Overview of DMAIC

DMAIC is a “structured problem-solving procedure” closely connected to Six Sigma.

Its five steps are:

- **Define** opportunities;
- **Measure** performance;
- **Analyze** opportunity;
- **Improve** performance;
- **Control** performance.
The Define step

The Define step is largely non-statistical.

Objectives

- Identify and validate the business improvement opportunity;
- Define critical customer requirements;
- Document processes;
- Establish project charter, build team.
The Measure step

The Measure step involves various statistical contributions.

Objectives

- Determine what to measure;
- Develop and validate measurement systems;
- Manage measurement data collection;
- Determine Sigma performance level.
Deciding what to measure is sometimes straightforward (e.g. diameter of a shaft); often, however, a system or process can be characterized in many ways, and choosing one as a focus is a non-trivial decision.

Similarly, how to measure it may be a serious decision. In some cases, there may be:

- a cheap and easy but imprecise method;
- a more expensive but precise method.

The Measure step includes collecting *baseline* data: the performance of the system before improvement.
The Analyze step

The Analyze step is inherently statistical.

Objectives

- Analyze data to understand reasons for variation and identify potential root causes;
- Determine process capability, throughput, cycle time.
- Formulate, investigate, and verify root cause hypotheses.
Statistical tools used in the Analyze step include:

- **Control charts** from current operations, which can reveal problems such as uncontrolled shifts or changes in variability;

- **Statistical inferences** such as parameter estimates and confidence intervals for key parameters;

- **Regression models** describing the impact of various factors on variables of interest.
The Improve step

The Improve step is also inherently statistical.

Objectives

- Generate and quantify potential solutions;
- Evaluate the solutions and select the best;
- Verify and gain approval for best solution.
Designed experiments are typically used to explore changes such as factor settings that can improve the performance of the system.

When many potential factors have been identified in earlier steps, a first screening experiment may be used to find those with the most impact, followed by more intensive study of their effects in a factorial design.

When improvements have been proposed, a validation experiment will confirm or refute the claimed performance.
The Control step

The Control step involves various statistical contributions.

Objectives

- Develop ongoing process management plans;
- Mistake-proof the process;
- Monitor and control critical process characteristics;
- Develop out-of-control action plans.
The validation experiment in the Improve step is usually a small-scale pilot study.

The procedures developed in the Control step are designed to ensure that the same improved performance is attained and maintained in routine operations.
Examples of DMAIC: Litigation Documents

**Dupont** used a DMAIC-structured project to improve its legal document handling.

If a document is needed for litigation and cannot be produced within 30 days, a court extension must be requested, incurring expense and loss of credibility.

The documents were all hard copy, but described in an electronic database.

The documents were managed by a contractor.
Define

Chosen CTQs (critical to quality):

- Cycle time (time from a request to the production of the requested document);
- Error rate;
- Non-value-added process activities;
- Costs.

The team mapped the entire document-production process.
Measure

The team studied the database, records of costs and errors, and cycle time (time from request to production).

The frequency of handling of documents was difficult to measure (lack of records?).

Errors such as pulling the wrong document cause non-value-added costs.
Analyze

Problems that were identified:
- High turnover rate for the contractor’s clerks;
- Inadequate training;
- Inattention—the clerks had no ownership of the process;
- A large volume of documents.

Underlying issue: the system was manual.
Improve

The team proposed to scan all documents.

Not a new idea!

- Previously rejected because of cost.
- This project quantified the cost of *not* implementing scanning, i.e. the costs associated with the manual process.

The team estimated a 50% reduction in cost of producing a document, and a 70% reduction in non-value-added costs due to errors.
Control

The new system tracks and reports per-document costs.

It can also track and report performance on other CTQs:

- Cycle time;
- Error rate;
- Non-value-added process activities.
Improving On-Time Delivery

An important customer of a machine tool manufacturer complained about an 85% on-time delivery rate.

Their contract specified a late delivery penalty: 15% of the price.

The customer was concerned about the manufacturer’s capability to meet its future production schedule.

The manufacturer did not want to lose this customer.
Define
Objective: 100% on-time deliveries.

Measure
The contract called for 8-week delivery.

The team identified 19 steps in the process leading from the receipt of an order to shipping and invoicing.

Historical data and new observations showed that the 8-week target could be met only if no issues arose.
Analyze

Identified problems:
- Supplier quality issues: premature failure of parts;
- Purchase order process delay;
- Delayed customer confirmation of configuration;
- Incorrect configuration.

Improve

- Supplier quality control: assist the supplier to improve quality, and stock critical spare parts to avoid shipping delays;
- Improve the purchase order process;
- Improve the ordering process with customer: provide the customer with a customized spreadsheet.
Control

- Revised, more visual, production tracking spreadsheet;
- Biweekly reporting;
- A project engineer monitors the progress of each tool on order.

These improvements led to 100% on-time delivery, and retention of the customer.
Improving Service Quality in a Bank

Define and Measure
Identified CTQs to be improved:
- Speed of service;
- Consistent service;
- An easy-to-use process;
- Pleasant environment;
- Knowledgeable staff.

Analyze
Many factors were identified; the team decided to focus on two:
- Improved teller and customer workstations;
- New training for staff.
**Improve**

The team decided to carry out a two-level two-factor factorial designed experiment:

- Workstation: previous versus new;
- Training: none versus new program.

This results in four **treatments**, that is combinations of factor levels, each used at one branch for 30 business days.

The response was measured in a survey of customer satisfaction. Presumably, the same survey was used in the Measure step?

**Control**

Not described; continued occasional surveys?