OPSMGT 370
Operations and Supply Chain Strategy

Week 2 - Lecture

Quality Management

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Outline

- What Is Quality?
- Dimensions of Quality
- Quality Tools
- TQM and QMS
- Focus of Quality Management
- Cost of Quality
- Quality, Profitability, and Productivity

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What Is Quality?

- *Oxford American Dictionary*
  - a degree or level of excellence
- American Society for Quality (ASQ)
  - totality of features and characteristics that satisfy needs without deficiencies
- Consumer's and producer's perspective
  - customer's expectations and producer's (provider's) capabilities should align
  - customer's voice needs to be heard by the producer

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What Is Quality: Customer's Perspective

- Fitness for use
  - how well product or service does what it is supposed to
- Quality of design
  - designing quality characteristics into a product or service
- A RollsRoyce and a Ford are equally "fit for use," but with different design dimensions.

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What Is Quality: A competitive priority

- "Differentiation": creating a value [for the customer] that is known uniquely industrywide. (Porter, 1980)
  - How well a company is distinguished through delivering a product or service that consistently conforms to (or exceeds) customer's needs.
  - A company's perspective on quality reflects how it thinks about customers, competition, and the business environment (Belohlav, 1993)

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Dimensions of Quality: Manufactured Products

1. Performance
   - basic operating characteristics of a product; how well a car handles or drives on gas mileage
2. Features
   - "extra" items added to basic features, such as a stereo CD or a leather interior in a car
3. Reliability
   - probability that a product will operate properly within an expected time frame; that is, a TV will work without repair for about seven years

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Dimensions of Quality: Manufactured Products

4. Conformance
   - degree to which a product meets pre–established standards
5. Durability
   - how long product lasts before replacement; with care, L.L. Bean boots may last a lifetime
6. Serviceability
   - ease of getting repairs, speed of repairs, courtesy and competence of repair person

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Dimensions of Quality: Manufactured Products

7. Aesthetics
   - how a product looks, feels, sounds, smells, or tastes
8. Safety
   - assurance that customer will not suffer injury or harm from a product; an especially important consideration for automobiles
9. Perceptions
   - subjective perceptions based on brand name, advertising, etc.

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Dimensions of Quality: Service

1. Time and timeliness
   - how long must a customer wait for service, and is it completed on time?
   - is an overnight package delivered overnight?
2. Completeness
   - is everything customer asked for provided?
   - is a mail order from a catalogue company complete when delivered?

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Dimensions of Quality: Service

3. Courtesy
   - how are customers treated by employees?
   - are catalogue phone operators nice and are their voices pleasant?
4. Consistency
   - is same level of service provided to each customer each time?
   - is your newspaper delivered on time every morning?

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Dimensions of Quality: Service

5. Accessibility and convenience
   - how easy is it to obtain service?
   - does service representative answer your calls quickly?
6. Accuracy
   - is service performed right every time?
   - is your bank or credit card statement correct every month?
7. Responsiveness
   - how well does company react to unusual situations?
   - how well is a telephone operator able to respond to a customer's questions?

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What Is Quality: Producer's Perspective

- Quality of conformance
  - making sure product or service is produced according to design
    - if new tires do not conform to specifications, they wobble
    - if a hotel room is not clean when a guest checks in, hotel is not functioning according to specifications of its design
- Broader view
  - Reducing environmental damage
  - Improving working conditions and safety

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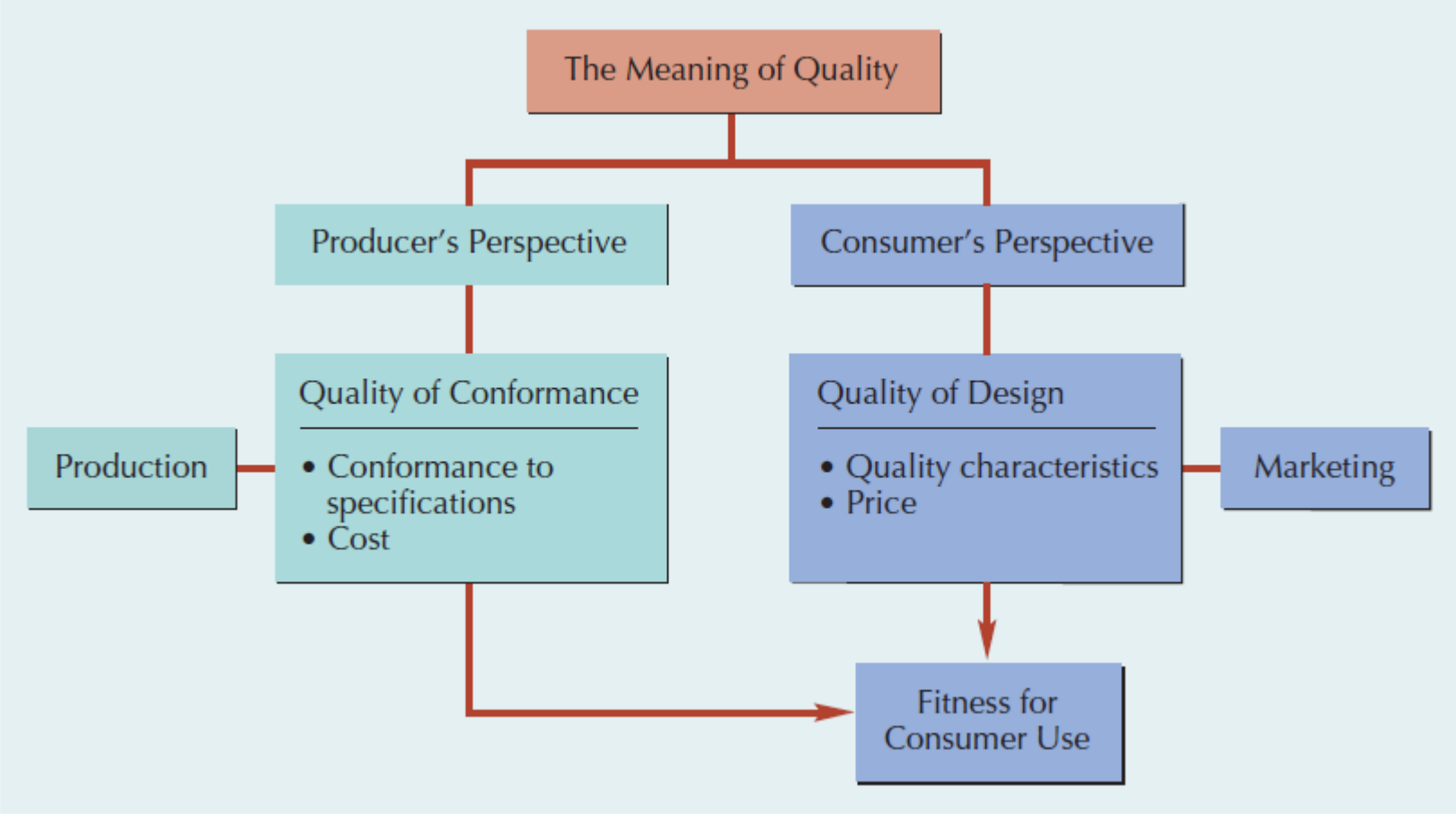
Meaning of Quality



