



ICT Tools for CORPORATE GOVERNANCE

Presented by-

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Course Information

- Lecture Notes: Handouts- delivery by Instructor
- <http://thuynгуenthithu.blogspot.com/>
- **Documents Reference:**
- New Corporate Governance- Successful Business Tools – Martill Hill, Springer, 2006.
- Corporate Governance and Risk management- David Crowtheer and Shalar Sefi, Ventus Publishing, 2010.
- Others.

Course Information

- Grading:
 - Attendance: 0,1
 - Midterm Test: 0,3
 - Final Test: 0,6

Course Information

- Requirements
 - Laptop needed
 - Attendants: COMPULSORY, No excuse for absenting (No more than 1/3 lessons)
 - Exercises: work at lecture times. Have Bonus!!!
 - Midterm Test: Announce before a week.
 - Final exam: Successful in conditional requirements.

Course Information

- Outlines
 - Chapter 1: Corporate Governance Concepts
 - Chapter 2: Financial Functions in MS Excel
 - Chapter 3: 7 Basic Quality Control Tools

Chapter one: Corporate Governance Concepts

1.1. what is Corporate Governance

CORPORATE

- ❑ A corporation is an organization created (incorporated) by a group of shareholders who have ownership of the corporation.
- ❑ The elected board of directors appoint and oversee management of the corporation .

GOVERNANCE

- ❑ Oxford English dictionary defines “governance” as the act, manner , fact or function of governing sway control.
- ❑ The word has Latin origins that suggest the notion of “steering”. it deals with the processes and systems by which an organization or society operates.

CORPORATE GOVERNANCE

- ❑ It is a broad concept and has been defined and understood differently by different groups and at different points of time .
- ❑ The Cadbury committee report defines it as “the system by which companies are directed and controlled”.
 - *“Corporate governance deals with the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment”.*
 - **-The Journal of Finance, Shleifer and Vishny [1997].**

SO

- The committee on the financial aspects of corporate governance (the Cadbury Committee), defines **corporate governance as the system by which companies are directed and controlled.**

1.2. DIFFERENCE BETWEEN

CORPORATE GOVERNANCE	CORPORATE MANAGEMENT
External Focus	Internal Focus
Governance assumes an open system	Management assumes a closed system
Strategy-orientated	Task-orientated
Concerned with where the company is going	Concerned with getting the company there

Corporate Governance vs. Management



Source: Robert Tricker, Corporate Governance, 1984

If management is about running the business, corporate governance is about seeing that it is run properly.

All companies need managing and governing.

1.3. FRAMEWORK OF GOVERNANCE

- ☐ Supervisory board/committee/team
- ☐ Audit committee
- ☐ Internal audit
- ☐ Statutory audit (legal)
- ☐ Disclosure of information
- ☐ Risk management framework
- ☐ Internal control framework
- ☐ **CONTROL IMPLEMENTATION**

[Reduce Fraud Risk Example](#) and [checklist Risk](#)

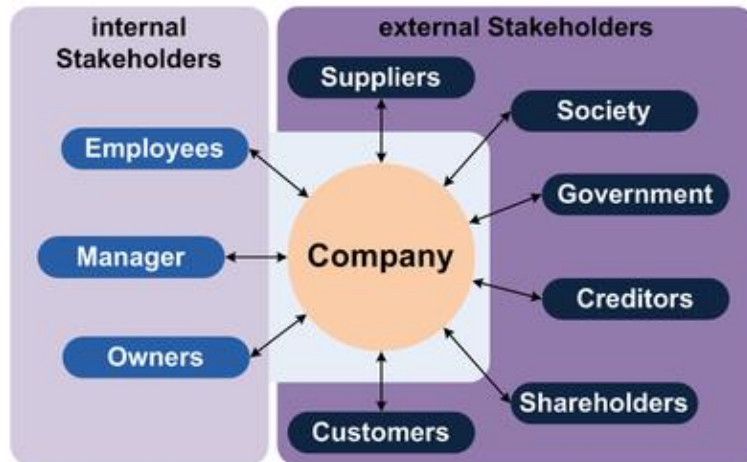
1.4. OBJECTIVES OF GOOD CORPORATE GOVERNANCES

- ☐ Strengthen management oversight functions and accountability.
- ☐ Balance skills, experience and independence on the board appropriate to the nature and extent of company operations.
- ☐ Establish a code to ensure integrity (quality of being honest)
- ☐ Safeguard the integrity of company reporting.
- ☐ Risk management and internal control.
- ☐ Disclosure of all relevant and material matters. (Display clearly)
- ☐ Recognition and preservation of needs of shareholders.

