The challenge for businesses today is to satisfy their customers through the exceptional performance of their processes...

**Quality at Crowne Plaza Christchurch**

- The Crowne Plaza is a luxury hotel with 298 guest rooms three restaurants, two lounges and 260 employees to serve 2,250 guests each week.
- **RESTAURANT PROCESS**
  - Consistency of presentation, consistency of content, timeliness of service
- **PROCUREMENT PROCESS**
  - Quality of products delivered, on-time delivery (of suppliers), quality of food
  - Employee empowerment opportunities to evaluate the processes
  - Guest preferences
  - Other staff to customize service for each guest.
  - The evaluation of these processes will depend on how well they satisfy their restaurant customers

**Process Performance & Quality**

- **Quality** is the ability of a product or service to consistently meet or exceed customer expectations
- **Quality Assurance**: Emphasis on finding and correcting defects before reaching market
- **Strategic Approach**: Proactive, focusing on preventing mistakes from occurring
  - Greater emphasis on customer satisfaction

**Costs of Poor Process Performance & Quality**

- **Defects**: Any instance when a process fails to satisfy its customer.
  - **Prevention costs** are associated with preventing defects before they happen.
  - **Appraisal costs** are incurred when the firm assesses the performance level of its processes.
  - **Internal failure costs** result from defects that are discovered during production of services or products.
  - **External failure costs** arise when a defect is discovered after the customer receives the service or product.
**Total Quality Management**

- **Total quality management** (TQM) is a philosophy that stresses three principles for achieving high levels of process performance and quality:
  1. Customer satisfaction
  2. Employee involvement
  3. Continuous improvement in performance

**Customer Satisfaction**

- Customers, internal or external, are satisfied when their expectations regarding a service or product have been met or exceeded.
  - **Conformance**: How a service or product conforms to performance specifications.
  - **Value**: How well the service or product serves its intended purpose at a price customers are willing to pay.
  - **Fitness for use**: How well a service or product performs its intended purpose.
  - **Support**: Support provided by the company after a service or product has been purchased.
  - **Psychological impressions**: atmosphere, image, or aesthetics

**Employee Involvement**

- One of the important elements of TQM is employee involvement.
  - **Quality at the source** is a philosophy whereby defects are caught and corrected where they were created.
  - **Teams**: Small groups of people who have a common purpose, set their own performance goals and approaches, and hold themselves accountable for success.
  - **Employee empowerment** is an approach to teamwork that moves responsibility for decisions further down the organizational chart to the level of the employee actually doing the job.
Continuous improvement is the philosophy of continually seeking ways to improve processes based on a Japanese concept called kaizen.

1. Train employees in the methods of statistical process control (SPC) and other tools.
2. Make SPC methods a normal aspect of operations.
3. Build work teams and encourage employee involvement.
4. Utilize problem-solving tools within the work teams.
5. Develop a sense of operator ownership in the process.

Statistical process control is the application of statistical techniques to determine whether a process is delivering what the customer wants.

- How will we collect the data?
  - **Sampling plan**: A plan that specifies a sample size, the time between successive samples, and decision rules that determine when action should be taken.
  - **Sample size**: A quantity of randomly selected observations of process outputs.
Sample Means and the Process Distribution

Sample statistics have their own distribution, which we call a sampling distribution.

The average value measured from a process typically falls in the center.

If there is too much spread, would need to identify an assignable cause.

Some spread (variability) in this sampling distribution is natural (common causes of variability).

Causes of Variation

- Two basic categories of variation in output include common causes and assignable causes.
- Common causes are the purely random, unidentifiable sources of variation that are unavoidable with the current process.
  - If process variability results solely from common causes of variation, a typical assumption is that the distribution is symmetric, with most observations near the center.
- Assignable causes of variation are any variation-causing factors that can be identified and eliminated, such as a machine needing repair.

Assignable Causes

- A process is said to be in statistical control when the location, spread, or shape of its distribution does not change over time.
- After the process is in statistical control, managers use SPC procedures to detect the onset of assignable causes so that they can be eliminated.

Statistical Process Control Methods

Control Charts for variables are used to monitor the mean and variability of the process distribution.

Two types of control charts:
- measurements
- attributes
Control Charts

Control chart: A time-ordered diagram that is used to determine whether observed variations are abnormal.