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What Is Quality: The Ultimate Perspective

- Customer's and producer's perspectives depend on each other
- Producer's perspective:
  - production process and COST
- Customer's perspective:
  - fitness for use and PRICE
- Customer's view must dominate

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Quality Tools

- Process Flow Chart
- Cause-and-Effect Diagram
- Check Sheet
- Pareto Analysis
- Histogram
- Scatter Diagram
- Statistical Process Control Chart

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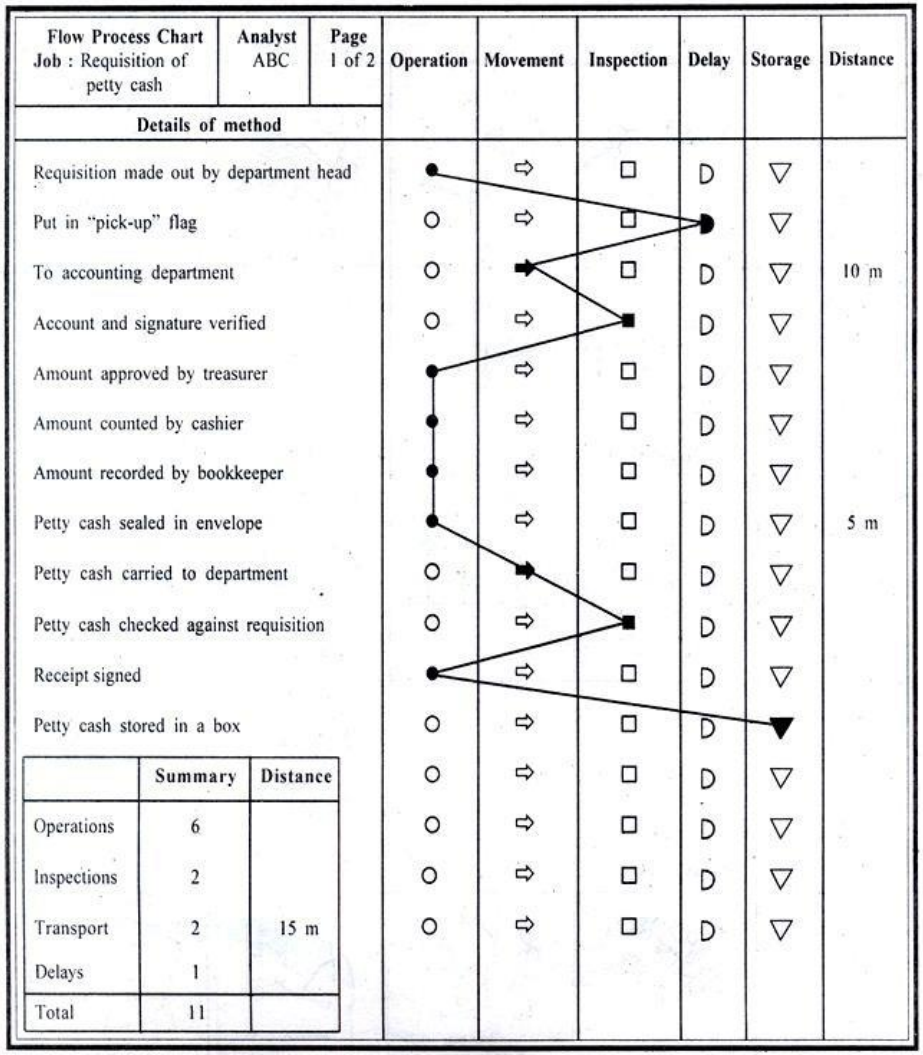
Flow Chart

- A diagram of the steps in a process
- Helps focus on location of problem in a process



Flow Process Chart Job : Requisition of petty cash	Analyst ABC	Page 1 of 2	Operation	Movement	Inspection	Delay	Storage	Distance
Details of method								
Requisition made out by department head			●	⇨	□	D	▽	
Put in "pick-up" flag			○	⇨	□	D	▽	
To accounting department			○	⇨	□	D	▽	10 m
Account and signature verified			○	⇨	□	D	▽	
Amount approved by treasurer			●	⇨	□	D	▽	
Amount counted by cashier			●	⇨	□	D	▽	
Amount recorded by bookkeeper			●	⇨	□	D	▽	
Petty cash sealed in envelope			●	⇨	□	D	▽	5 m
Petty cash carried to department			○	⇨	□	D	▽	
Petty cash checked against requisition			○	⇨	□	D	▽	
Receipt signed			●	⇨	□	D	▽	
Petty cash stored in a box			○	⇨	□	D	▽	
			○	⇨	□	D	▽	
			○	⇨	□	D	▽	
			○	⇨	□	D	▽	
			○	⇨	□	D	▽	

