



# STATISTICAL QUALITY CONTROL WITH A FOCUS ON BUILDING NECESSARY WORK SKILLS

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## Instructor Summary: *Statistical Quality Control with a Focus on Building Necessary Work Skills*

This document provides instructor guidelines for one of the ten integrated curriculum projects developed for the NSF-funded Necessary Skills Now (NSN) project (award #1501990). The NSN project partners consist of CORD and three national centers supported through the NSF's Advanced Technological Education (ATE) program: National Center for Systems Security and Information Assurance (CSSIA), Florida Advanced Technological Education Center (FLATE), and South Carolina Advanced Technological Education National Resource Center (SC ATE). The NSN project is designed to integrate employability skills into technical exercises, activities, and labs. The project partners created self-contained instructional modules vertically aligned to associate degree programs in **mechatronics/automation in manufacturing** and **cybersecurity in information technology**. (The activities described in this document support courses in manufacturing.) Six categories of employability skills, repeatedly mentioned in workforce surveys and research reports, served as the focus of the integrated curriculum:

|                                                            |                                                               |                                                              |
|------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------|
| <i>skill category</i><br><b>1</b><br>TEAMWORK              | <i>skill category</i><br><b>2</b><br>PROBLEM SOLVING          | <i>skill category</i><br><b>3</b><br>VERBAL COMMUNICATION    |
| <i>skill category</i><br><b>4</b><br>WRITTEN COMMUNICATION | <i>skill category</i><br><b>5</b><br>DEPENDABILITY/WORK ETHIC | <i>skill category</i><br><b>6</b><br>PLANNING AND ORGANIZING |

### Project Overview

#### Purpose

The purpose of the project described in this module is to integrate employability skills (teamwork, problem solving, verbal communication, written communication, dependability/work ethic, and planning and organization skills) into activities that focus on statistical quality control in manufacturing.

#### Courses for Implementation

- Quality
- Production/Processes
- Metrology
- Rapid Prototyping
- Supply Chain
- Packaging

#### Key Terms/Major Topics

- Data acquisition
- Measurement skills
- Lean manufacturing concepts
- Statistical process control
- 3D printing and scanning
- Packaging design and functionality
- Productivity and efficiency (downtime, utilization, etc.)

#### Discussion

##### Industry Scenario

Consumer goods manufacturers purchase packaging materials (containers, bottles, boxes, caps, etc.) that meet specifications defined by those manufacturers. Consistency in packaging enhances production efficiency and productivity. Students will work in teams to complete a statistical quality control project by measuring and validating data from actual packaging materials. Individual students and teams will be assessed on teamwork, communication, data acquisition and analysis, and a final presentation.

**Note:** The preferred instructional method is for each team to partner with a consumer goods manufacturer that can provide the packaging materials to achieve the scenario goals and make the activity as authentic as possible. If a manufacturer is not available, there are two options for completing the project: (1) Use the simulated data provided with the scenario or (2) purchase products such as cases of soda or water. The instructor can adjust the wording of the scenario to accommodate a fictional project, for example:

The Sure-fit packaging company needs a statistical quality control project completed. Students will work in teams as technicians to measure and validate data from actual packaging materials.

### Student Learning Objectives

#### Technical

- Students should be able to compare and contrast measured dimensions versus specified dimensions.
- Students should be able to create a process for gathering and analyzing data.
- Students should be able to create, organize, and execute a basic project plan.
- Students should be able to synthesize a formal presentation from information obtained through project assignments.

#### Written Communication

- Students should be able to read and understand written procedural guidelines.
- Students should be able to create well-written entries for their project plans.
- Students should be able to provide well-written presentation documents.

#### Verbal Communication

- Students should be able to demonstrate effective verbal communication skills in providing and responding to verbal directions.
- Students should be able to demonstrate effective verbal communication skills in presenting a team project.
- Students should be able to demonstrate effective verbal communication skills with classmates, project team members, and instructors.