PARTIES TO CORPORATE GOVERNANCE

- ☐ Board of directors
- ☐ Managers
- ☐ Workers
- ☐ Shareholders or owners
- ☐ Regulators
- ☐ Customers
- ☐ Suppliers
- ☐ Community(people affected by the actions of the organization.)

Company's related people



1.5. Effects of Information Technology on Financial Services

- Computers that accept voice inputs and recognize fingerprints may become cost effective for financial service delivery systems.
- Small, inexpensive personal computers in both home and office will make it possible for customers to interact with a multiplicity of financial service offer-ors (such as bankers)

Financial Service Providers

- Banks, savings and loan associations, and credit unions probably will concentrate on transaction processing.
- Emphasis will be placed on computer and telecommunication-based systems for delivering financial services (data processing, securities, brokerage, and insurance).

Users of Financial Services

- individual consumers are likely to use home terminals to interact with financial service delivery systems.
- Consumer financial service packages are likely to be offered in conjunction with other information-based consumer services such as home shopping, investment advisories, computer games, travel reservations, etc.

1.6. Discuss Allocation of Risk

- What are the alternatives for apportioning (divide) risk between financial institutions and their customers and clients?
- Some changes in the delivery of financial services increase the possibility that the privacy of citizens could be eroded or violated. How can we reduce that possibility?

- Are additional actions needed to safeguard the integrity of national payment and transaction systems against risk of disruptions from systems failure, hostile attack, and natural disasters?

- What alternatives are available for controlling the risk of theft from or associated with financial service institutions?

1.7. Other definitions

- The objective of the firm
 - Corporate Finance is about decisions made by corporations. Three distinct characteristics:
- 1. Corporations are legal entities, i.e. legally distinct from its owners and pay their own taxes
- 2. Corporations have limited liability, which means that shareholders can only lose their initial investment in case of bankruptcy.
- 3. Corporations have separated ownership and control as owners are rarely managing the firm
- **The objective of the firm is to maximize shareholder value by increasing the value of the company's stock.**
 - is to maximize the value of the business or firm

The Firm: Structural Set-Up

- **firm** generically to refer to any business,
- large or small, manufacturing or service, private or public.
- The firm's investments are generically termed **assets** (fixed assets, which are long-lived, and current assets, which are short-term).
- The assets that the firm has already invested in are called **assets in place**

The financial balance sheet of a firm

Assets		Liabilities	
Existing Investments Generate cashflows today Includes long lived (fixed) and short-lived (working capital) assets	Assets in Place	Debt	Fixed Claim on cashflows Little or No role in management <i>Fixed Maturity</i> <i>Tax Deductible</i>
Expected Value that will be created by future investments	Growth Assets	Equity	Residual Claim on cashflows Significant Role in management <i>Perpetual Lives</i>

The Investment Principle

- Invest in assets and projects that *yield a return greater than the minimum acceptable **hurdle rate** (rate of return for investing resources in a new investment)*. It should be *higher for riskier projects* and should reflect the *financing mix* used—owners' funds (equity) or borrowed money (debt).
- Returns on projects should be measured based on *cash flows* generated and the *timing* of these cash flows; they should also consider both *positive and negative side effects* of these projects

The Financing Principle

- Choose a *financing mix (debt and equity)* that maximizes the value of the investments made and *match the financing to the nature of the assets* being financed

The Dividend Principle

- If there are not enough investments that earn the hurdle rate, *return the cash* to the owners of the business. In the case of a publicly traded firm, the *form of the return*—dividends or stock buybacks—will depend on what stockholders prefer