	Summary	Distance
Operations	6	
Inspections	2	
Transport	2	15 m
Delays	1	
Total	11	

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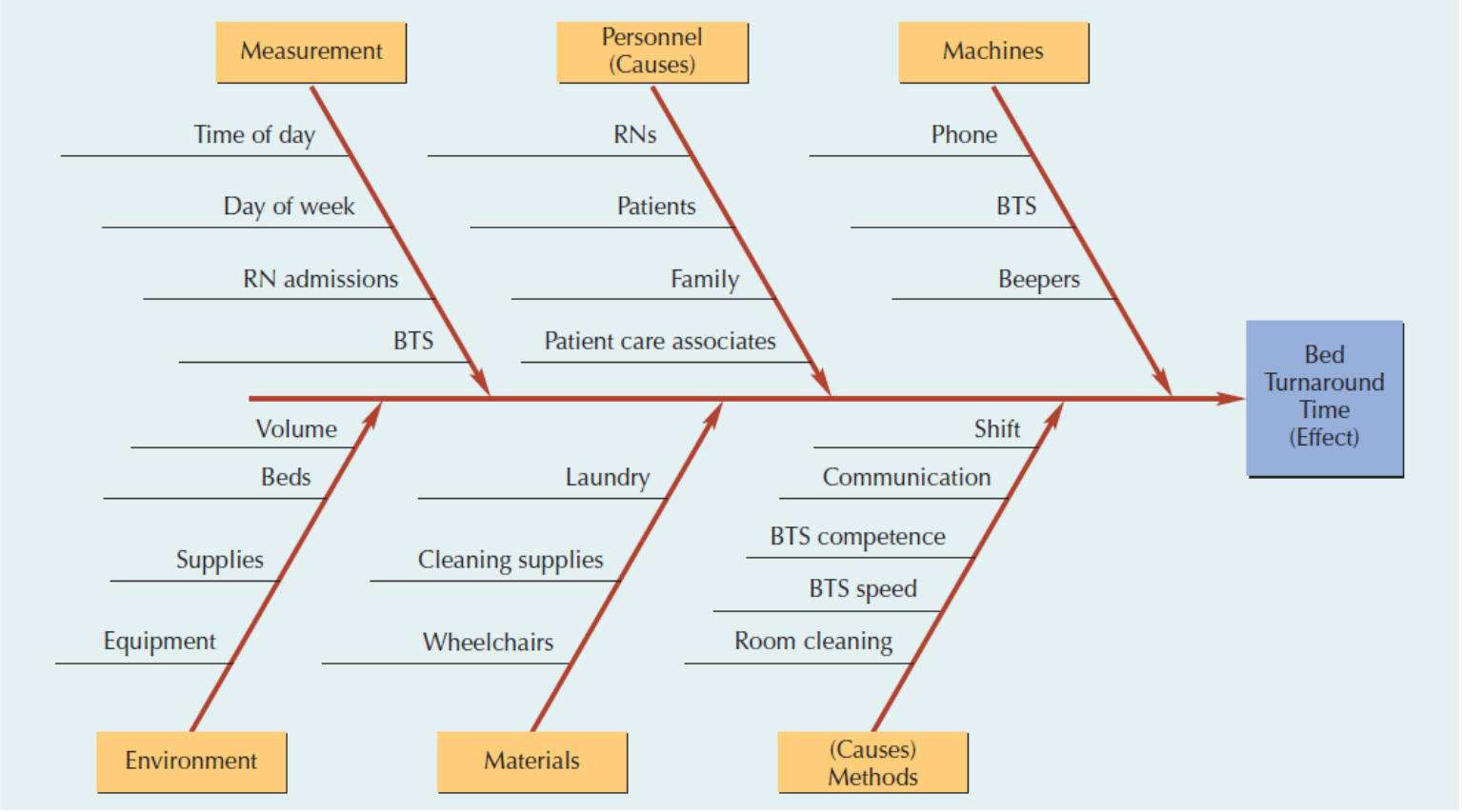
Cause-and-Effect Diagram

- Cause-and-effect diagram ("fishbone" diagram)
  - chart showing different categories of problem causes



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Cause-and-Effect Matrix

- Cause-and-effect matrix
  - grid used to prioritize causes of quality problems

				Key Output (*Y*) Variables (*CTQCs*)							
				1	2	3	4	5	6		
				Turnaround time	Patient flow	Physician time	Emergency dept.	Patient time	Operating room		Rank of *X* Variables/ Importance to Customer
	Key Input (*X*) Variables	Customer rank		1	3	2	5	6	4		
		Weight		*10*	*9*	*9*	*7*	*7*	*8*	Score	
1	BTS			9	8	10	5		5	348	3
2	Beepers			7	5	8	7	5		222	7
3	Volume			7	10	6	8	5	5	338	4
4	Beds			4		9				121	10
5	Time of day			3	4	5	7	10		209	8
6	Day of week			9	10	6			6	282	5
7	Communication			9	8	10	4	7	9	429	1
8	BTS competence			10	9	7		7	7	349	2
9	Room cleaning			7	5	3	8	8	4	230	6
10	Supplies			8	9					161	9

(8)(10) + (9)(9) = 161

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Check Sheets and Histograms

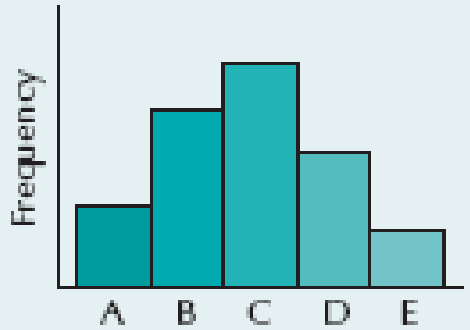
- Tally number of defects from a list of causes

