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An Introduction to Web-Based Training for Statistical Process Control (SPC)

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An Introduction to Web-Based Training for Statistical Process Control (SPC)

AN INTRODUCTION TO WEB-BASED TRAINING FOR STATISTICAL PROCESS CONTROL (SPC)

A Research Paper for Presentation

to the Graduate Faculty of the

Industrial Technology Department

University of Northern Iowa

Submitted in Partial Fulfillment of the Requirements

for the Non-Thesis Master of Arts Degree

by

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I. RESEARCH PROPOSAL

Statement of the Problem

John Deere Waterloo Works had been using statistical process control in its manufacturing and assembly operations since the mid-nineteen seventies. Over the years this process had evolved from using hand-written paper control charts to using computer devices to collect data and generate charts. A variety of computer hardware and software products were being used. Training on statistical concepts and use of the various devices had deteriorated to the point that it was no longer a formal process. SPC training passed from one employee to another in the course of break-in to perform a specific job.

A team had been formed to select one statistical process control software package to be used throughout the Waterloo Works. This team had selected a product and was in the process of converting over to it. A formal training program needed to be developed as part of this conversion. The training program had to be easy to present to large numbers of users. It needed to provide them with general knowledge of basic SPC principles and specific knowledge about the new SPC software.

The problem of this study was to develop a curriculum outline and sample training module for web-based statistical process control training that would be used at John Deere Waterloo Works.

Statement of Purpose

The purpose of this study was to determine the course goal and unit objectives for SPC training, prepare an outline of the course content and develop a means to deliver the training using the John Deere Waterloo Works Intranet. The results of this study would form the foundation for development of a comprehensive web-based SPC training course for John Deere Waterloo Works.

Statement of Need

The need for the study was based on the following factors:

1. John Deere Waterloo Works had an immediate need to train large numbers of employees in the use of a new SPC software package that was being implemented. The fact that many employees had never had basic SPC training or had some training far in the past also fueled the need for this study.

2. The World Wide Web technology was readily accessible in industry and adaptable to a multitude of business applications including training. Hall (1998) stated ". . . the fastest growing segment of the market for Web browsers and servers are companies' internal intranets." Computers being used in industry for applications such as labor reporting, inventory control and numerical control of machine tools could become training workstations simply by installing web browser software.

3. Simple methods of delivering training to large audiences were needed in industry. According to Hites and Ewing (1996), "By its very nature, the Web

facilitates the easy distribution of knowledge and instructional resources regionally, globally, or within an enterprise."

Research Questions

The study was intended to answer the following questions:

1. What was the goal of the SPC training course?
2. What specific objectives needed to be met?
3. What would be the content of each of the training modules?
4. How could student – trainer interaction be accomplished?
5. How would student comprehension of the subject matter be measured?
6. How could student progress be recorded and tracked?
7. Could the course be designed so it could be tailored to individual student needs?

Assumptions

The following assumptions were made in the pursuit of this study:

1. All operators and assemblers who would use the new SPC software would require some degree of training.
2. Web browser software would be available on shop-floor computers for delivery of the training to those who needed it.
3. Waterloo Works Information Systems department would provide server space and support for the Web-based SPC training that was developed.

Delimitations

This study was delimited to SPC training at John Deere Waterloo Works and its usage of DataMyte's Quantum SPC suite of software products. The results of this study were not intended to be applicable to other John Deere Units, other industries, or the use of different SPC data collection and analysis software products.

Statement of Procedure / Methodology

The methodology that was followed for this study was as follows:

1. Related literature was reviewed.

2. A questionnaire was developed to assist in the determination of the SPC training needs at John Deere Waterloo Works. The questionnaire was completed by key SPC personnel in the organization. Results were evaluated and used as a basis for developing the course content.

3. Course goals and unit objectives were identified and an outline of course content was developed.

4. One module was selected to serve as the pilot for development of course materials.

5. Training and evaluation materials were developed for the pilot module.

6. The pilot module was posted on the John Deere Waterloo intranet for testing. Individuals were selected to test the pilot module. Feedback was gathered from the test group for use in improvement of the training and development of future modules.

7. The results of the study were summarized in a written report.

Definition of Terms

Browser – a software package that allows one to access information on the WorldWide Web (McManus,1996).

Chat Room – "an on-line interactive discussion group on the Internet" (Miriam-Webster, 1998).

Chunking – presenting information in discrete, instructional units (Dyer, 1998).

FAQ (Frequently Asked Questions) – a list of commonly asked questions with answers (Dyer, 1998).

Goals – broad statements of instructional intent (Dyer, 1998).

HTML (Hypertext Markup Language) – formatting instructions that are inserted into text documents so browsers can display the documents properly (Dyer, 1998), and (McManus, 1996).

Hypertext – "a database format in which information related to that on a display can be accessed directly from the display" (Miriam-Webster, 1998).

Objectives – specific steps leading to the accomplishment of a goal (Dyer, 1998).

Server – "a computer in a network that is used to provide services (as access to files or shared peripherals or the routing of electronic mail) to other computers in the network "(Miriam-Webster, 1998).

SPC (Statistical Process Control) – "the application of statistical techniques to control a process" (Summers, 1997).

WBT (Web-based training) – computer-based training that uses Web technologies and is delivered across networks (Kilby, 1997).

II. REVIEW OF RELATED LITERATURE

The review of literature on Web-based training revealed the advantages and disadvantages of using WBT. It also uncovered a process to use in developing WBT courses. Techniques to use in developing course materials as well as those that should be avoided were also covered in the literature.

Advantages of Web-based Training

The desirability of using Web-based training lies in the fact that it exhibits several advantages over other types of training. These advantages cover a wide spectrum. WBT is easy to develop and update. Maintenance and development costs are low when compared to most other types of training. WBT is readily accessible and convenient for students to use.

Most experts agree that one advantage WBT exhibits over more conventional types of training is the fact that it is easy to develop and update. McManus pointed out in 1996 that WBT is easy to update to meet the needs of changing subject matter. Hites and Ewing (1996) said that WBT is easy to create, modify and maintain and Kilby (1997) included the easy update of content in his list of advantages of WBT. "Presentations can be easily created, updated, and shared" according to Dyer (1998).

There are cost advantages associated with using WBT. According to Dyer (1998) duplication of effort is eliminated, less technical support is required and printing costs are reduced since the training material is electronic. In addition, distribution of the training worldwide is inexpensive, travel costs are reduced and

the actual time to complete the training averages approximately 50% of that for instructor led training (Hall, 1998). Kilby (1997) points out the need for less technical support, the shift from costly programming to less expensive interface and content design and quicker turn-around of the finished product as cost advantages for WBT.

WBT is widely accessible since it is platform independent. The same training can be delivered to students with Macintosh, Windows or Unix operating systems by using the Web. The only requirements to receive WBT are a computer with Web browser software, a network connection and Web access. All of these are readily available on most personal computers.

The convenience of use is another major advantage of WBT. Hall (1998) sums up the convenience of WBT in two concepts. The first concept is "at their own pace and in their own place" which refers to the student's ability to receive the training from anywhere and as often as necessary. The second concept that Hall points out is that the training is "just in time and just enough." This means that students can access the training at any time and complete only as much as they need at each session.

Kilby (1997) and Dyer (1998) both point out the fact that access to the training is controllable as a further advantage of WBT. Student access and progress can also be tracked and monitored. The use of email, chat pages and electronic mailing lists enhance communications between students and between

students and the instructor. They also provide the ability for the instructor to actively involve the learner in the training (McManus, 1996).

Disadvantages of Web-based Training

While there are many advantages to Web-based training, there are also disadvantages. WBT requires the instructors to adopt new thinking and methodologies. Current technologies can limit the training. Poorly designed Web-based training programs provide opportunity for students to get lost. Changes outside of the control of the instructor and/or designer can adversely affect the impact of the training. According to Dyer (1998), some of these problems will be overcome as experience is gained in the use of WBT and others will require advancements in technology.

The instructors must learn and use non-linear thinking if they are going to develop effective Web-based training programs (Dyer, 1998). This is a requirement since Web information is accessed in a non-linear manner (Smith & Drakely, 1998). Hites and Ewing (1996) found that it is nearly impossible to predetermine how or at what point a user will enter and leave the instructional environment. Dyer points out that training in the use of Web-based tools is also required to design WBT courses. Dyer warns that instructors will also find that it is easy to focus on the technology rather than on student needs.

The technology can be a disadvantage of WBT. Kilby (1997) and Hall (1998) both explain that bandwidth limitations can cause slow performance for sound, video and graphics. Long waits for loading of images and sounds can

greatly detract from the effectiveness of the training. Hites and Ewing (1996) learned that there are some inherent limitations in Web page layout. Kilby says that there is limited formatting of content available in current browsers. According to Hall, the level of inter-activity is often limited in WBT but this will improve with experience.

The content of Web-based training courses can be greatly enhanced by providing links to external web sites (McManus, 1996). The disadvantage exists because these links outside of the course material can change or even disappear as those pages or links change. Moving to links outside of the course can also cause students to become disoriented and lost (Hites and Ewing, 1996).

