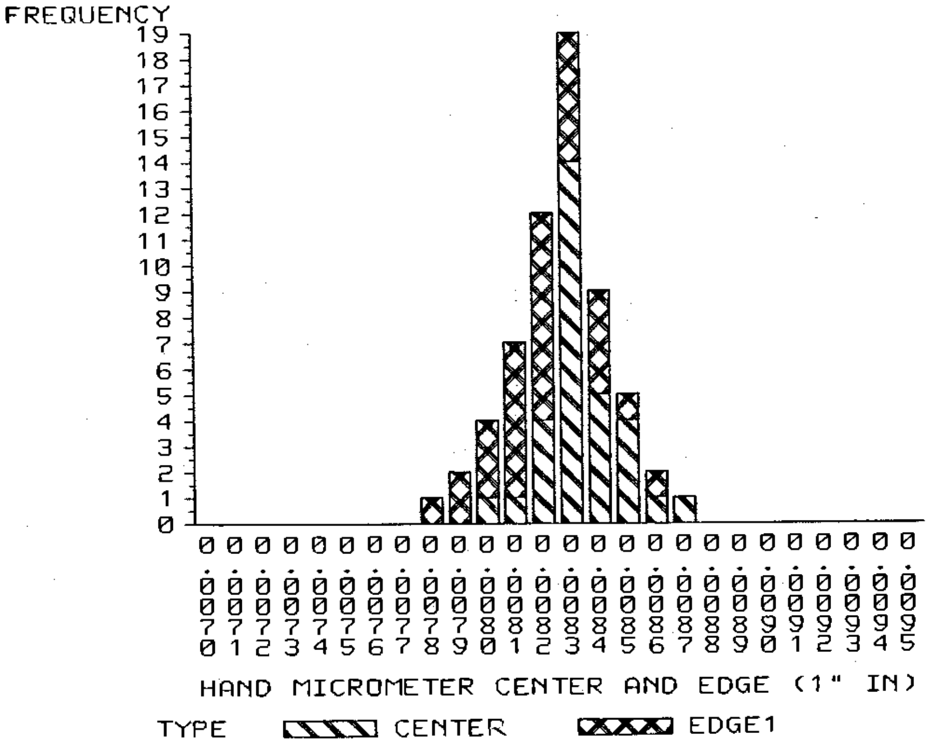

EXHIBIT 3

.0083 NOMINAL GAUGE

VARIATION BETWEEN CENTER AND EDGE GAUGE

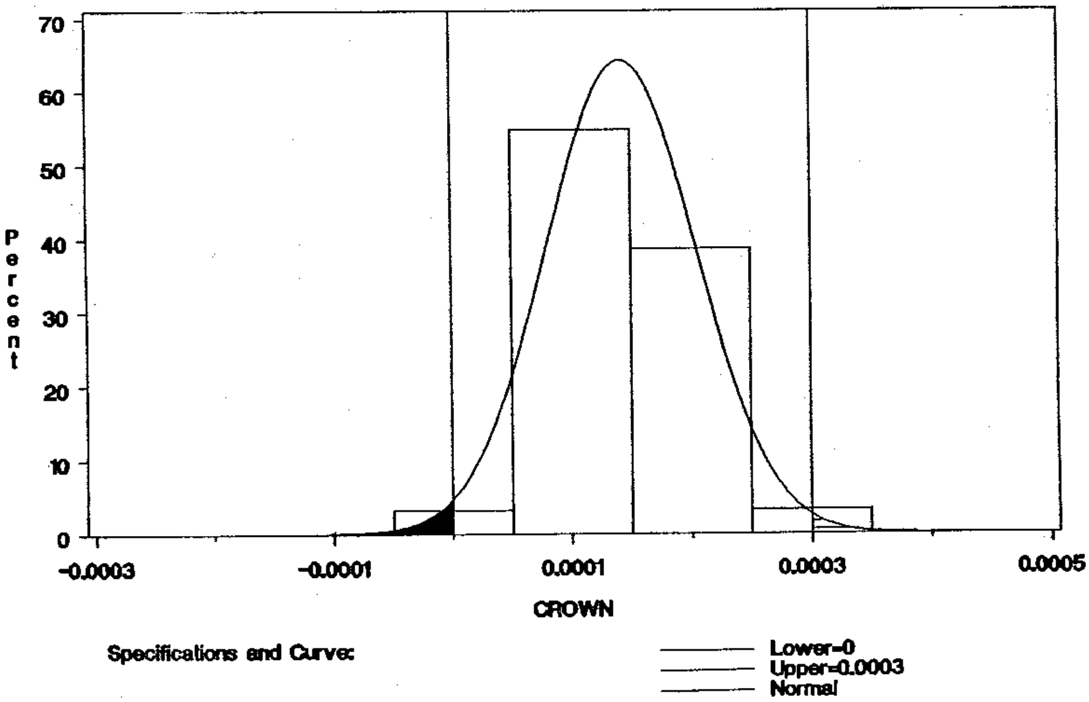

EXHIBIT 4

EXHIBIT 5

.0003 NOMINAL GAUGE
VARIATION BETWEEN CENTER AND EDGE GAUGE

CAPABILITY

VARIABLE=CROWN

FITTED DISTRIBUTION: NORMAL

PARAMETERS		GOODNESS-OF-FIT	
MEAN (MU)	.000141935	CHI-SQUARE	0.940600
STD DEV (SIGMA)	.000062044	DF	6
		PR > CHI-SQUARE	0.987486

SPECIFICATIONS

LSL	0	USL	0.0003
OBS PCT < LSL	0	OBS PCT > USL	0
EST PCT < LSL	1.10787	EST PCT > USL	0.542305

LSL	0	% < LSL	0
		% BETWEEN	100
USL	0.0003	% > USL	0

INDICES

CPL	0.762552	CPU	0.849206
CP	0.805879	CPK	0.762552
K	0.0537634		

SUMMARY

SAS/QC has provided the user with a means to quickly and accurately analyze basic as well as complex data. In a manufacturing enviroment that requires increasing needs for SPC (Statistical Process Control) to monitor simple as well as complex processes, the SAS/QC software enables the user to produce statistical charts and data, easily, and efficiently. SAS/QC and SAS/GRAPH has enabled the user to satisfy customer needs in relationship to statistical data and graphics concerning the product he is purchasing, in a professional manner.

This simple illustration of the effectivness of the SAS/QC software and some of the capabilities of SAS/GRAPH is a significant factor in our steel processing. The ability to show data in a manner easily understood and professionally documented in graphics and statistics enables the producer to illustrate to the customer the product capabilities in relation to his specifications and limits.

Since quality is the key to maintaining customers and their confidence, SAS/QC has provided the user with a tool that quickly and efficiently describes and monitors products and results in process changes. This will in turn reflect the ability of the manufacturer to meet the needs of the consumer and maintain the reputation of being a QUALITY SUPPLIER.