- Frequency diagram of data for quality problem

Check Sheet

Items	1	2	3	4
Dirt	𝍸			𝍸
Old		𝍷		𝍷
Temp.	𝍷	𝍸	𝍸	
Fault	𝍸𝍷		𝍸	

Histogram



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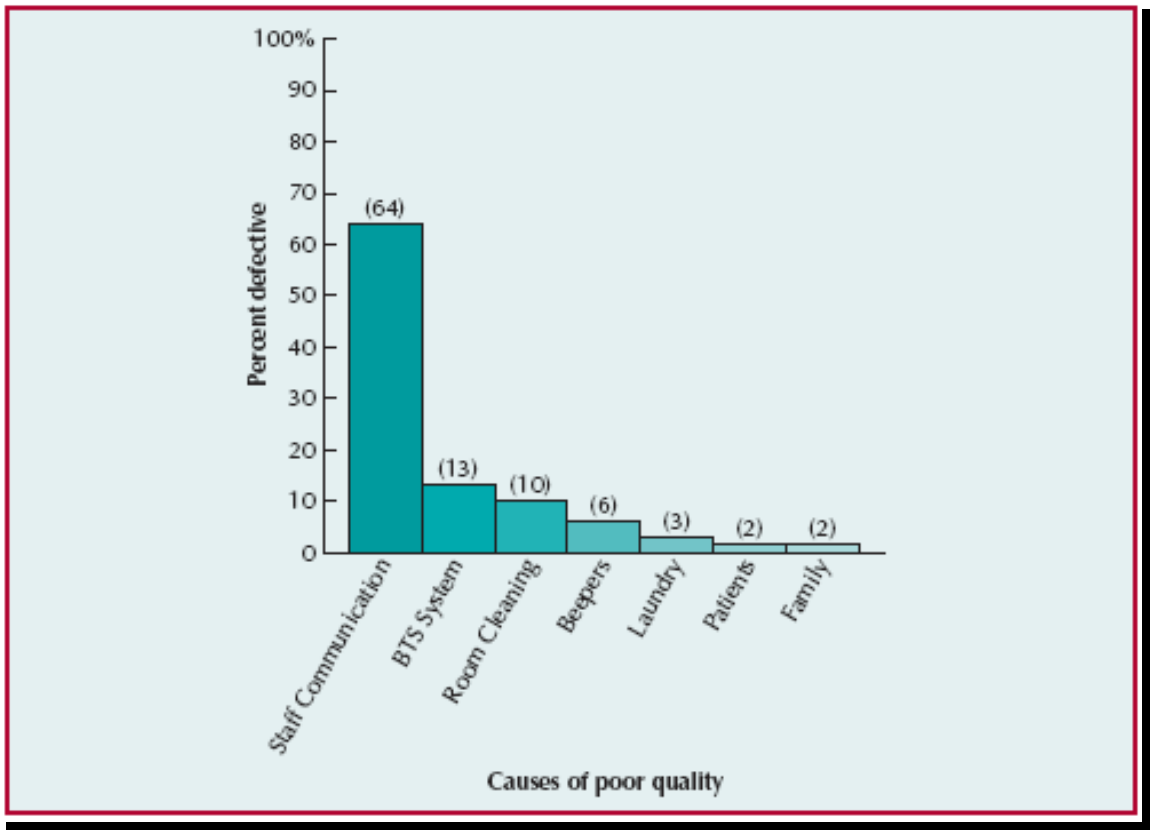
Pareto Analysis

- Pareto analysis
  - most quality problems result from a few causes

Cause	*Number of Defects*	*Percentage*
Staff communication	83	64%
BTS system	17	13
Room cleaning	13	10
Beepers	7	6
Laundry	4	3
Patients	3	2
Family	3	2
	130	100%

Pareto Chart



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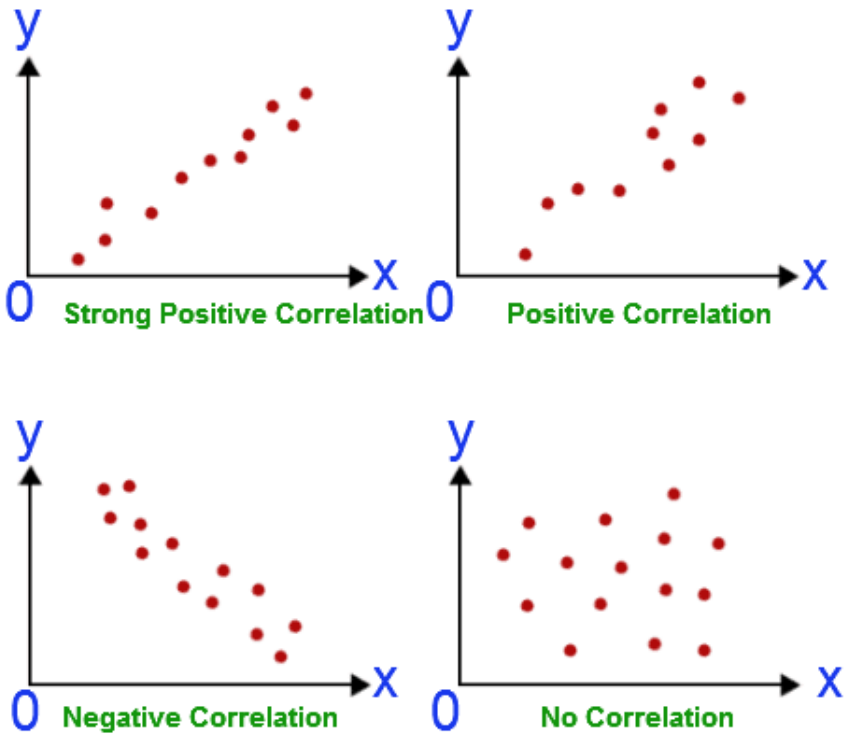
Scatter Diagram