Corporate Financial Decisions, Firm Value, and Equity Value

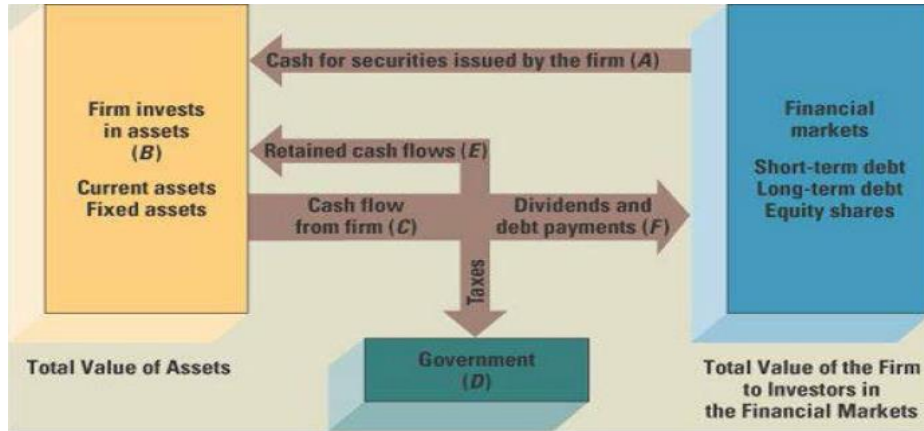
- If the objective function in corporate finance is to maximize firm value. → firm value must be linked to the three corporate finance decisions outlined—investment, financing, and dividend decisions.
- Investment: How to increase the value of firm?
- Financing: How to allocate the financial resources?
- Dividend decision: How to distribute the dividend payments to shareholders, managers

- Firm Value (FV): an economic measure reflecting the market value of a whole business. It is a sum of claims of all claimants: creditors (secured and unsecured) and equityholders .
- **Equity value** is the value of a company available to owners or shareholders. It is the FV plus all cash and cash equivalents, short and long-term investments, and less all short-term debt, long-term debt and minority interests

The Importance of Cash Flows

- How do financial managers create value?

Cash Flows between the Firm and the Financial Markets



Over time, if the cash paid to shareholders and bondholders (F) is greater than the cash raised in the financial markets (A), value will be created.

Accounting Profit versus Cash Flows

- The Midland Company refines and trades gold. At the end of the year, it sold 2,500 ounces of gold for \$1 million. The company had acquired the gold for \$900,000 at the beginning of the year. The company paid cash for the gold when it was purchased.

The Midland Company Accounting View Income Statement Year Ended December 31	
Sales	\$1,000,000
– Costs	– 900,000
Profit	\$ 100,000

Timing of Cash Flows

- The Midland Company is attempting to choose between two proposals for new products. Both proposals will provide additional cash flows over a four-year period and will initially cost \$10,000. The cash flows from the proposals are as follows. **Which one we can choose?**

Year	New Product A	New Product B
1	\$ 0	\$ 4,000
2	0	4,000
3	0	4,000
4	20,000	4,000
Total	\$20,000	\$16,000

Risk of Cash Flows

- The Midland Company is considering expanding operations overseas. It is evaluating Europe and Japan as possible sites. Europe is considered to be relatively safe, whereas operating in Japan is seen as very risky. In both cases the company would close down operations after one year.
- After doing a complete financial analysis, Midland has come up with the following cash flows of the alternative plans for expansion under three scenarios—pessimistic, most likely, and optimistic. **Which one is better choice?**

	Pessimistic	Most Likely	Optimistic
Europe	\$75,000	\$100,000	\$125,000
Japan	0	150,000	200,000

The Balance Sheet

- The **balance sheet** is an accountant's snapshot of a firm's accounting value on a particular date, as though the firm stood momentarily still. The balance sheet has two sides: On the left are the assets and on the right are the liabilities and stockholders' equity. The balance sheet states what the firm owns and how it is financed.
- $\text{Assets} \equiv \text{Liabilities} + \text{Stockholders' equity}$

The Balance Sheet of the U.S. Composite Corporation

U.S. COMPOSITE CORPORATION					
Balance Sheet					
2010 and 2009					
(\$ in millions)					
Assets	2010	2009	Liabilities (Debt) and Stockholders' Equity	2010	2009
Current assets:			Current liabilities:		
Cash and equivalents	\$ 140	\$ 107	Accounts payable	\$ 213	\$ 197
Accounts receivable	294	270	Notes payable	50	53
Inventories	269	280	Accrued expenses	223	205
Other	58	50	Total current liabilities	\$ 486	\$ 455
Total current assets	\$ 761	\$ 707	Long-term liabilities:		
Fixed assets:			Deferred taxes	\$ 117	\$ 104
Property, plant, and equipment	\$1,423	\$1,274	Long-term debt ¹	471	458
Less accumulated depreciation	550	460	Total long-term liabilities	\$ 588	\$ 562
Net property, plant, and equipment	873	814	Stockholders' equity:		
Intangible assets and others	245	221	Preferred stock	\$ 39	\$ 39
Total fixed assets	\$1,118	\$1,035	Common stock (\$1 par value)	55	32
			Capital surplus	347	327
			Accumulated retained earnings	390	347
			Less treasury stock ²	26	20
			Total equity	\$ 805	\$ 725
Total assets	\$1,879	\$1,742	Total liabilities and stockholders' equity ³	\$1,879	\$1,742

¹Long-term debt rose by \$471 million - \$458 million = \$13 million. This is the difference between \$86 million new debt and \$73 million in retirement of old debt.