There are other disadvantages to WBT besides the limitations of the technology and the opportunity for students to become confused. WBT requires a trained staff to administer the server and provide server access (Dyer, 1998). Hall (1996) lists two additional disadvantages to WBT namely, (a) some students are uneasy with self-directed training and (b) not all courses are suited to delivery by a computer.

WBT Development Process

Developing a course for delivery across the Web follows much the same process as developing a course for instructor led delivery. Dyer (1998) tells us that while there are many instructional models available, none deal specifically with WBT and it would be hard to develop a standard since the Web is so dynamic. He also states "we can still use existing models to plan our instruction."

McManus (1996) explains two major schools of theory in instructional design, the Objectivists and the Constructivists and presents a model of each. Kilby (1997) bases his development process on the Instructional Systems Design (ISD) process which he says is a comprehensive approach that fits both classroom and computer-based training design.

It is generally agreed that WBT like other forms of training must be based on the needs of the students. A student needs analysis early in the development cycle can be a useful tool. Verification of student needs generates a purpose for the instruction that can be used as a basis for student evaluation (Dyer, 1998). Kilby's (1997) "tasks/user analysis" step helps the instructor and/or course designer understand how to structure the course so it meets the students' needs.

A goal based on outcomes of the training needs to be developed. All training has a goal of promoting specific learning (McManus, 1996). Dyer (1998) tells us that a goal of "'student learning' is too vague." He suggests that the goal be "smart" which he defines as being specific, measurable, achievable, realistic and including a time factor indicating when the goal needs to be met. McManus explanation of the ISD model says that the goal should be defined in terms of terminal behavior.

After the broad goal statement is developed the course is further defined by specific objectives. Dyer (1998) defines these objectives as the steps taken to accomplish the goal. The second step in the traditional models of creating instruction is to break down goal behavior into a "hierarchy of subordinate skills"

according to McManus (1996). The objectives let the student know what they should get from the training and assist the instructor in keeping content, assignments and exams in line with the topics according to Dyer.

A content outline is developed using the goal, objectives and student analysis previously completed (Dyer, 1998). This is the beginning step in creating the course materials and actual Web pages. Creation of the Web pages involves knowledge and usage of HTML (HyperText Markup Language). McManus (1996) provides links to several resources on HTML and also points out that imitation of other's is an excellent way to learn HTML. Most Web browsers provide some means to view and save the HTML that produces a page and McManus recommends doing this when you see a Web page that you like. Kilby (1997) tells us that "interface design is one of the most critical phases of the development process." Dyer warns that care should be taken to provide examples that the students will understand. McManus points out that adding media such as sound and video to your Web pages decreases the speed and warns developers to make sure the content delivered is worth it. His recommendation is "when in doubt – leave it out." McManus further explains that the use of forms in your WBT can greatly enhance active involvement of the learner in the training.

After the Web pages are developed they should be evaluated. Kilby (1997) recommends using actual users or others with similar levels of knowledge and skill to do the interface testing. An evaluation plan that includes the what,

when and how of the evaluation is proposed by Dyer (1998). Dyer also recommends a dry-run or pretest of the course prior to implementation if time permits it. Hall (1998) lists criteria that can be used to evaluate WBT including (a) content, (b) instructional design, (c) interactivity, (d) navigation, (e) motivational components, (f) use of media, (g) evaluation, (h) aesthetics, (i) record keeping and (j) tone.

The final element in the instructional development process is revision of the materials based on the results of the evaluation. Kilby (1997) recommends ongoing evaluation and testing because modifications in features and content may require additional testing. Student questions and feedback are good sources of information on changes that should be made. Dyer (1998) has several recommendations regarding changes. He notes that minor changes can be made while a course is in progress but cautions against making large changes in this environment as it could tend to confuse students. Dyer uses FAQ's and email to communicate changes to students. Keeping a master file of all Web pages that includes documentation of all changes helps in the maintenance over the life of the course according to Dyer.

Techniques to Use and Techniques to Avoid

The experts give many tips that will improve the effectiveness of WBT. The foremost of these is to focus on the outcomes of the training by following the goal and objectives of the training. McManus (1996) reminds us to keep the instructional aspects as our first consideration. The choice of media types should

be based on the learning objectives according to Kilby (1997). Dyer (1998) emphasizes covering the course objectives.

Good WBT provides for interaction with the students. Interactions set instruction apart from documentation and positive and corrective feedback is necessary for successful interaction (Hites & Ewing, 1996). Involve the students and answer questions directly to the student asking (Dyer, 1998). Kilby (1997) says to provide ample opportunity for user interaction with the information.

The WBT environment shouldn't hinder learning. Two essential qualities are readability and navigability according to Hites and Ewing (1996). They explain that navigation should be easy, intuitive and consistent. Kilby (1997) reminds us that people learn in a variety of ways. Modular design of Web pages makes them easy to read, write and maintain according to Dyer (1998). Dyer defines modular pages as small independent units that address one theme and perform one of four functions, (a) motivation, (b) orientation, (c) guidance and (d) reference.

Smith and Drakely (1998) list 12 techniques that "take advantage of the on-line medium and work around its limitations.

1. Create a hierarchical list. . .
2. Create a visual metastructure. . .
3. Make it modular. . .
4. Make the content modular. . .
5. Chunk the text. . .

6. Label topics. . .
7. Don't bury information. . .
8. Use emphasis sparingly. . .
9. Use on-line writing techniques. . .
10. Use links effectively. . .
11. Use graphics wisely. . .
12. Use an effective layout and design. . ."

Techniques to avoid in WBT mirror those to use. Focusing on the technology rather than the learning objectives is the primary error to avoid. Dyer (1998) warns us not to let technology get in the way of the training. "Never use technology just because you know how or want to impress someone" (Kilby, 1997). According to Hall (1998) multimedia bells and whistles become gratuitous if they don't contribute to the course objectives. Smith and Drakely (1998) point out that too many colors and too much movement can detract from the message being presented and caution against overuse of the "fancy stuff." Ineffective use of the technology can defeat the purpose of using it in the first place.

III. PROCEDURE / METHODOLOGY

The purpose of this study was to develop and test a sample Web-based SPC training module. The results of the study were to form the foundation for development of a complete Web-based training course. To achieve these goals the following methodology was followed.

1. Literature on Web-based training was located and reviewed. This was done to provide knowledge on the technology to be used in the actual development of a sample training module. Many excellent sources of information on Web-based training were located on the Web. The literature was read, notes were taken and a summary of the findings was prepared.

2. A questionnaire was developed to determine what needs existed for the SPC training (see Appendix B). The questionnaire listed 72 possible training topics grouped into five categories. It provided room for respondents to add topics that were not listed. The questionnaire was distributed to 20 individuals who were responsible for training operators on the new software in the various Waterloo Works business units. Each recipient was asked to estimate the numbers of users that would require training on each of the topics listed on the questionnaire.

The 12 questionnaires that were completed and returned represented 14 of the 20 recipients since two were completed jointly by pairs of recipients. This was a response rate of 70%. The results of those surveys were combined. A pareto chart of the count of users needing training on each topic was developed

for each category. A percentage of users needing training was calculated for each topic. A grand average percentage was then calculated for each category by averaging the topic percentages. The grand average of each of the five categories was used to set the order of priority for developing the instructional materials. The topic pareto charts were used to break the categories into training modules and to aid in the development of the objectives for each module (see Appendix C).

3. The course goal was defined by the problem of this research. Results of the questionnaire were used to identify the objectives and content of the various modules to be included in the training. A course outline based on the goal and objectives was developed.

4. Module 1.1 "How to use this training" was selected to serve as the sample module for this study. This module was selected because it could be completed within the time constraints of this study. This module provided users with the basic usage techniques needed for all of the other training modules.

5. A home page for the Web-based training course was developed (see Figure 1 of chapter IV). A course navigational Web page using hypertext links to PowerPoint presentations for the individual training modules was developed (see Figure 2 of chapter IV). Additional hypertext links were also provided on the navigational page (see Figure 3 of chapter IV). One link allowed users to return to the JDWW home page and another provided a means to e-mail questions and comments about the training to the instructors. A PowerPoint presentation was

developed for module 1.1 (see Figures 4 – 9 of chapter IV) and a link to it was provided on the navigational Web page. References on the course topics were researched. A bibliography of SPC references was compiled for use in developing the course modules (see Appendix D).

6. The pilot training materials were posted on the JDWW intranet. Layoffs of wage personnel postponed testing by actual users until a future date. Four salaried employees were selected to review the sample module and course outline. Feedback from these four evaluators on the course materials was very favorable. All four asked for the opportunity to evaluate future modules as they are developed.

7. The results of the study were summarized in this report.

IV. RESULTS

Course Goal

To provide JDWW employees with the knowledge and skills necessary to gather and interpret SPC data using DataMyte Quantum SPC/DC.