#### Teamwork

- Students should demonstrate the ability to work in a variety of roles to promote the success of a team.
- Students should demonstrate the ability to assess personality profiles to create and encourage effective working teams.

#### Dependability and Work Ethics

- Students should be able to identify and perform ethical data collection and reporting.
- Students should demonstrate dependability and work ethic while working as team members.
- Students should punctually attend all course sessions and complete course requirements on time.

#### Planning and Organizing

- Students should demonstrate the ability to collaborate with their team members in planning and organizing their projects and final presentations.
- Students should be able to organize data in a clear and precise manner.

#### Problem Solving

- Students should be able to perform a root-cause analysis for nonconforming packaging materials.

### Teaching Strategies

This project is divided into four main activities:

**Activity 1: Team Building.** This activity includes the DISC assessment, group discussion, and the Hole Tarp activity. It should take 120–150 minutes to complete.

**Activity 2: Define the Project – Creating the Project Plan.** This activity introduces students to the process of identifying goals and planning the project. It should take 180–240 minutes to complete.

**Activity 3: Data Collection.** This activity introduces students to the measurement of packaging material combinations and associated data collection. The activity should be completed using authentic packaging materials. It can also be completed with sample data sets. Students should be assigned to draw conclusions based on the data analysis. The activity should take 180–240 minutes to complete.

**Activity 4: Final Presentation.** Each project team will deliver a formal presentation about its findings from Activities 1, 2, and 3. Duration will depend on the number of presentations.

If time does not allow for completion of all suggested activities, the instructor can opt to infuse selected activities into the curriculum in use.

Instructors should carefully review the industry scenario and reflect on its importance to the overall project. The scenario should serve as an authentic frame of reference that enables students to experience “real-world” situations in the manufacturing industry. An industry scenario can help students become more aware of the skills that manufacturing employees (engineers, technologists, technicians, etc.) should possess. Industry scenarios provide a link between academic activities and situations that students may later experience as employees in manufacturing environments.

Instructors should emphasize the employability skills that students are working on during project activities. At the end of each class session, instructors are encouraged to ask students to reflect on the employability skills they are practicing.

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### Student/Group Activity Steps

#### ACTIVITY 1: Team Building

##### *Activity Preparation*

Instructors should reserve lab facilities as needed and make sure all necessary equipment and materials are available.

Instructors should assign students to teams and explain that these teams will work together for the duration of the project.

##### *Activity Steps*

1. DISC Assessment
  - a. Students should take the DISC assessment at <https://discpersonalitytesting.com/>.

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- b. Instructors should review and compile the DISC assessment data by plotting students' personality types (without names) on a blank bar graph worksheet showing the distribution of personalities in the class (handout provided: [2a/b Student Personality Types Blank Bar Graph.pdf/xlsx](#)).
  - c. Instructors should assign students to six teams based on their individual DISC assessments. As much as possible, instructors should mix up the assessment results so that there are different DISC styles in each team. Once students are in their assigned teams, have them briefly discuss their personality testing results with each other. Instructors should encourage discussion among the teams by posing questions. Examples: Why do you think you received the DISC results you did? Do you agree with the results? What are advantages and disadvantages to having different personality traits on a team?
2. Team Building Activity
    - a. Perform the Hole Tarp Teambuilding Activity ([3 Hole Tarp Teambuilding Activity Directions.pdf](#)).
    - b. After the activity has been completed, bring the teams together to debrief the entire group about the team experience. Encourage discussion by posing questions. Examples: What was it like to work in a group? Were you able to accomplish the task? Could you have completed the task alone? What made the group succeed or fail? How would you improve your team experience?
3. Team Building Reading
    - a. Teams should be assigned to read *The Ideal Team Player* by Patrick Lencioni (copyright 2016). This must be read before the final presentation as teams will use concepts from the book in the final presentation.
    - b. **Note:** If an instructor is using an online learning management system (LMS, e.g., D2L, Canvas, Blackboard), periodic discussion boards can be assigned for students to submit entries regarding the book. Instructors may choose to provide an open-forum discussion or use specific prompts to focus the discussion. A certain number of responses should be required to encourage engagement. The file [4 Online Discussion Rubric.pdf](#) (provided) can be used to grade discussion prompts.