²Treasury stock rose by \$6 million. This reflects the repurchase of \$6 million of U.S. Composite's company stock.

³U.S. Composite reports \$43 million in new equity. The company issued 23 million shares at a price of \$1.87. The par value of common stock increased by \$23 million and capital surplus increased by \$20 million.

Market Value versus Book Value

- The Cooney Corporation has fixed assets with a book value of \$700 and an appraised market value of about \$1,000. Net working capital is \$400 on the books, but approximately \$600 would be realized if all the current accounts were liquidated. Cooney has \$500 in long-term debt, both book value and market value. What is the book value of the equity? What is the market value?

Answer

- We can construct two simplified balance sheets, one in accounting (book value) terms and one in economic (market value) terms:

COONEY CORPORATION Balance Sheets Market Value versus Book Value					
Assets			Liabilities and Shareholders' Equity		
	Book	Market		Book	Market
Net working capital	\$ 400	\$ 600	Long-term debt	\$ 500	\$ 500
Net fixed assets	700	1,000	Shareholders' equity	600	1,100
	<u>\$1,100</u>	<u>\$1,600</u>		<u>\$1,100</u>	<u>\$1,600</u>

The Income Statement

- The **income statement** measures performance over a specific period—say a year. The accounting definition of income is:
- Revenue – Expenses \equiv Income

The Income Statement of the U.S. Composite Corporation

U.S. COMPOSITE CORPORATION Income Statement 2010 (\$ in millions)	
Total operating revenues	\$2,262
Cost of goods sold	1,655
Selling, general, and administrative expenses	327
Depreciation	90
Operating income	\$ 190
Other income	29
Earnings before interest and taxes (EBIT)	\$ 219
Interest expense	49
Pretax income	\$ 170
Taxes	84
Current: \$71	
Deferred: 13	
Net income	\$ 86
Addition to retained earnings:	\$ 43
Dividends:	43

NOTE: There are 29 million shares outstanding. Earnings per share and dividends per share can be calculated as follows:

$$\begin{aligned}
 \text{Earnings per share} &= \frac{\text{Net income}}{\text{Total shares outstanding}} \\
 &= \frac{\$86}{29} \\
 &= \$2.97 \text{ per share}
 \end{aligned}$$

$$\begin{aligned}
 \text{Dividends per share} &= \frac{\text{Dividends}}{\text{Total shares outstanding}} \\
 &= \frac{\$43}{29} \\
 &= \$1.48 \text{ per share}
 \end{aligned}$$

Financial Cash Flow

- The value of a firm's assets is always equal to the combined value of the liabilities and the value of the equity, the cash flows received from the firm's assets (that is, its operating activities), $CF(A)$, must equal the cash flows to the firm's creditors, $CF(B)$, and equity investors, $CF(S)$:
- **$CF(A) \equiv CF(B) + CF(S)$**

- The first step in determining cash flows of the firm is to figure out the cash flow from operations.
- The operating cash flow is the cash flow generated by business activities, including sales of goods and services. Operating cash flow reflects tax payments, but not financing, capital spending, or changes in net working capital:

	\$ in millions
Earnings before interest and taxes	\$219
Depreciation	90
Current taxes	-71
Operating cash flow	<u>\$238</u>

U.S. COMPOSITE CORPORATION Financial Cash Flow 2010 (\$ in millions)	
Cash flow of the firm	
Operating cash flow	\$238
(Earnings before interest and taxes plus depreciation minus taxes)	
Capital spending	– 173
(Acquisitions of fixed assets minus sales of fixed assets)	
Additions to net working capital	– 23
Total	<u>\$ 42</u>
Cash flow to investors in the firm	
Debt	\$ 36
(Interest plus retirement of debt minus long-term debt financing)	
Equity	6
(Dividends plus repurchase of equity minus new equity financing)	
Total	<u>\$ 42</u>