Course Objectives

Unit I – Getting Started

Upon completion of Unit 1 students will be able to:

1. Access and navigate through the online training modules.
2. Identify which modules they should complete.

Unit 2 – SPC Concepts

Upon completion of Unit 2 students will be able to:

1. Identify two types of variation present in manufacturing processes.
2. Demonstrate how over adjustment affects process variation.
3. Identify normal, skewed and bimodal distributions using histograms.
4. Explain what outliers are and why their cause needs to be identified.
5. Calculate the mean or average of a series of measurements.
6. Demonstrate how the mean, range and standard deviation are used to identify process variation.
7. Define sample and population as they apply to SPC.
8. Explain what determines if a process is stable and why a stable process is predictable.

Unit 3 – Process Capability

Upon completion of Unit 3 students will be able to:

1. Define process capability.
2. Explain process capability indices including Cr, Cpk and PPM.
3. Identify the process capability guidelines used at JDWW.

Unit 4 – Quantum SPC/DC

Upon completion of Unit 4 students will be able to:

1. Start Quantum SPC/DC and log in.
2. Open a data collection setup.
3. Enter data manually and electronically.
4. Delete, edit and re-take data readings.
5. Enter assignable cause and corrective action identifiers.
6. Identify what information is given by the various SPC/DC windows.
7. Explain the difference between unreasonable and out-of-spec readings and how Quantum handles them.
8. Quit Quantum.

Unit 5 – Control Charts

Upon completion of Unit 5 students will be able to:

1. Explain the difference between variable and attribute data.
2. Explain control limits are and how they are determined.
3. Identify whether a process is in-control or out-of-control using a control chart.

4. Explain what subgroups are and why they are used.
5. Identify Xbar & R, Xbar & Sigma and Individuals & Moving Range variable control charts.
6. Identify three trend indicators on a control chart and explain what they tell about the process.
7. Interpret variables control charts and explain what action should be taken based on that interpretation.
8. Identify 4 types of attribute control charts and when they are used.
9. Interpret a pareto chart.

Unit 6 – 3000 Series Data Collectors

Upon completion of Unit 4 students will be able to:

1. Turn on the data collector.
2. Use the data collector menus for navigation.
3. Open a data collection setup.
4. Enter data manually and electronically.
5. Review collected data.
6. Delete, edit and re-take data readings.
7. Enter assignable cause and corrective action identifiers.
8. View charts of the data.
9. Turn off the data collector.

Course Outline

I. Unit 1 – Getting Started

A. Module 1.1 – How to use this training

1. PowerPoint presentations

2. Checkpoints

B. Module 1.2 – Course overview

1. Content and objectives for units two through six

2. Recommendations for selecting and completing units

II. Unit 2 – SPC Concepts

A. Module 2.1 – Variation

1. Variation in nature

2. Variation in processes

a. Acceptable variation

b. Assignable cause variation

c. Goal of SPC is to reduce and control variation

3. Effects of over adjustment on process variation

B. Module 2.2 – Histograms and distributions

1. Histogram

a. Graph that shows process variation

b. Histogram axes and cells

c. Interpreting histograms

1.) Shape of histogram

a.) Bell-shaped curve is normal

b.) High point approximates process average

c.) Width shows process spread or variation

2.) Outliers

2. Distributions

a. Normal distribution

b. Bimodal distribution

1.) Multiple peaks

2.) Usually indicates a process problem

3.) Possible causes

c. Skewed distribution

1.) "Pushed over"

2.) Not always bad

3.) Possible causes

C. Module 2.3 – Basic statistical concepts

1. Data

a. Population – all data

b. Sample – subset of population

2. Mean or average

a. How it is calculated

b. Indication of normal process output

c. Does not indicate process variation

d. Sample problems

3. Range

a. How it is calculated

b. Indication of process variation

c. Smaller is better

4. Standard deviation

a. Calculation not important for this course

b. Referred to as "sigma"

c. Indication of normal process variation

d. Used with mean to predict process output

1.) Plus or minus three sigma

2.) Examples

5. Stable processes

a. No unusual variation

b. Predictable output

6. Effects of over adjustment on process variation

D. Module 2.4 – Unit 2 Checkpoint

III. Unit 3 – Process Capability.

A. Module 3.1 – Process capability basics

1. Specifications

2. Definition of process capability

3. Explanation of six sigma quality

a. Plus or minus three sigma equals specifications

b. Shift in process mean results in product that is out-of - specification

4. Explanation of eight sigma quality

a. Plus or minus four sigma fits within specifications

b. Process variation is 75% of specification

c. Minor shifts in process mean can be tolerated

B. Module 3.2 – Capability indices

1. Capability ratio (Cr)

a. Ratio of process variation to specification limits

b. Equals six sigma divided by total tolerance

c. Indicates the expected process variation

d. Predicts whether the process is capable of producing parts to specification but does not tell if process output is acceptable

2. Cpk

a. Compares process output to specification limits

b. Is the relationship of the process mean to the closest specification limit

c. Indicates both process spread (variation) and targeting

d. Tells if process output is acceptable

3. PPM

a. Parts per million defective

b. Predicts how many parts will be produced out-of-specification

c. Indicates both process spread (variation) and targeting

d. Tells if process output is acceptable

C. Module 3.3 – JDWW capability guidelines

1. Cpk or PPM used to determine if a process is capable

a. Acceptable level

1.) Eight-sigma quality level

2.) Cpk => 1.33, PPM <= 32

b. Exception levels

1.) Do not require corrective action if cost prohibitive

2.) Six-sigma quality level

3.) Cpk < 1.33 >= 1.00, PPM > 32 <= 1350

c. Unacceptable levels

1.) Corrective action is required

2.) Cpk < 1.00, PPM > 1350

2. How Cr is used

a. Generally indicates severity of corrective action

b. Poor Cpk or PPM with good Cr is usually a relatively easy fix

c. Poor Cpk or PPM with poor Cr is usually a difficult fix

D. Module 3.4 – Unit 3 Checkpoint

IV. Unit 4 – Quantum SPC/DC.

A. Module 4.1 – Quantum SPC/DC basics

1. Starting Quantum SPC/DC
2. Logging in
3. Opening a part setup for data collection

B. Module 4.2 – Collecting and editing data

1. Manual data entry
2. Using electronic gages for data input
3. Out of specification readings
4. Unreasonable readings
5. Deleting a data reading
6. Editing data
7. Re-taking a data reading
8. Entering assignable causes and corrective actions
9. Editing assignable causes and corrective actions

C. Module 4.3 – Screens and navigation

1. Quantum windows
    a. Data entry window overview
    b. Characteristic notes window
    c. Control chart windows overview
    d. Histogram window overview
    e. Statistics windows
2. Quitting Quantum SPC/DC
3. Shutdown and restart for database backup

D. Module 4.4 – Unit 4 Checkpoint

V. Unit 5 – Control Charts.

A. Module 5.1 – Variable vs. attribute data

1. Variable data – measurable
2. Attribute data
    a. Countable
    b. Pareto charts

B. Module 5.2 – Control chart basics

1. Graphs of past process performance
2. Use of subgroups
    a. Averages
    b. Central limit theorum
3. Centerline
4. Control limits
5. Types of control charts
    a. Variables control charts
        1.) Xbar and R charts
        2.) Xbar and S charts
        3.) Individuals and Moving Range charts
    b. Attributes control charts
        1.) c charts
        2.) np charts