### ACTIVITY 2: Define the Project - Creating the Project Plan

#### *Activity Preparation*

Instructors should reserve lab facilities as needed and make sure all necessary equipment and materials are available.

Instructors should assign students to teams and explain that these teams will work together for the duration of the project.

Each student team will create a project plan for completing its measurement activities and data collection (Activity 3). The plan should include the following: goals, action items, timeline, and materials list. (Teams will turn in their final project plans.)

#### *Activity Steps*

1. Creating the Project Plan: Goals
  - a. Determine the deliverables and goals for the project.
  - b. Instructors should lead the teams through a discussion on how to set SMART goals and how goal-setting establishes focus and creates urgency among team members.

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- c. Review the SMART goal process:  
**S** specific / **M** measurable / **A** achievable / **R** relevant / **T** timely
  - d. Instructors may choose to show the following video, which provides an overview of SMART goal planning: <https://youtu.be/1-SvuFIQjK8>
  - e. Instructors should hand out copies of the [5 SMART Goal Worksheet.pdf](#) (provided) for teams to use while creating their goals.
  - f. Instructors should meet with each team to discuss its goals and offer feedback if goals need refinement.
2. Creating the Project Plan: Action Items and Timeline
- a. Now that the goals have been determined, the teams should create action items and timelines for achieving the goals.
  - b. Instructors should provide each team access to the [6 Action Item Excel Worksheet.xlsx](#) (provided) to use in creating and assigning the project action items and timeline.
  - c. Instructors should discuss with the importance of planning and organization. (This topic could be the focus of a discussion post in an LMS.)
  - d. Instructors should consider informing students about planning and organization tools such as Gantt charts.
    - Gantt overview video: <https://youtu.be/ADK58IRPKh8>
    - Free Gantt chart templates: <https://www.officetimeline.com/gantt-chart-template>
3. Creating the Project Plan: Materials List
- a. Teams should create a materials list, using the [7 Materials List Guidelines Worksheet.pdf](#) (provided), for both the materials being measured and the tools used for data collection.

### ACTIVITY 3: Data Collection

#### *Activity Preparation*

Instructors should reserve lab facilities as needed and make sure all necessary equipment and materials are available.

Instructors should assign students to teams and explain that these teams will work together for the duration of the project.

Three (3) packaging material combinations will be measured. Depending on class size, two teams should be assigned to each packaging material combination. Example combination: 1-liter polyethylene bottles with 28mm polyethylene caps

#### *Activity Steps*

- 1. Data Collection Activities: Ethics
  - a. Instructors should discuss the ethics of independent data collection and analysis.
    - Video resource: Data Collection and Ethical Practices in Research and Experimentation, <https://youtu.be/WfsbG3wQV5Q>
    - Discussion post-activity, in-class debate

### 2. Data Collection Activities: Measurement Data

- a. Teams should complete their measurement data.
  - Instructors should discuss appropriate ways to record and track data and the format(s) in which the data should be presented (graphs, tables, etc.). Graphs can be completed by hand or using graphing software such as Excel or Minitab. Instructors should clearly state expectations on what information hand-drawn graphs should include.
  - Students may require assistance in using measurement tools such as calipers and micrometers.
  - Instructors should discuss the mathematical analysis required. This will depend on what kind of calculation the instructor wants the students to perform. Examples: Mean, standard deviation, variability, normal distribution, control charts, null hypothesis
- b. Alternate assignment/sample data sets: In the event that packaging materials are not available, sample data sets for packaging material combinations have been provided. (See the sample data xlxs files.) Instructors should discuss possible ways the sample data was collected.

### ACTIVITY 4: Final Presentation

#### *Activity Preparation*

Instructors should reserve lab facilities as needed and make sure all necessary equipment and materials are available.

Instructors should assign students to teams and explain that these teams will work together for the duration of the project.