- Another important component of cash flow involves changes in fixed assets. For example, when U.S. Composite sold its power systems subsidiary in 2010, it generated \$25 million in cash flow. The net change in fixed assets equals the acquisition of fixed assets minus the sales of fixed assets. The result is the cash flow used for capital spending:

Acquisition of fixed assets	\$198	
Sales of fixed assets	– 25	
Capital spending	<u>\$173</u>	(\$149 + 24 = Increase in property, plant, and equipment + Increase in intangible assets)

- Total cash flows generated by the firm's assets are then equal to:

Operating cash flow	\$238
Capital spending	– 173
Additions to net working capital	– 23
Total cash flow of the firm	<u>\$ 42</u>

- Greene Co. shows the following information on its 2008 income statement:
 - Sales = \$138,000
 - Costs = \$71,500
 - Other expenses = \$4,100
 - Depreciation expense = \$10,100
 - Interest expense = \$7,900
 - Taxes = \$17,760
 - Dividends = \$5,400.
- In addition, you're told that the firm issued \$2,500 in new equity during 2008, and redeemed \$3,800 in outstanding long-term debt.
- What is the 2008 operating cash flow?

- **To calculate the OCF, we first need to construct an income statement. The income statement starts with revenues and subtracts costs to arrive at EBIT. We then subtract out interest to get taxable income, and then subtract taxes to arrive at net income**
- **$OCF = EBIT + Depreciation - Taxes$**

- Titan Football Manufacturing had the following operating results for 2008:
 - Sales = \$18,450
 - Costs = \$13,610
 - Depreciation expense = \$2,420
 - Interest expense = \$260
 - Dividends = \$450.
 - At the beginning of the year:
 - Net fixed assets: \$12,100
 - Current Assets: \$3,020
 - Current Liabilities: \$2,260
 - At the end of the year:
 - Net fixed assets: \$12,700
 - Current Assets: \$4,690
 - Current Liabilities: \$2,720
 - The tax rate for 2008 was 35 percent
- What is the net income for 2008?
- What is the operating cash flow for 2008?

Guide

- To calculate the OCF, we first need to construct an income statement. The income statement starts with revenues and subtracts costs to arrive at EBIT.
- We then subtract out interest to get taxable income, and then subtract taxes to arrive at net income
- $OCF = EBIT + Depreciation - Taxes$

Corporate Tax Rates

- Corporate tax rates in effect for 2008 are shown in Table belows. As shown, corporate tax rates rise from 15 percent to 39 percent, but they drop back to 34 percent on income over \$335,000. They then rise to 38 percent and subsequently fall to 35 percent.

Taxable Income	Tax Rate
\$ 0– 50,000	15%
50,001– 75,000	25
75,001– 100,000	34
100,001– 335,000	39
335,001–10,000,000	34
10,000,001–15,000,000	35
15,000,001–18,333,333	38
18,333,334+	35

Average versus Marginal Tax Rates

- Your **average tax rate** is your tax bill divided by your taxable income—in other words, the percentage of your income that goes to pay taxes.
- Your **marginal tax rate** is the tax you would pay (in percent) if you earned one more dollar

The difference between average and marginal tax rates

- Suppose our corporation has a taxable income of \$200,000. What is the tax bill? Using above Table (Corporate tax rates), we can figure our tax bill like this:

(1) Taxable Income	(2) Marginal Tax Rate	(3) Total Tax	(3)/(1) Average Tax Rate
\$ 45,000	15%	\$ 6,750	15.00%
70,000	25	12,500	17.86
95,000	34	20,550	21.63
250,000	39	80,750	32.30
1,000,000	34	340,000	34.00
17,500,000	38	6,100,000	34.86
50,000,000	35	17,500,000	35.00
100,000,000	35	35,000,000	35.00

- So income of 200000 will be:

$$\begin{array}{rcl}
 .15(\$ 50,000) & = & \$ 7,500 \\
 .25(\$ 75,000 - 50,000) & = & 6,250 \\
 .34(\$100,000 - 75,000) & = & 8,500 \\
 .39(\$200,000 - 100,000) & = & \underline{39,000} \\
 & & \underline{\underline{\$61,250}}
 \end{array}$$

- Our total tax is thus \$61,250.

- what is the average tax rate? We had a taxable income of \$200,000 and a tax bill of \$61,250, so the average tax rate is $\$61,250/200,000 = 30.625\%$.
- What is the marginal tax rate? If we made one more dollar, the tax on that dollar would be 39 cents, so our marginal rate is 39 percent.