3.) p charts

4.) u charts

C. Module 5.3 – Control chart interpretation

1. In control

a. All points within control limits

b. Points vary randomly above and below the centerline

2. Out of control

a. Individual points outside of control limits

b. Presence of patterns

1.) Process shifts

2.) Upward or downward trends

3.) Cycles

4.) Stratifications

3. Dealing with out-of –control conditions

a. Identify cause

b. Initiate corrective action

D. Module 5.4 – Unit 5 Checkpoint

VI. Unit 6 – 3000 Series Data Collectors.

A. Module 6.1 – Data collector overview

1. Parts of the data collector

2. Turning the data collector on

3. Data collector menus

a. The main menu

b. The data menu

c. The parts menu

d. The options menu

4. Loading part setups for data collection

B. Module 6.2 – Collecting and editing data

1. Manual data entry

2. Using electronic gages for data input

3. Out of specification readings

4. Unreasonable readings

5. Deleting a data reading

6. Editing data

7. Re-taking a data reading

8. Entering assignable causes and corrective actions

9. Editing assignable causes and corrective actions

C. Module 6.3 – Viewing charts

1. Configuring default charts

2. Viewing variables charts

3. Viewing attributes charts

D. Module 6.4 – Unit 6 Checkpoint

Sample Screens

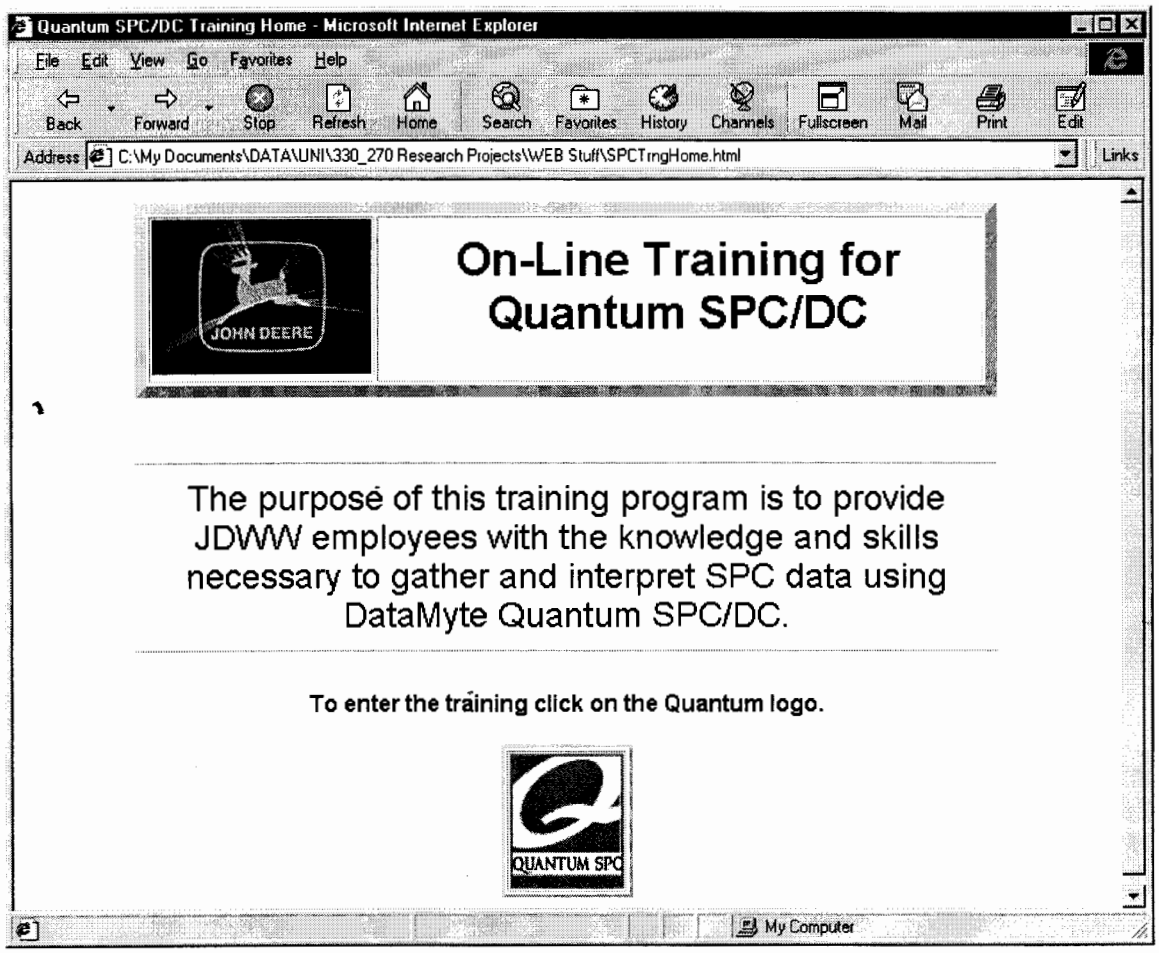

Figure 1. Quantum SPC/DC web-based training home page.

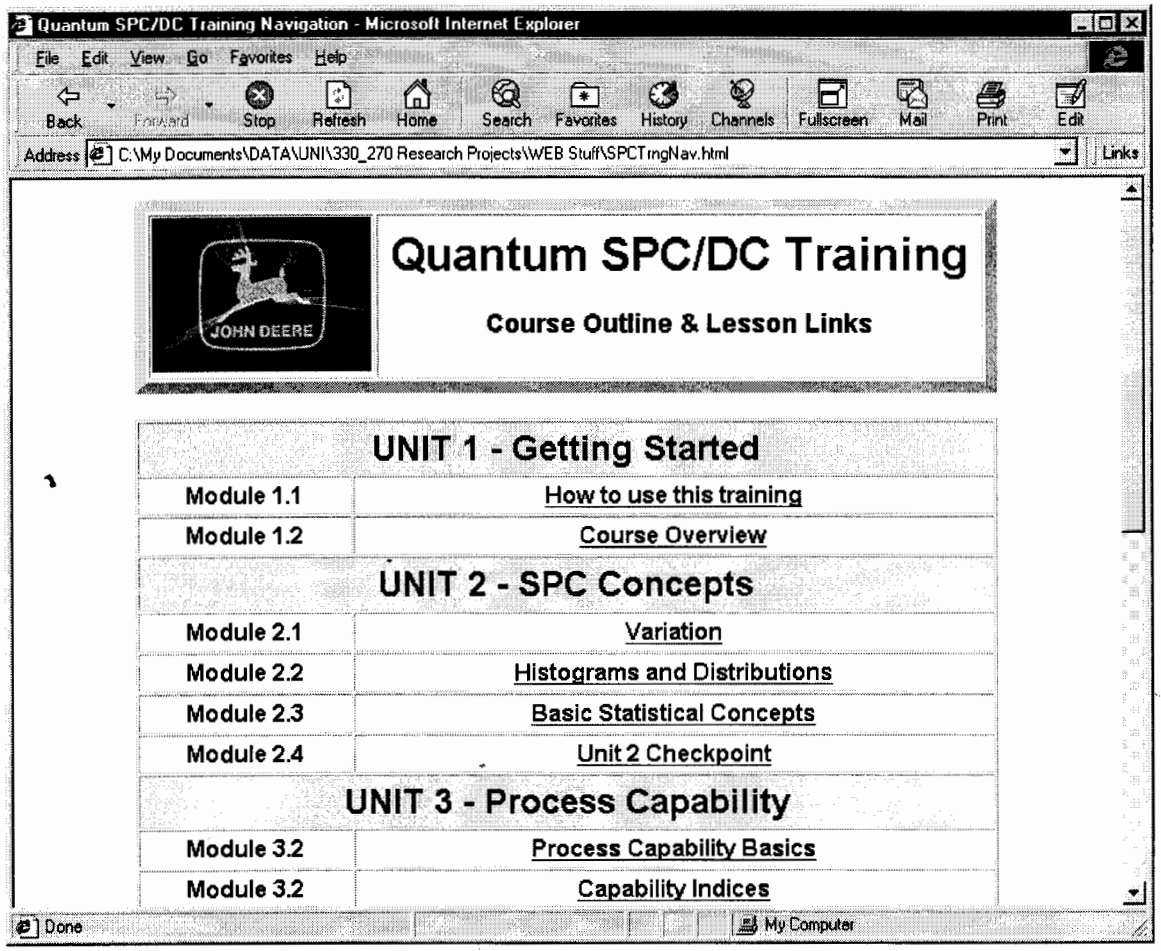

Figure 2. Quantum SPC/DC web-based training navigation page.