- Graph showing relationship between 2 variables in a process
  - Identifies pattern that may cause a quality problem



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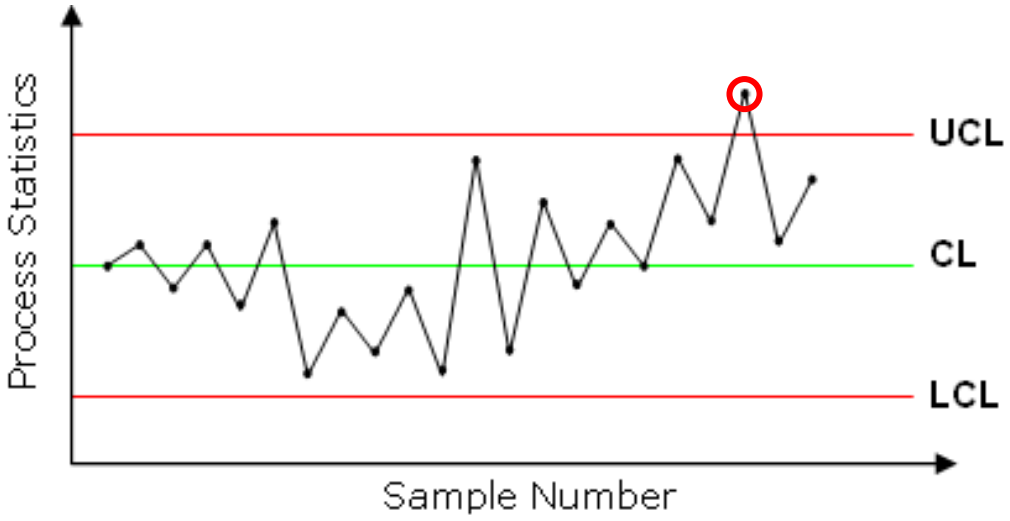
Control Chart

- A chart with statistical upper and lower limits
  - If sample statistics remain between these limits we assume the process is in control



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TQM and QMS

- Total Quality Management (TQM)
  - customer-oriented, leadership, strategic planning, employee responsibility, continuous improvement, cooperation, statistical methods, and training and education
- Quality Management System (QMS)
  - system to achieve customer satisfaction that complements other company systems

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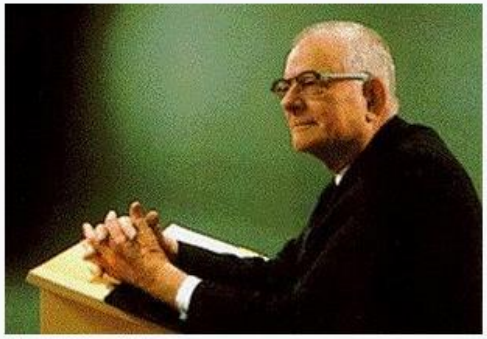
Deming's 14 principles: Essence of TQM

- Many in Japan credit Deming as one of the inspirations for what has become known as the Japanese post-war economic miracle of 1950 to 1960, when Japan rose from the ashes of war on the road to becoming the second-largest economy in the world through processes partially influenced by the ideas Deming taught:
  - Better design of products to improve service
  - Higher level of uniform product quality
  - Improvement of product testing in the workplace and in research centers
  - Greater sales through side [global] markets

W. Edwards Deming



Born	October 14, 1900 Sioux City, Iowa
Died	December 20, 1993 (aged 93) Washington, D.C.
Alma mater	University of Wyoming BS University of Colorado MS Yale University PhD
	Scientific career
Fields	Statistician
Influences	Walter A. Shewhart

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Deming's 14 principles:

1. Create constancy of purpose
2. Adopt philosophy of prevention
3. Cease mass inspection
4. Select a few suppliers based on quality
5. Constantly improve system and workers
6. Institute worker training
7. Instill leadership among supervisors
8. Eliminate fear among employees
9. Eliminate barriers between departments
10. Eliminate slogans
11. Eliminate numerical quotas
12. Enhance worker pride
13. Institute vigorous training and education programs
14. Develop a commitment from top management to implement above 13 points

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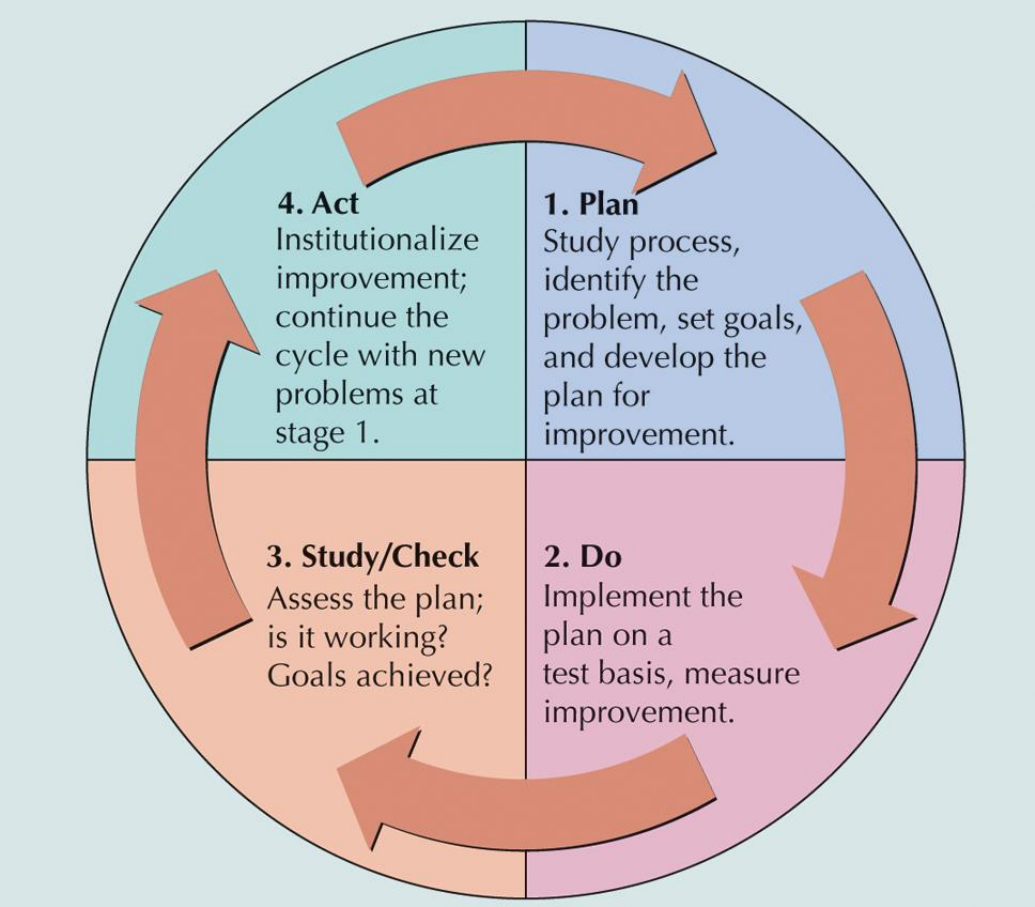
Deming's PDCA Cycle