Questions

- **1. Building a Balance Sheet** Culligan, Inc., has current assets of \$5,300, net fixed assets of \$26,000, current liabilities of \$3,900, and long-term debt of \$14,200. What is the value of the shareholders' equity account for this firm? How much is net working capital?

- **2. Building an Income Statement** Ragsdale, Inc., has sales of \$493,000, costs of \$210,000, depreciation expense of \$35,000, interest expense of \$19,000, and a tax rate of 35 percent. What is the net income for the firm? Suppose the company paid out \$50,000 in cash dividends. What is the addition to retained earnings?

- **3. Market Values and Book Values** Klingon Cruisers, Inc., purchased new cloaking machinery three years ago for \$9.5 million. The machinery can be sold to the Romulans today for \$6.3 million. Klingon's current balance sheet shows net fixed assets of \$5 million, current liabilities of \$2.1 million, and net working capital of \$800,000. If all the current assets were liquidated today, the company would receive \$2.8 million cash.
- What is the book value of Klingon's assets today? What is the market value?

- 4a. Algernon, Inc., has a taxable income of \$85,000. What is its tax bill? What is its average tax rate? Its marginal tax rate?
- **4b, Calculating Taxes** The Herrera Co. had \$246,000 in taxable income. Using the rates from Table above, calculate the company's income taxes. What is the average tax rate? What is the marginal tax rate?

- **5. Calculating Cash Flows** Given the information for Anna's Tennis Shop, Inc., in the previous two problems, suppose you also know that the firm's net capital spending for 2010 was \$875,000 and that the firm reduced its net working capital investment by \$69,000. What was the firm's 2010 operating cash flow?

PRICIPLES OF CORPORATE GOVERNANCE

Directors

- ☐ Every listed company should be headed by an effective board which should lead and control the company.
- ☐ There should be board balance of executive & non executive directors such that no individual can dominate the board decision making.
- ☐ The board should be supplied with timely information to enable it to discharge its duties.
- ☐ There should be formal and transparent procedure for the appointment of new directors to the board.
- ☐ All directors should be required to submit themselves for re-election at regular intervals and at least every three years.
- ☐ Others:

FACTORS INFLUENCING QUALITY OF GOVERNANCE

- ☐ Integrity of the management
- ☐ Ability of the board
- ☐ Adequacy of the process
- ☐ Commitment level of individual board members
- ☐ Quality of corporate reporting
- ☐ Participation of stakeholders in the management