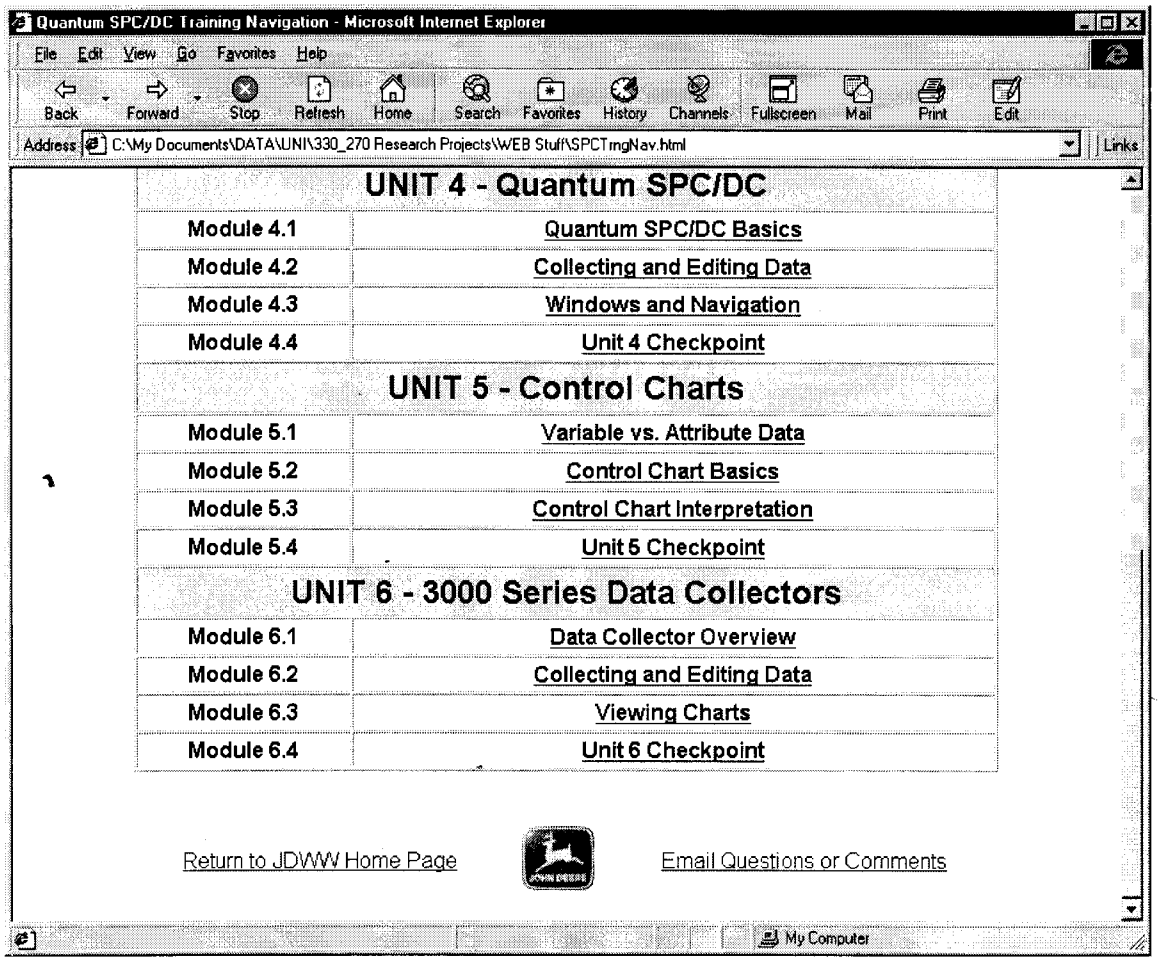

Figure 3. Hypertext links for email and return to JDWW home page.

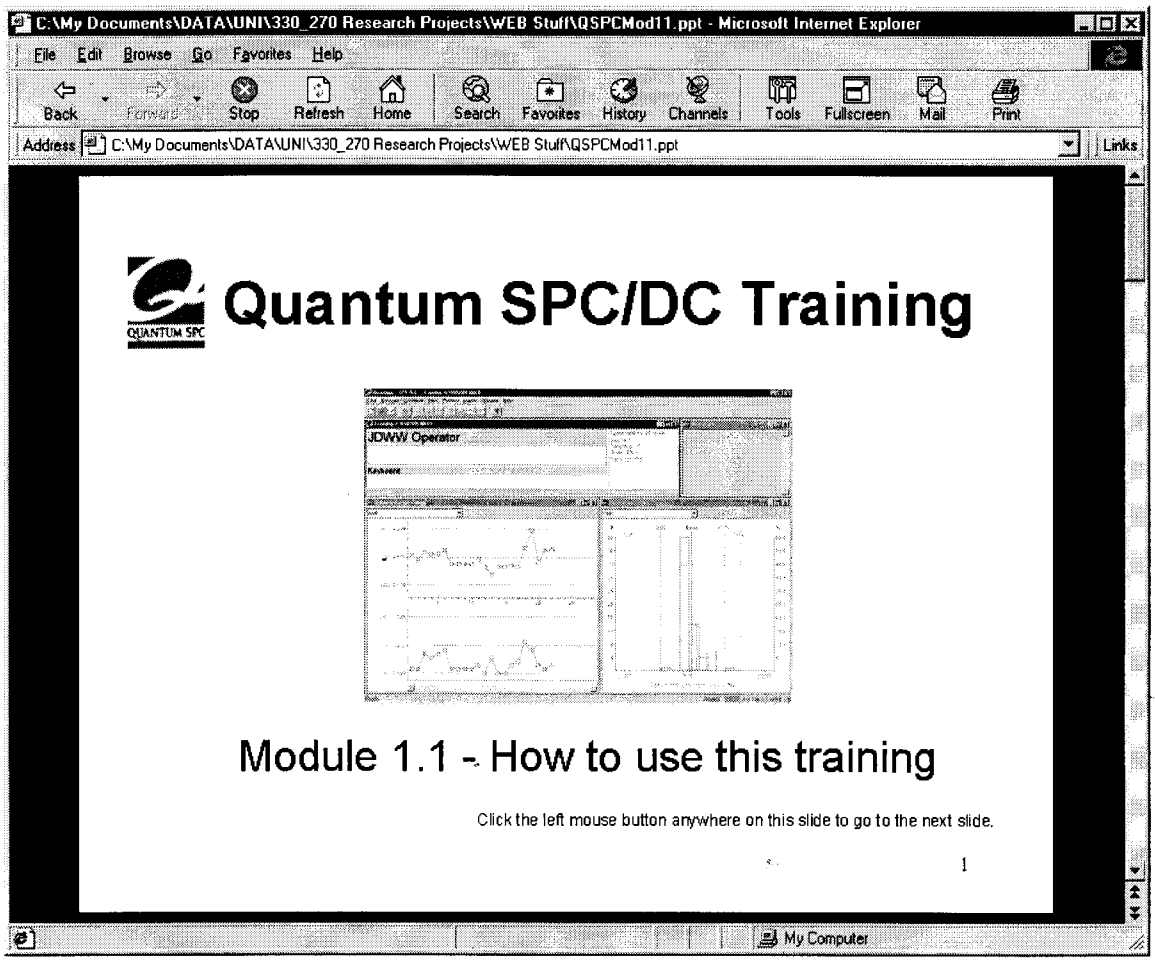

Figure 4. Module 1.1 PowerPoint presentation – slide 1.

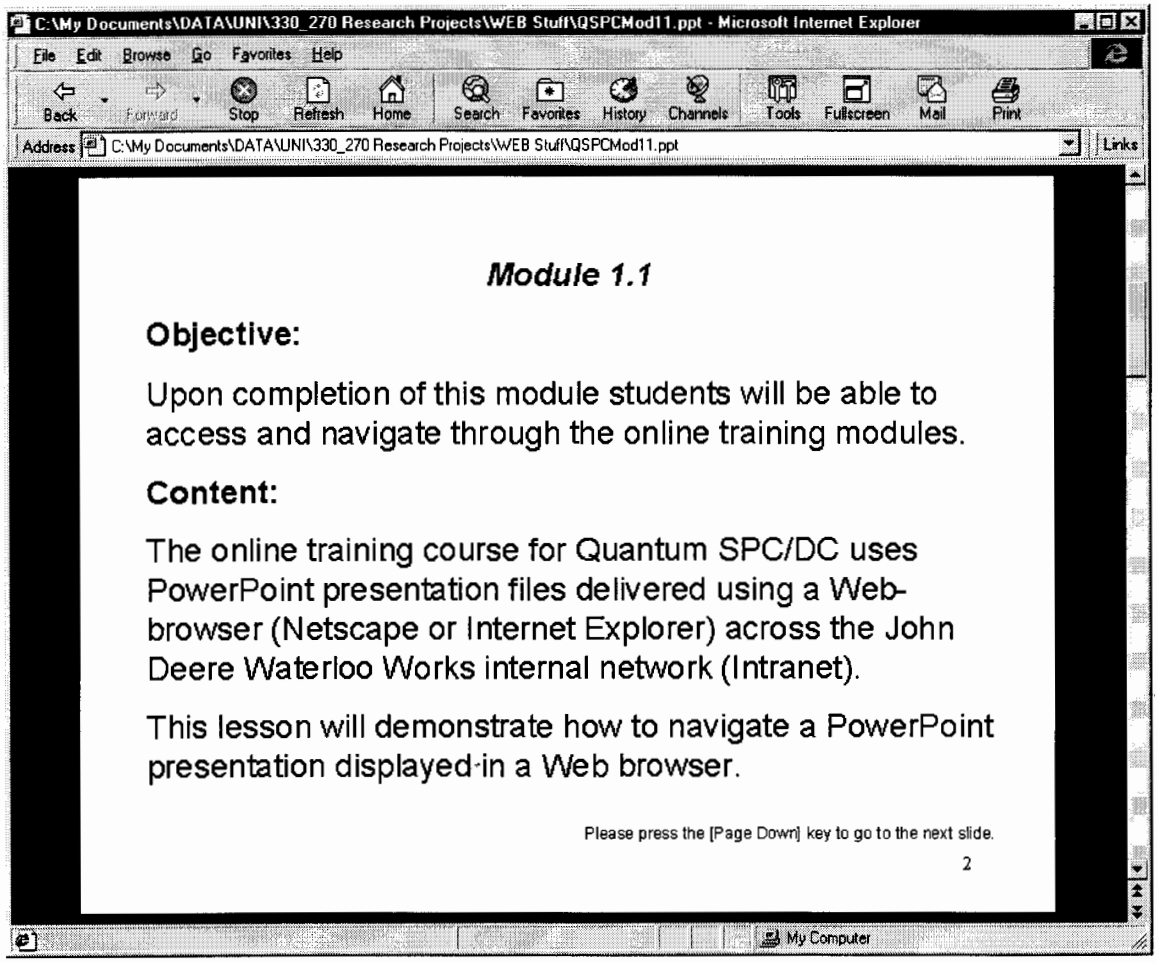

Figure 5. Module 1.1 PowerPoint presentation – slide 2.