- Continuous improvement paradigm



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Focus of Quality Management—Customers

- TQM and QMSs
  - serve to achieve customer satisfaction
- Satisfied customers are less likely to switch to a competitor
- It costs 5-6 times more to attract new customers as to keep an existing one
- 94-96% of dissatisfied customers don’t complain
- Small increases in customer retention mean large increases in profits

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Cost of Quality

- Cost of Achieving Good Quality
  - Prevention costs
    - costs incurred during product design
  - Appraisal costs
    - costs of measuring, testing, and analyzing
- Cost of Poor Quality
  - Internal failure costs
    - include scrap, rework, process failure, downtime, and price reductions
  - External failure costs
    - include complaints, returns, warranty claims, liability, and lost sales

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Prevention Costs

- Quality planning costs
  - costs of developing and implementing quality management program
- Product-design costs
  - costs of designing products with quality characteristics
- Process costs
  - costs expended to make sure productive process conforms to quality specifications
- Training costs
  - costs of developing and putting on quality training programs for employees and management
- Information costs
  - costs of acquiring and maintaining data related to quality, and development and analysis of reports on quality performance

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Appraisal Costs

- Inspection and testing
  - costs of testing and inspecting materials, parts, and product at various stages and at end of process
- Test equipment costs
  - costs of maintaining equipment used in testing quality characteristics of products
- Operator costs
  - costs of time spent by operators to gather data for testing product quality, to make equipment adjustments to maintain quality, and to stop work to assess quality

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Internal Failure Costs

- Scrap costs
  - costs of poor-quality products that must be discarded, including labor, material, and indirect costs
- Rework costs
  - costs of fixing defective products to conform to quality specifications
- Process failure costs
  - costs of determining why production process is producing poor-quality products
- Process downtime costs
  - costs of shutting down productive process to fix problem
- Price-downgrading costs
  - costs of discounting poor-quality products—that is, selling products as "seconds"

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External Failure Costs

- Customer complaint costs
  - costs of investigating and satisfactorily responding to a customer complaint resulting from a poor-quality product
- Product return costs
  - costs of handling and replacing poor-quality products returned by customer
- Warranty claims costs
  - costs of complying with product warranties
- Product liability costs
  - litigation costs resulting from product liability and customer injury
- Lost sales costs
  - costs incurred because customers are dissatisfied with poor-quality products and do not make additional purchases

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Quality–Cost Relationship

- Cost of quality
  - difference between price of nonconformance and conformance
  - cost of doing things wrong
    - 20 to 35% of revenues
  - cost of doing things right
    - 3 to 4% of revenues

- Do the costs of appraisal and prevention increase or decrease as one nears zero defects?

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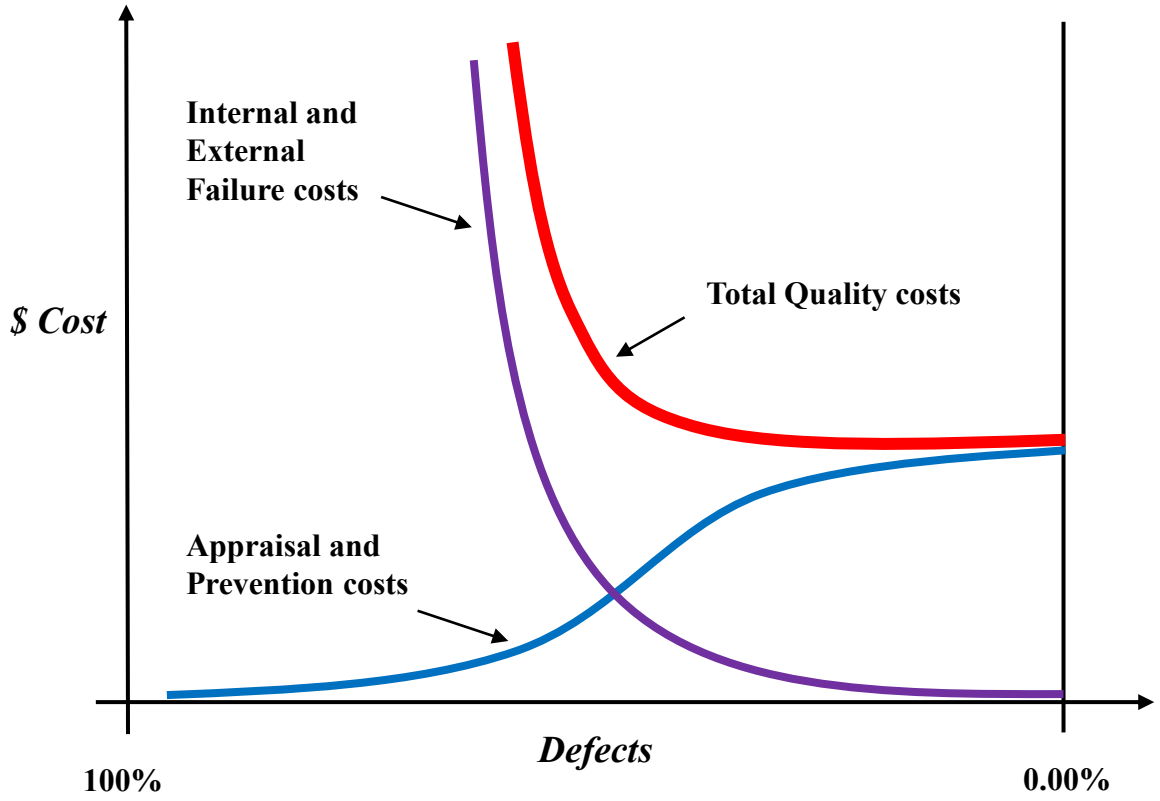
Quality–Cost Relationship