A sample statistic that falls between the UCL and the LCL indicates that the process is exhibiting common causes of variation; a statistic that falls outside the control limits indicates that the process is exhibiting assignable causes of variation.

Control Chart Examples

- 1 or more points outside the control limits
- 9 or more in a row above (or below) the process centerline
- 6 or more consecutive points moving in the same direction
- 14 points in a row, alternating up and down

If any of these signals occur, then the process is OUT OF CONTROL!!!

Control Charts for Groups of Measurements

Control Charts for variables are used to monitor the mean and variability of the process distribution.

- R-chart (Range Chart) is used to monitor process variability.
- x-chart is used to see whether the process is generating output, on average, consistent with a target value set by management for the process or whether its current performance, with respect to the average of the performance measure, is consistent with past performance.

How to construct SPC Charts

1. Isolate the measurement of interest (create run chart)
2. Calculate process control centerline (add to run chart)
   - This describes the location of the process
3. Calculate upper & lower control limits (add to run chart)
   - For normally distributed data, 99.7% of observations fall within 3σ of the mean
   - Calculate 3σ control limits
     - UCL: μ+3σ
     - LCL: μ-3σ
4. Determine whether process is in control

Suppose you take several observations from different locations from a single process...
Example 6.1

West Allis is concerned about their production of a special metal screw used by their largest customers. The diameter of the screw is critical. Data from five samples is shown in the table below. Sample size is 4. Is the process in statistical control?

Control Charts for Attributes

\[ p_{\text{chart}}: \text{A chart used for controlling the proportion of defective services or products generated by the process.} \]

\[ \sigma_p = \sqrt{p(1-p)/n} \]

Where

- \( n = \) sample size
- \( \bar{p} = \) central line on the chart, which can be either the historical average population proportion defective or a target value.

Control limits are:

\[ \text{UCL}_{p} = \bar{p} + 3\sigma_p \]

\[ \text{LCL}_{p} = \bar{p} - 3\sigma_p \]

c-Charts

\[ c_{\text{chart}}: \text{A chart used for controlling the number of defects when more than one defect can be present in a service or product.} \]

The underlying sampling distribution for a c-chart is the Poisson distribution.

- The mean of the distribution is \( \bar{c} \)
- The standard deviation is \( \sqrt{\bar{c}} \)
- A useful tactic is to use the normal approximation to the Poisson so that the central line of the chart is \( c \) and the control limits are

\[ \text{UCL}_c = \bar{c} + 3\sqrt{\bar{c}} \]

\[ \text{LCL}_c = \bar{c} - 3\sqrt{\bar{c}} \]

Process Capability

Process capability is the ability of the process to meet the design specifications for a service or product.

- Nominal value is a target for design specifications.
- Tolerance is an allowance above or below the nominal value.
**Process Capability Ratio, $C_p$**

The process capability ratio, $C_p$, is the tolerance width divided by 6 standard deviations (process variability).

$$C_p = \frac{\text{Upper specification} - \text{Lower specification}}{6\sigma}$$

- If $C_p > 2$, the process can operate within 6-sigma limits.
- If $C_p > 1.33$, the process can operate within 4-sigma limits.
- If $C_p > 1$, the process can operate within 3-sigma limits.

We need to ensure that the process is capable. If a process is capable, the tolerance width must be greater than 6 standard deviations.

**Process Capability Index, $C_{pk}$**

The process capability index, $C_{pk}$, is an index that measures the potential for a process to generate defective outputs relative to either upper or lower specifications.

$$C_{pk} = \min \left( \frac{\bar{x} - \text{Lower specification}}{3\sigma}, \frac{\text{Upper specification} - \bar{x}}{3\sigma} \right)$$

We take the minimum of the two ratios because it gives the worst-case situation. If BOTH $C_p$ and $C_{pk}$ are $>\text{some target value}$, the process is capable.

**Effects of Reducing Variability on Process Capability**

- 6-sigma means 0.002 defects per million.
- 4-sigma means 63 defects per million.
- 2-sigma means 45,600 defects per million.

**Six Sigma**

- Six Sigma is a comprehensive and flexible system for achieving, sustaining, and maximizing business success by minimizing defects and variability in processes.