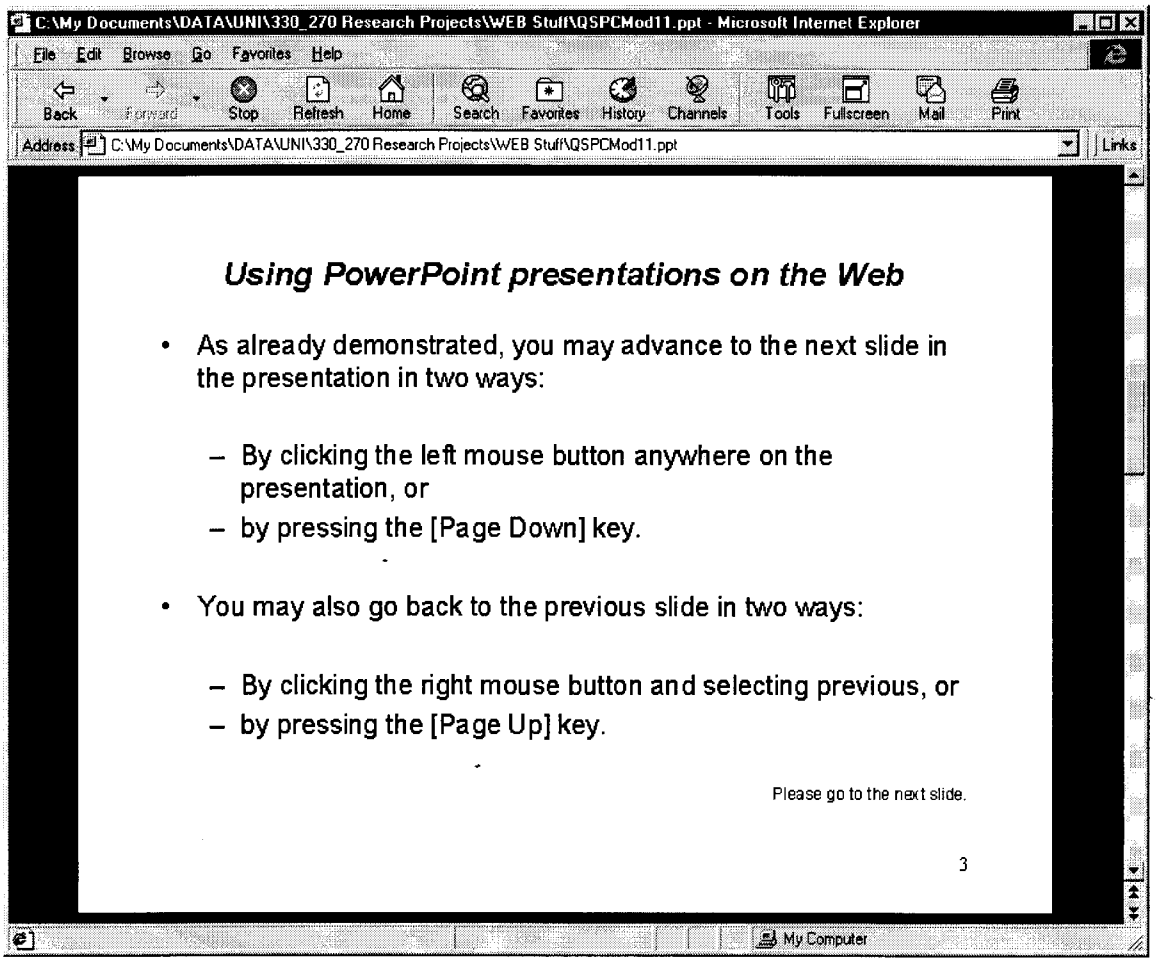

Figure 6. Module 1.1 PowerPoint presentation – slide 3.

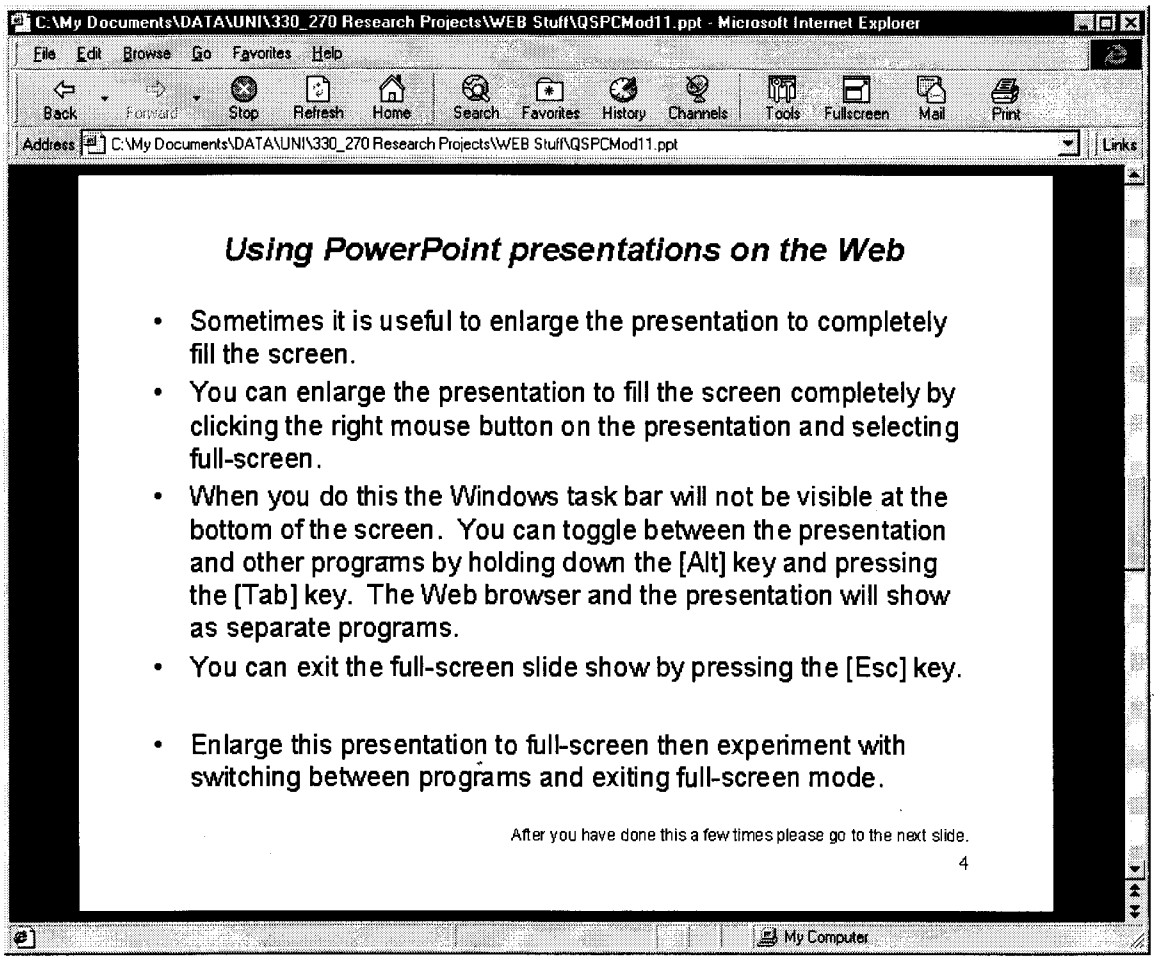

Figure 7. Module 1.1 PowerPoint presentation – slide 4.