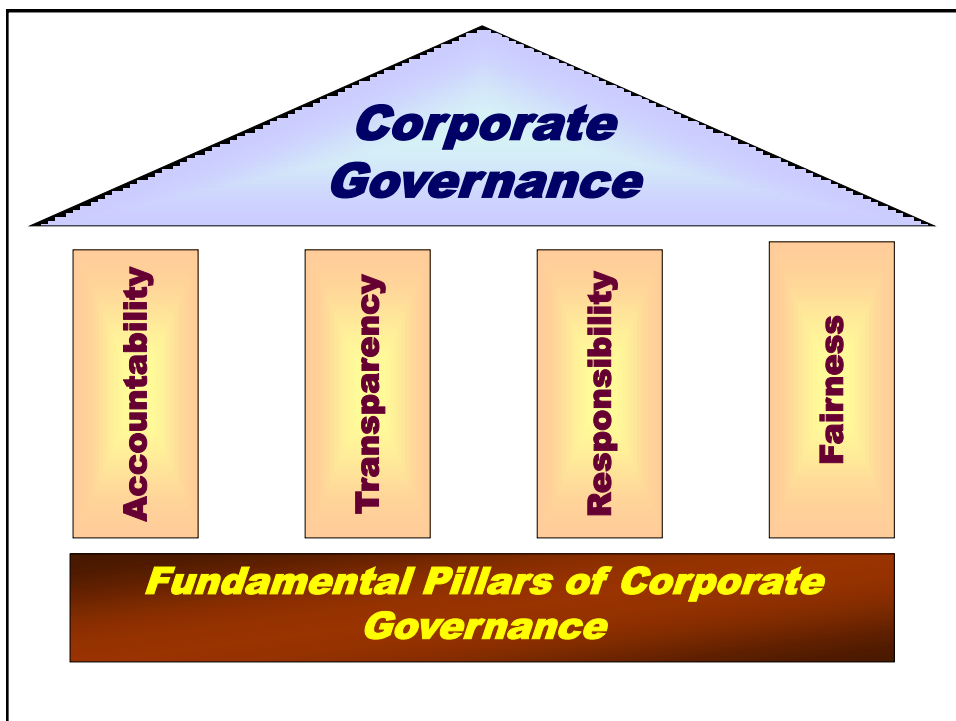
TRENDS IN CORPORATE GOVERNANCE

- ☐ Demand for greater transparency and accountability
- ☐ Written job descriptions detailing roles and responsibilities of chairman and board members.
- ☐ Core competencies for board members are defined and those without skills or expertise not invited.
- ☐ Development of performance criteria and annual evaluations of the board.
- ☐ Orientation for new members.
- ☐ Ongoing training
- ☐ Succession planning

THE BOARD RESPONSIBILITIES

- ☐ Overseeing strategic development & planning
- ☐ Management selection, supervision and upgrading.
- ☐ Maintenance of good member relations.
- ☐ Protecting and optimizing the organization's assets.
- ☐ Fulfilling legal requirements.

Example



Accountability

Clarifying governance roles & responsibilities, and supporting voluntary efforts to ensure the alignment of managerial and shareholder interests and monitoring by the board of directors capable of objectivity and sound judgment.

Transparency

Requiring timely disclosure of adequate information concerning corporate financial performance

Responsibility

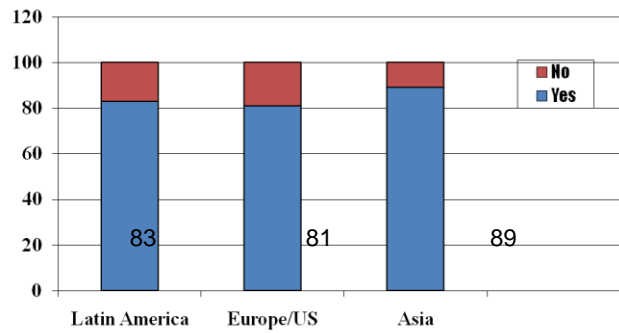
Ensuring that corporations comply with relevant laws and regulations that reflect the society's values

Fairness

Ensuring the protection of shareholders' rights and the enforceability of contracts with service/resource providers

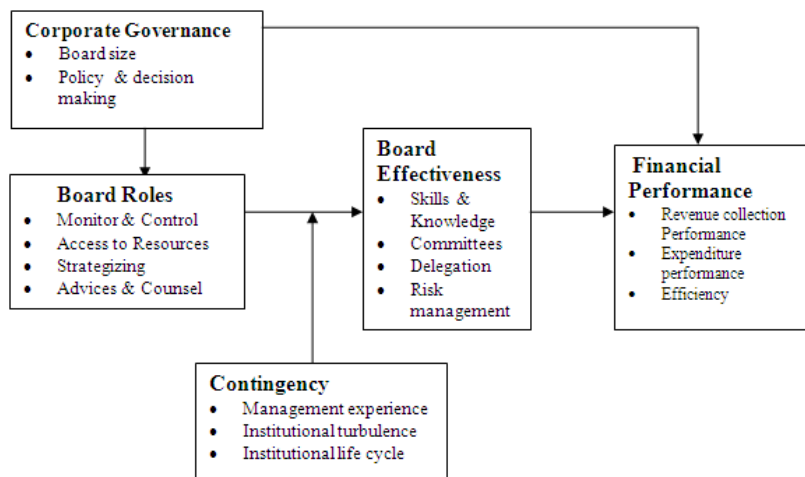
CORPORATE GOVERNANCE

Investors are Willing to Pay More For a Company With Good Board Governance Practices



Companies are willing to pay 18 % to 28% more for better governance.

Conceptual Framework For CG



Source: A modification of the model by Gavin & Geoffrey (2004).]