  - It relies heavily on the principles and tools of TQM.
  - It is driven by a close understanding of customer needs; the use of facts, data, and statistical analysis; and diligent attention to managing, improving, and reinventing business processes.

  - Six Sigma is also driven by the principles and tools of TQM.
International Quality Documentation Standards

- **ISO 9000**: A set of standards governing documentation of a quality program.
- **ISO 14000**: Documentation standards that require participating companies to keep track of their raw materials use and their generation, treatment, and disposal of hazardous wastes.

Malcolm Baldrige National Quality Award

Named after the late secretary of commerce, a strong proponent of enhancing quality as a means of reducing the trade deficit, **The award promotes, recognizes, and publicizes quality strategies and achievements.**

1. Category 1 — Leadership 120 points
2. Category 2 — Strategic Planning 85 points
3. Category 3 — Customer and Market Focus 85 points
4. Category 4 — Measurement, Analysis, and Knowledge Management 90 points
5. Category 5 — Human Resource Focus 85 points
6. Category 6 — Process Management 85 points
7. Category 7 — Business Results 450 points

Concepts of TQM

- Service quality is more difficult to measure than the quality of goods
- Service quality perceptions depend on:
  - Intangible differences between products
  - Intangible expectations customers have of those products
- The Operations Manager must recognize:
  1. The tangible component of services is important
  2. The service process is important
  3. The service is judged against the customer’s expectations
  4. Exceptions will occur

Key Dimensions of PRODUCT Quality

- Performance
- Features
- Reliability
- Conformance
- Durability
- Serviceability
- Aesthetics
- Perceived quality
- Value
**Key Dimensions of SERVICE Quality**

- Reliability
- Responsiveness
- Competence
- Access
- Courtesy
- Communication
- Credibility
- Security
- Understanding/knowing the customer
- Tangibles

**Service Specifications at UPS**

- Turn in sales leads
- Hair can’t grow below the collar
- Sideburns can’t grow below the bottom of the ear
- No beard
- Toot horn when arriving at business or residence
- Present parcels for five steps ahead
- Load boxes neatly and evenly, like a stack of bricks
- Walk briskly, no running allowed
- Sport clean uniform every day
- Black or brown polishable shoes, matching socks

**Concepts of TQM**

- Service quality is more difficult to measure than the quality of goods
- Service quality perceptions depend on:
  - Intangible differences between products
  - Intangible expectations customers have of those products
- Need a service recovery strategy
  - Managers should have a plan for when services fail

**When and Where to Inspect**

- At the supplier’s plant while the supplier is producing
- At your facility upon receipt of goods from the supplier
- Before costly or irreversible processes
- During the step-by-step production process
- When production or service is complete
- Before delivery to your customer
- At the point of customer contact

**SOME PROBLEMS**

- Worker fatigue
- Measurement error
- Process variability
## Service Industry Inspection

<table>
<thead>
<tr>
<th>Organization</th>
<th>What is Inspected</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive Garden Restaurant</td>
<td>Busboy</td>
<td>Serves water and bread within 1 minute</td>
</tr>
<tr>
<td></td>
<td>Busboy</td>
<td>Clears all entrée items and crumbs prior to dessert</td>
</tr>
<tr>
<td></td>
<td>Waiter</td>
<td>Knows and suggest specials, desserts</td>
</tr>
</tbody>
</table>

### Table 6.5

<table>
<thead>
<tr>
<th>Organization</th>
<th>What is Inspected</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordstrom Department Store</td>
<td>Display areas</td>
<td>Attractive, well-organized, stocked, good lighting</td>
</tr>
<tr>
<td></td>
<td>Stockrooms</td>
<td>Rotation of goods, organized, clean</td>
</tr>
<tr>
<td></td>
<td>Salesclerks</td>
<td>Neat, courteous, very knowledgeable</td>
</tr>
</tbody>
</table>

### HW2 (part 2)

**PROCESS STRATEGY**
- Reverse engineer the process for constructing this airplane.
- How do I work with teams?

**PROCESS ANALYSIS**
- Develop a flowchart for constructing this airplane.

**PROCESS PERFORMANCE & QUALITY**
- For each step in the design, how can quality be monitored?
  - Inspection necessary?
- Re-construct the paper airplane you have been assigned and comment on the instructions you have been given.