Instructors should establish the team presentation schedule.

#### *Activity Steps*

1. Instructors should explain the presentation requirements to the teams.
  - a. Requirements (examples):
    - How data was collected
    - What tools were used and why
    - Analysis of data (What does it say?)
    - What did you learn (good and bad) from working in a team?
    - Format (time limit, slide count, number of speakers, etc.)
  - b. The document [8 Final Presentation Guidelines and Assessment.pdf](#) has been provided as a resource.



### Expected Results

#### ACTIVITY 1

- DISC assessment results
- DISC assessment group discussion
- Team building activity
- Team building activity group discussion
- *The Ideal Team Player* review

#### ACTIVITY 2

- Develop the project plan

#### ACTIVITY 3

- Data collection

#### ACTIVITY 4

- Formal presentation delivered by each team

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### Equipment/Materials

Standard classroom technology equipment (computer, projector, etc.)

Computers with Internet access and presentation software (Microsoft PowerPoint, Apple Keynote, Powtoon, Prezi, etc.)

*The Ideal Team Player* (copyright 2016)

Packaging materials for data collection

Measurement tools

Tarps

Tennis balls

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### Instructor Resources

#### Handouts and Supplemental Materials

- 2 Student Personality Types Blank Bar Graph.pdf/xlsx
- 3 Hole Tarp Teambuilding Activity Directions.pdf
- 4 Online Discussion Rubric.pdf
- 5 SMART Goal Worksheet.pdf
- 6 Action Item Excel Worksheet.xlsx

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7 Materials List Guidelines Worksheet.pdf

8 Final Presentation Guidelines and Assessment.pdf

9 Team Member Participation Evaluation Worksheet.xlsx

### Alternate Assignment/Sample Data Sets

10 Sample Bottle Data–Group1.xlsx

11 Sample Bottle Data–Group2.xlsx

12 Sample Bottle Data–Group3.xlsx

13 Sample Bottle Specs 1.pdf

14 Sample Bottle Specs 2.pdf

15 Sample Bottle Specs 3.pdf

16 Sample Bottle Specs 4.pdf

### Videos

SMART Goal Planning Overview

<https://youtu.be/1-SvuFIQjK8>

Gantt Chart Overview

<https://youtu.be/ADK58IRPKh8>

Data Collection and Ethical Practices in Research and Experimentation

<https://youtu.be/WfsbG3wQVSQ>

### Websites

DISC Personality Assessment

<http://discpersonalitytesting.com>

Free Gantt Chart Templates

<https://www.officetimeline.com/gantt-chart-template>

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## Assessment

Students should be assessed according to their completion of the tasks and deliverables. Teams should fill out and complete the corresponding forms or documents as required in the activities.

Instructors should grade and provide feedback on the team activities. Each student will receive an individual grade based on individual results and team collaboration. Instructors can use the provided student evaluation documents as support for grading.

Assessment tools have been provided for the following:

**Final Presentation - Final Presentation Guidelines and Assessment:** Each team will communicate a summary of its project activities and findings in a formal presentation.

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**Teamwork - Team Member Participation Evaluation Worksheet:** Team members assess each other based on participation and contribution. Each student receives a copy of the file and fills it out for him- or herself and the other team members. All students should participate and work as team members. The instructor should follow up on student participation on a regular basis.

**Online Discussion - Online Discussion Rubric:** Students should participate and collaborate in group discussion activities.

Additional opportunities for assessment include:

- Evaluation of the project plan
- Data collection check-in points
- Team and individual check-in points (halfway through the project) using the hungry, humble, and smart chart from *The Ideal Team Player*. Students can be asked how they see themselves in relation to the definitions presented by the author. All students can be asked to describe where their team members fit on the chart. The goal of this assessment step is to show the value of self-awareness and how it can be used to foster teamwork.

Instructors should feel free to create additional assessment tools such as those listed below:

- Additional rubrics
- Performance task checklists
- Observations
- Quizzes, tests
- Writing prompts
- Laboratory reports