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Measuring and Reporting Quality Costs

- Index numbers
  - ratios that measure quality costs against a base value
  - labor index
    - ratio of quality cost to labor hours
  - cost index
    - ratio of quality cost to manufacturing cost
  - sales index
    - ratio of quality cost to sales
  - production index
    - ratio of quality cost to units of final product

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Cost of Quality

- Example

	Year			
	2010	2011	2012	2013
Quality Costs				
Prevention	27,000	41,500	74,600	112,300
Appraisal	155,000	122,500	113,400	107,000
Internal failure	386,400	469,200	347,800	219,100
External failure	242,000	196,000	103,500	106,000
Total	810,400	829,200	639,300	544,400
Accounting Measures				
Sales	4,360,000	4,450,000	5,050,000	5,190,000
Manufacturing costs	1,760,000	1,810,000	1,880,000	1,890,000

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Cost of Quality

Quality index = total quality costs/base * 100

- Example:
  - 2010 quality cost per SALES (Quality sales index):
    810,400 * 100 / 4,360,000 = 18.58%

Year	Quality Sales Index (%)	Quality Manufacturing Cost Index (%)
2010	18.58	46.04
2011	18.63	45.18
2012	12.66	34.00
2013	10.49	28.80

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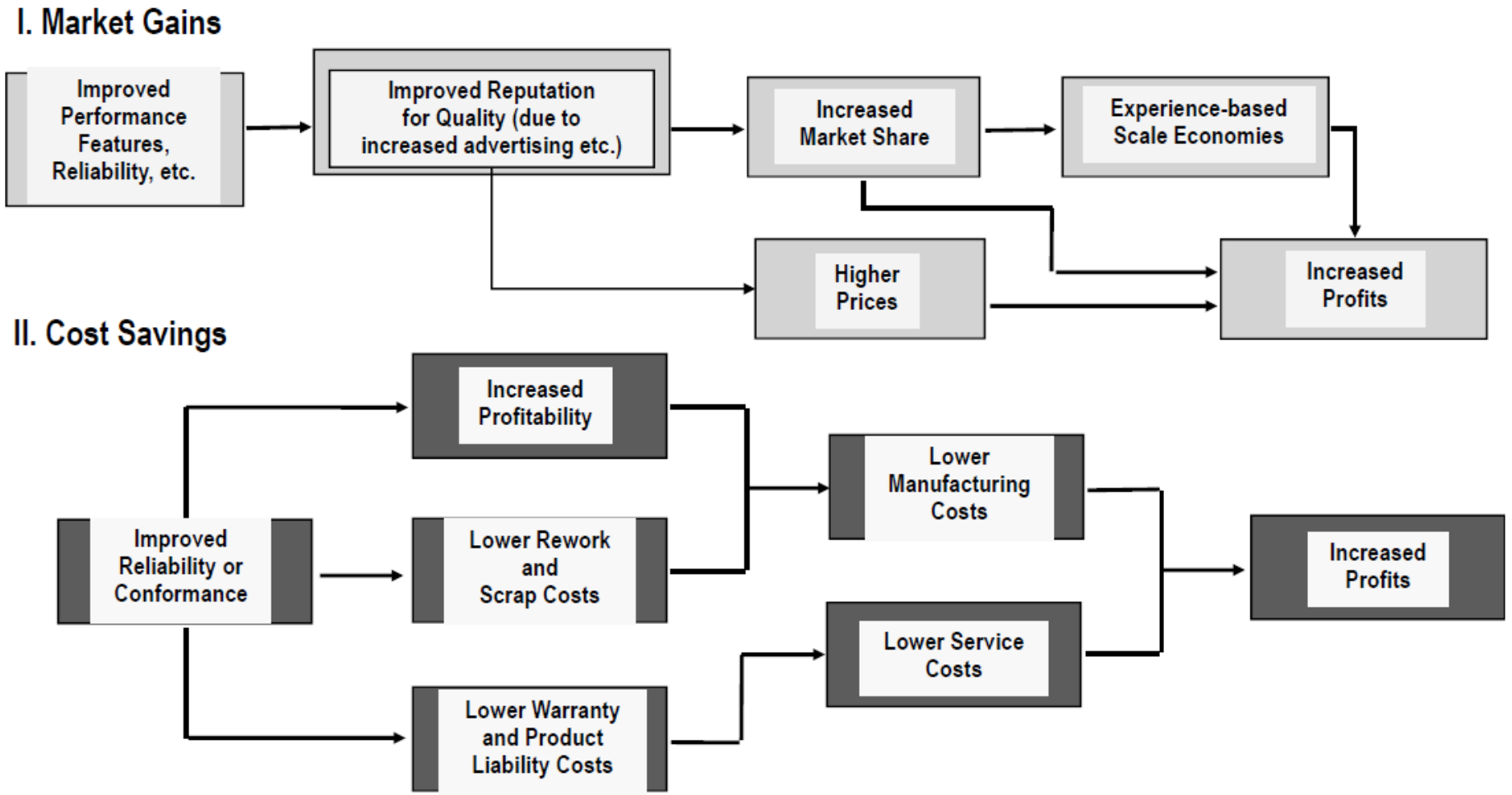
Quality and Profitability