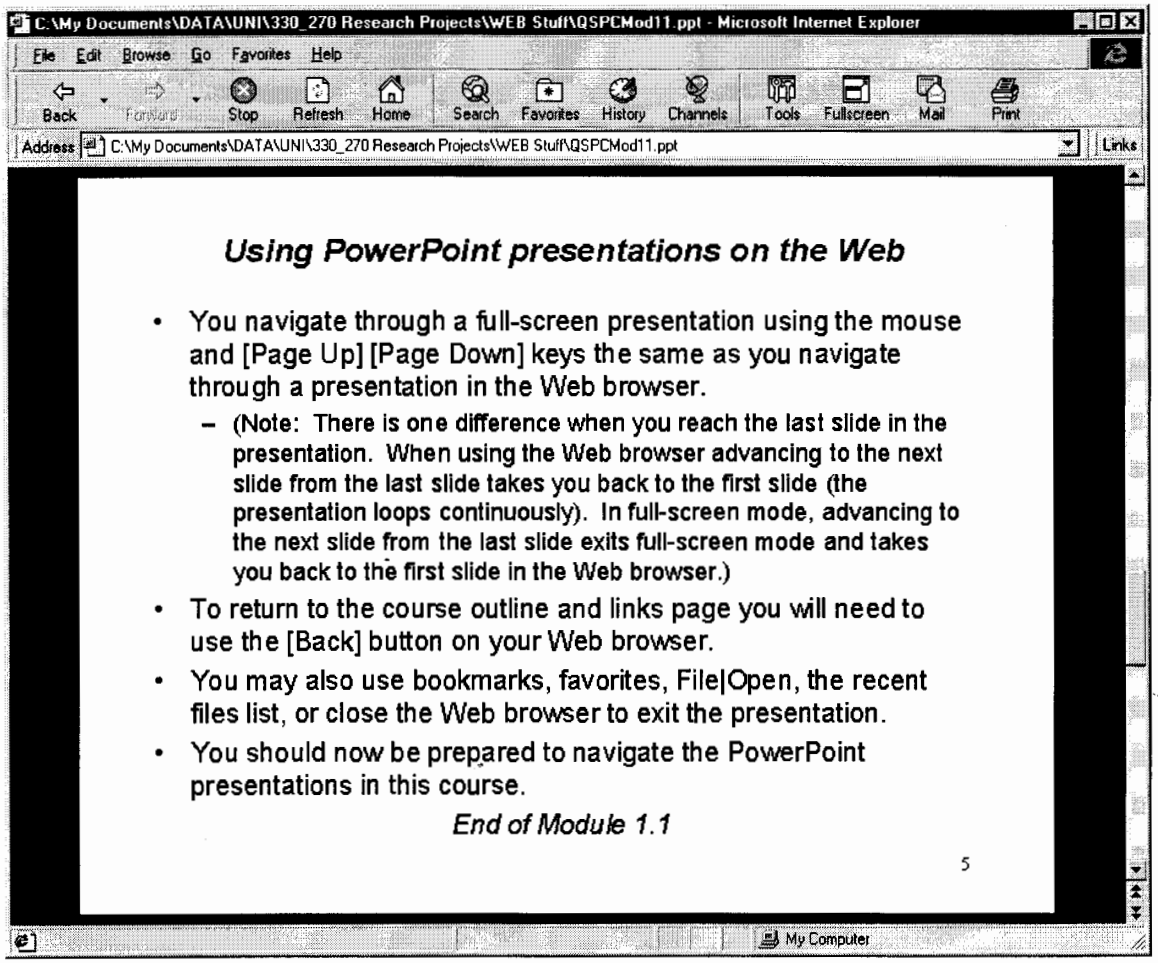

Figure 8. Module 1.1 PowerPoint presentation – slide 5.

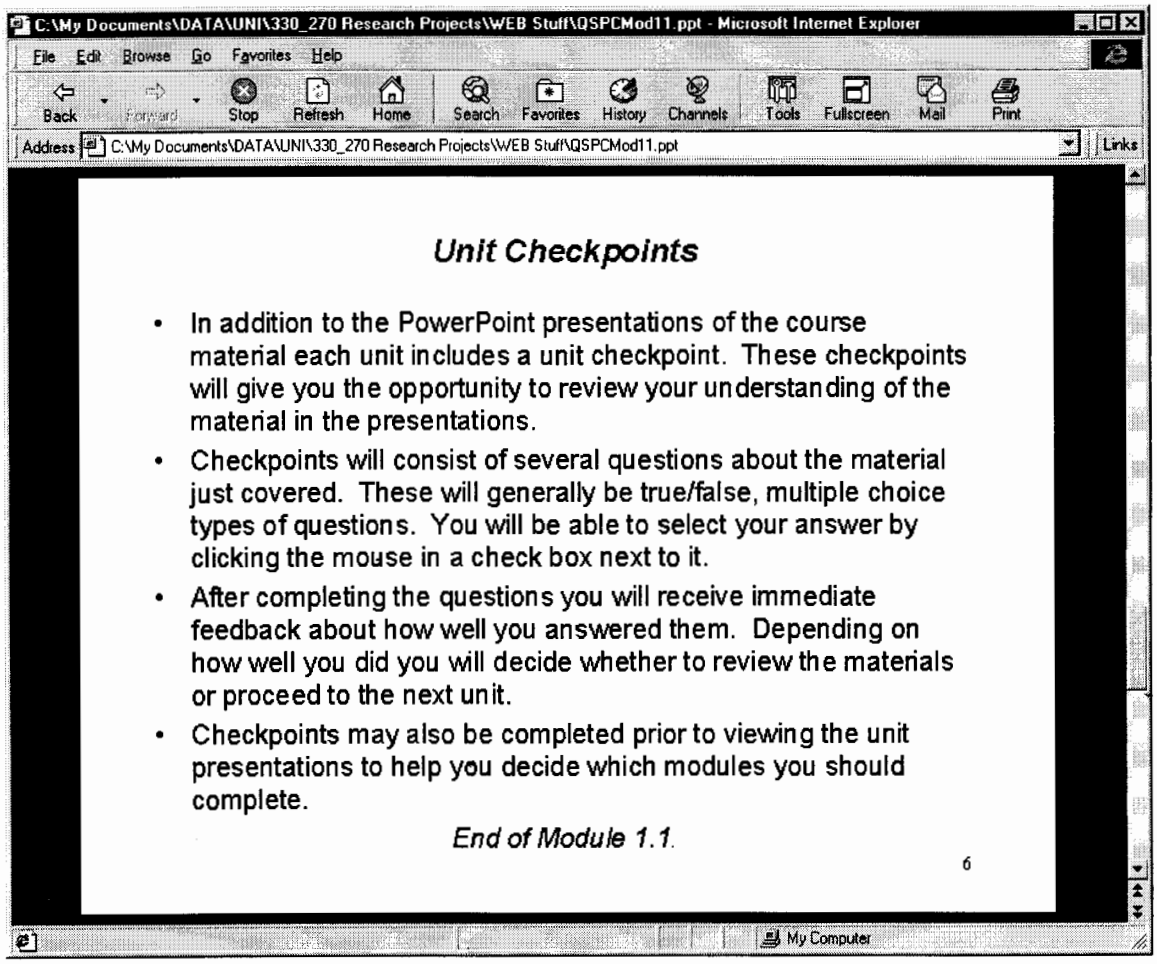

Figure 9. Module 1.1 PowerPoint presentation – slide 6.

V. CONCLUSIONS

Summary

The purpose of this study was to determine the course goal and unit objectives for SPC training, prepare an outline of the course content and develop a means to deliver the training using the John Deere Waterloo Works Intranet. The materials developed were intended to serve as a prototype for a comprehensive web-based SPC training course for John Deere Waterloo Works.

Seven research questions that would impact the design of the training modules were posed prior to the start of the study. These questions were intended to direct the research and methodology of the study. Answers to these questions were derived over the course of the study.

The first three questions dealt with the goal, objectives and content of the individual training modules. These were answered by the definition of the problem and the results of the questionnaires. Those answers are provided in the results chapter of this report.

The fourth question asked how student – trainer interaction could be accomplished. The review of the literature was used to answer this question. E-mail, FAQ's, forms, and chat were given as means to provide the needed interaction in a web-based training course. E-mail was selected as the means that would be used for the sample module. To accomplish this a hypertext e-mail link was provided on the navigation page. This directed student's questions and comments to the developer/trainer. It was decided to attempt to incorporate

additional means for interaction into the course as additional modules are developed.

Questions 5 and 6 dealt with measuring and tracking student progress. Review of the literature revealed a variety of ways to accomplish this. These range from forms designed with HTML (McManus, 1996) to commercial software products. Generally this is accomplished by using some sort of log in system. The use of a log in system presented a concern that was beyond the scope of this study. JDWW had the capability to require user log in for the training and user log in was currently in use for several other JDWW Web applications. The problem arose from the fact that the majority of employees that would be using the training are wage employees who generally are not issued computer user id's and passwords. JDWW site security personnel will need to be involved in determining whether issuing permanent global user id's for wage employees or establishing a procedure for using temporary course-related id's will be the best alternative.

A second concern related to tracking user comprehension and progress was unveiled. This dealt with how the course would be delivered. The course could be delivered similar to other training where students register for it and it is scheduled to take place during a specific time frame. Using this method makes it easy to know who is taking the course, when they began and when they are expected to complete it. This method simplifies the tracking of student progress but restricts the flexibility for students to get the training when it is needed which

is a major advantage of web-based training. Resolution of this concern was beyond the time constraints of this study.

The final research question to be addressed was whether the course could be designed to be tailored to individual student needs. The review of the literature revealed that web-based training is well suited to tailoring to meet individual needs. The questionnaires revealed that individual needs of the students would vary considerably throughout JDWW. The key for accomplishing this was to break the course into discrete modules. Keeping the course modular allowed students the ability to complete only those modules that met the student's individual needs. Another method that was incorporated into the course outline was the use of checkpoints which would be used to test the students' understanding of the material for each unit. Checkpoints could be accessed before starting a unit to allow students to determine which modules in the unit they understand and which they need to complete.

Recommendations

This study only provided the foundation for further development of the web-based SPC training course at JDWW. It verified that a web-based training program is a viable solution to the problem of the study. Based on the findings it is evident that development of the course materials should continue.

The research revealed several areas that will require further investigation and development in order to complete the training program. The writer

recommends that the following items be addressed during the development process:

1. The experts agree that evaluation of the course by actual users is important in the development of training. Since this could not be completed in this study due to uncontrollable circumstances it is recommended that this be a priority during future development. It is also recommended that this be done periodically throughout the development phase.

2. The findings revealed that further investigation should be done regarding the need to monitor and track student progress. This will require interdisciplinary involvement by several JDWW departments including Training, Information Services and Quality Assurance. Since the results of this investigation will impact the design of the training modules it is recommended that a group be formed in the very near future to address this issue.

3. Since the respondents to the questionnaires have a definite vested interest in the final training materials they need to be involved more actively in the further development of those materials. It is recommended that individuals willing to spend time and effort in the development of the course materials be sought from this group. These individuals should be trained in the use of HTML and should work together to complete the remaining modules. Those individuals who do not elect to be actively involved in the development of the course materials should be used as a review board to provide input on the materials as they are developed.

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APPENDIX A

Proposal Form for 330:270

RECEIVED - IND TECH NOV 04 1998

VIII. PROPOSAL FORM FOR 330:270
RESEARCH PROJECTS IN INDUSTRIAL TECHNOLOGY

Name Richard Juel

Proposal for Project in Industrial Supervision and Management
(Major Area)

Title An Introduction to Web based Training for Statistical Process Control (SPC).

Research activities which will be carried out:

- X 1. Library research.
- X 2. Field trips to one or more industrial companies.
- X 3. Interviews with skilled industry personnel and other knowledgeable industrial personnel.
- ____ 4. Visit stock brokerage houses.
- X 5. Correspondence with industrial manufacturers and suppliers.
- X 6. Locate appropriate audio-visual aids.
- X 7. Laboratory work (indicate intended activity).
  Development of a sample Web-based training module.
- ____ 8. Drafting (indicate intended activity).
  _____
- ____ 9. Preparation of specialized equipment (specify).
  _____
- X 10. Write report.
- X 11. Other. Correspondence and/or interviews with experts on Web-based training.
- ____ 12. Other. _____

Rational for proposed Project: The need for this study is based on the following factors:

1. John Deere Waterloo Works has an immediate need to train large numbers of employees in the use of a new SPC software tool being implemented.
2. The World-Wide Web is an emerging technology that is readily accessible in industry and adaptable to a multitude of business applications including training.
3. Simple methods for delivering training to large audiences are needed in industry.

10/28/98 — Date — Student Signature

11/4/98 — Date — Consulting Professor

10/28/98 — Date — Course Professor

APPENDIX B

Quantum SPC/DC Operator Training Questionnaire

Quantum SPC/DC Operator Training Questionnaire

Please take a few minutes to answer the following questions. Your responses will be used to determine the content of the Operator SPC training modules.

_____ Approximately how many operators will be using Quantum SPC/DC in your area (all shifts)?

Of all the operators that will be using Quantum SPC/DC, how many should be trained on:

A. SPC Basics
_____ Variation - What it is, How it is measured, How it affects processes
_____ Histograms & Outliers
_____ Distributions - Normal, Skewed, Bi-Modal, etc.
_____ Populations & Samples
_____ Mean
_____ Range
_____ Standard Deviation
_____ Overadjustment
_____ Variable and Attribute data types

B. Control Chart Basics
_____ Subgroups
_____ Central Limit Theorum
_____ Centerline
_____ Control Limits
_____ Xbar & R Charts
_____ Xbar & Sigma Charts
_____ Individuals and Moving Range Charts
_____ c Charts
_____ np Charts
_____ p Charts
_____ u Charts
_____ Pareto Charts
Control Chart Evaluation
_____ In control/Out of control
_____ Outliers
_____ Run checks
_____ Shift checks
_____ Stability checks

C. Process Capability Basics
_____ Definition - What process capability is. What it is not.
Capability indices (measures)
_____ Cr
_____ Cp
_____ Cpk
_____ Cpu
_____ Cpl
_____ PPM
_____ JDWW process capability guidelines
_____ Process Improvements
_____ How overadjustment affects process capability

D. Using Quantum SPC/DC

_____ Starting Quantum
_____ Logging on
_____ Loading setups
_____ Explanation of the data entry window
_____ Entering data
_____ Manual data entry
_____ Electronic gage data entry
_____ Out-of-Spec readings
_____ Unreasonable readings
_____ Editing data
_____ Re-taking data
_____ Deleting data
_____ End of subgroup data entry - what happens
_____ Entering Assignable Causes and Corrective Actions
_____ Explanation of characteristic notes window
_____ Explanation of control chart windows
_____ Variables control charts
_____ Attribute control charts
_____ Explanation of the histogram window
_____ Explanation of pareto chart window
_____ Explanation of statistics windows
_____ Quitting Quantum

E. Using 3000 series portable data collectors

_____ Data collector overview
_____ Turning on the power
_____ Parts of the screen
_____ Data collector menus
_____ Loading setups
_____ Entering data
_____ Manual data entry
_____ Electronic gage data entry
_____ Out-of-Spec readings
_____ Unreasonable readings
_____ Editing data
_____ Re-taking data
_____ Deleting data
_____ End of subgroup data entry - what happens
_____ Entering Assignable Causes and Corrective Actions
_____ Reviewing collected data
_____ Viewing charts

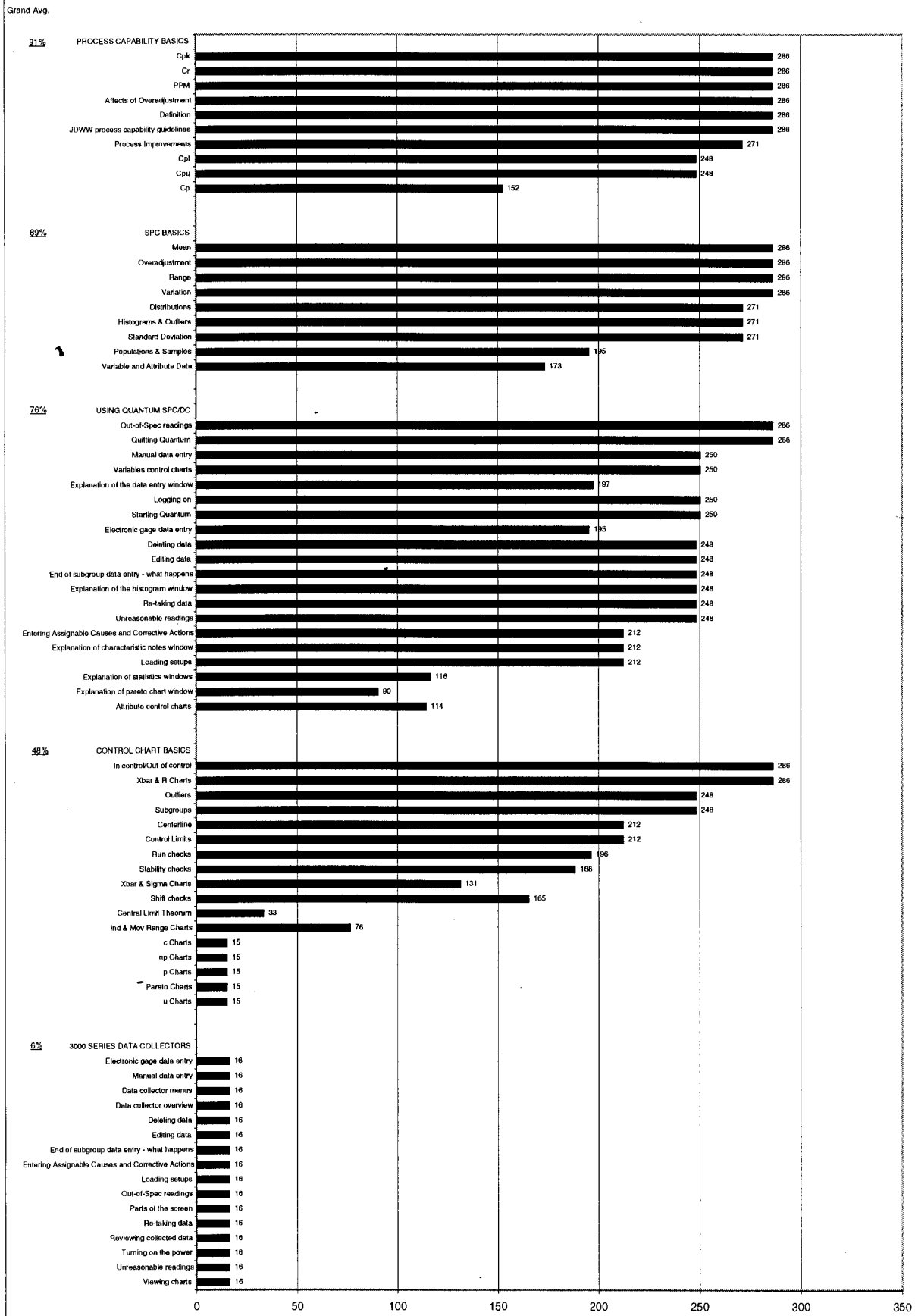
Use the following space to list any other topics that you feel should be included in a Quantum SPC/DC operator training course. (Note: Training on the basics of using a computer and Windows was intentionally left out of this questionnaire as that is a separate and broader training concern that is being addressed by others.)

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

APPENDIX C

Questionnaire Results

Questionnaire Results



APPENDIX D

SPC Bibliography

SPC Bibliography

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