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Quality and Productivity

- Productivity = output / input
- Quality impact on productivity
  - fewer defects increase output, and quality improvement reduces inputs
- Yield
  - a measure of productivity

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Measuring Product Yield and Productivity

Yield=(total input)(% good units) + (total input)(1-%good units)(% reworked)

or

Y=(I)(%G)+(I)(1-%G)(%R)

Where,

I = initial quantity started in production

%G = percentage of good units produced

%R = percentage of defective units that are successfully reworked

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Computing Product Yield

- Example: Motor manufacturer
  - Starts a batch of 100 motors.
  - 80 % are good when produced
  - 50 % of the defective motors can be reworked

$$Y = (I)(\%G) + (I)(1-\%G)(\%R)$$

$$= 100(0.80) + 100(1-0.80)(0.50) = 90 \text{ motors}$$

Increase quality to 90% good

$$Y = 100(0.90) + 100(1-0.90)(.50) = 95 \text{ motors}$$

Computing Product Cost per Unit

$$\text{Product Cost} = \frac{(K_d)(I)+(K_r)(R)}{Y}$$

where:
K_d = direct manufacturing cost per unit
I = input
K_r = rework cost per unit
R = reworked units
Y = yield

Cost per Unit

- Example: Motor manufacturer
  - Direct cost = $30
  - Rework cost = $12
  - 80 % good
  - 50 % can be reworked

$$\frac{(K_d)(I)+(K_r)(R)}{Y} = \frac{\$30*100 + \$12*10}{90 \text{ motors}} = \$34.67/\text{motor}$$

Increase quality to 90% good

$$= \frac{\$30*100 + \$12*5}{95 \text{ motors}} = \$32.21/\text{motor}$$

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Computing Product Yield for Multistage Processes

$$Y = (I)(\%g_1)(\%g_2) \ldots (\%g_n)$$

where:
I = input of items to the production process that will result in finished products
g_i = good-quality, work-in-process products at stage i

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Multistage Yield

- Example: Motor manufacturer

Stage	Good Quality
1	0.93
2	0.95
3	0.97
4	0.92

$Y = (I)(\%g_1)(\%g_2) \ldots (\%g_n)$

= 100 * 0.93 * 0.95 * 0.97 * 0.92 = 78.8 motors

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Initial Batch Size For 100 Motors

$$I = \frac{Y}{(\%g_1)(\%g_2)\ \ldots\ (\%g_n)}$$

$$= \frac{100}{0.93 * 0.95 * 0.97 * 0.92} = 126.88 \rightarrow 127$$

Quality–Productivity Ratio (QPR)

- productivity index that includes productivity and quality costs

$$\text{QPR} = \frac{\text{(good-quality units)}}{\text{(input) (processing cost) + (reworked units) (rework cost)}}(100)$$

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Quality Productivity Ratio

- Example: Motor manufacturer
  - Direct cost = $30
  - Rework cost = $12
  - 80 % good
  - 50 % can be reworked
  - Initial size=100

Base Case

$$QPR = \frac{80 + 10}{100 * \$30 + 10 * \$12}(100) = 2.89$$

Case 1: Increase I to 200

$$QPR = \frac{160 + 20}{200 * \$30 + 20 * \$12}(100) = 2.89 \rightarrow \text{NO CHANGE}$$

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Quality Productivity Ratio

Case 2: Reduce direct cost to $26 and rework cost to $10

$$QPR = \frac{80 + 10}{100 * \$26 + 10 * \$10} (100) = 3.33$$

Case 3: Increase %G to 95%

$$QPR = \frac{95 + 2.5}{100 * \$30 + 2.5 * \$12} (100) = 3.22$$

Case 4: Decrease costs and increase %G

$$QPR = \frac{95 + 2.5}{100 * \$26 + 2.5 * \$10} (100) = 3.71$$

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Why Do Quality Programs Fail?

- Ettlie (1997) cites a paper by Buran (1994) with the following results:
  - Over 50% of surveyed companies report that quality programs have not led to better performance
  - Less than one-third of U.S. Fortune 500 firms believe quality programs significantly impacted competitiveness
  - Over 85% of ISO 9000 registrants think that it will take eight years or more to recover their costs.

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Why Do Quality Programs Fail?

- Some typical reasons for the failures:
- Poor implementation
  - too fast, too many techniques, “program” mentality, as Bartlett (1997) reports that an average company implements a new tool (i.e., program) every 5 moths!
- Lack of commitment from employees
- Not truly listening to customers
- Lack of commitment from senior management
- Poor communications
- Incorrect understanding of and attitude towards quality implementation
  - *"A company that thinks "We've got the answer, all we've got to do is plug this in", is going to do worse than fail - it's going to make everybody cynical" (Henry Mintzberg)*

Week 2 Learning plan

- Today's lecture:
  - What Is Quality and Quality Management?
  - Quality Tools
  - Focus of Quality Management
  - Role of Employees in Quality
  - Quality in Service Companies
  - Cost of Quality
  - Quality, Profitability and Productivity
- This week tutorial:
  - Read the case **"Turnaround at the Preston plant"** available on Canvas.
  - Come with your thoughts about the story and your answers to the questions at the end of the case.
- Group Project sign up