Corporate governance

- **Board size** : too small or too large ?
- Depending on the circumstances, the board may benefit from having a member with industry experience, legal expertise or perhaps a director representative of stakeholder. Gavin and Geoffrey, (2004).
- Optimal board size: Epstein et al., (2004), a board of 9-13 members - for most companies(not too small or large); an average of 16 directors (3 within and 13 outside directors) to be appropriate for larger companies; insurance firms in Thailand was 10

- **Policy and decision making:** It is its duty with respect to delegating authority
- Given the complexity of the business environment, it is impossible for the board to be the sole decision making body in the company. Instead, each board needs to work on developing an appropriate method and level of delegation of authority

Board roles

- **Monitoring and control**
- **Strategizing:** is to ensure that the strategy of the company will lead to the long-term creation of shareholder wealth or other stated major goals of the organization.
- **Accessing resources:** By acting in an open, professional and ethical manner in their dealings with people outside the organization, board members also raise the profile of the firm and enhance its reputation

- **Advice and counsel:** it is important for the board to share its experience with management, particularly the CEO, to serve the interests of the company.
- **Contingency , board roles and board effectiveness:** management experience; lifecycle; turbulence may influence to board roles and corporate performance

Board effectiveness

- **Skills and knowledge:** Board members must have the right mix of skills and knowledge. For instance, they should possess both functional knowledge in traditional areas of business such as accounting, finance, legal or marketing as well as industry specific knowledge that will enable members to truly understand specific company issues and challenges

- **Committees :** committee is a group of members to whom some specific role has been delegated by a full board. Committees can be used to gather, review and summarize information and report back to the full board for decision or can be delegated specific decision making powers

- **Delegation:** Given the complexity of the business environment, it is impossible for the board to be the sole decision-making body in the company. Instead, each board needs to work on developing an appropriate method and level of delegation of authority.
- The board needs to clearly articulate and document the delegations it makes

- **Risk management:** Risk management includes the identification of all significant risks faced by the company and ensuring that appropriate policies are in place to moderate the impact of these risks

Financial performance

- Measure by accounting ratios: return on capital employed, return on assets, and return on equity
- CAMEL Model : Capital adequacy, Asset quality, Management, Earnings and Liquidity (- Enable to pay on cash)

CASE STUDY - DISCUSSIONS

- **Governance on sale:**
 - How to Delivery on time (schedule)
 - Risk: Sale staffs may do a plan in which a supplier can not afford enough production goods
 - Solution???

- **Apply the policy for credit sale and check the credit quality**
- **Risk:** Sale staffs may provide over limitation on credit sale to increase sale turnover so that a company may take a risk of credit sale
- **Solution???**

- **Delivery the right quantity and quality products for the right customers.**
- **Risk:** A company may delivery a wrong product or mistake product (or not enough quantity) → customer complain → Redelivery→ cost more money.
- **Solutions????**

- **Make right invoice**
- **Risk:** Staffs may do the invoices without delivery or incorrect invoice (quantity, quality, wrong product, etc.) or duplicate invoice for one product
- **Solutions???**

- **Fully enter into account correctly when paying on cash**
- **Risk: Cashier** may steal the customers paying cash before record it as sale turnover
- **Solutions???**

Buying from suppliers

- **Prevent fraud (cheating) on making orders to the suppliers**
- **Risk:** Staffs may cheating on orders to suppliers such as unreal orders to request a paying for these orders (secure illegal money from company)
- **Solution???**

- **Control the commissions (not allow) from suppliers**
- **Risk: Staffs** may choose un-suitable suppliers (not good for product quality; high price; etc.) as they can receive high commissions from these suppliers.
- **Solution???**

Control cash and bank account

- **Control on cash**
- **Risk:** Cash may be used in wrong purpose or be stolen.
- **Solutions???**

- **Control staffs transfer money (withdraw) illegally.**
- **Risk:** Authorized staff , who can sign for bank account paying, may do illegal transfer or withdraw money (for private purpose). Or Staffs may have a signature from Boss (the signed person ignore the receipt) .
- **Solutions???**

Chapter 3: 7 Basic Quality Control Tools – 7 QC Tools

- Check Sheet
- Ishikawa Diagram
- Pareto Chart
- Control Chart
- Histogram
- Scattergram
- Stratification

3.1 Check Sheet

- Definition: Is a form (document) used to collect data in real time at the location where the data is generated. The data it captures can be quantitative or qualitative. When the information is quantitative, the check sheet is sometimes called a **tally sheet**.
- Use for collecting data
- Input for other analysis tools
- For example:

Motor Assembly Check Sheet								
Name of Data Recorder: <u>Lester B. Rapp</u>								
Location: <u>Rochester, New York</u>								
Data Collection Dates: <u>1/17 - 1/23</u>								
Defect Types/ Event Occurrence	Dates							TOTAL
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Supplied parts rusted								20
Misaligned weld								5
Improper test procedure								0
Wrong part issued								3
Film on parts								0
Voids in casting								6
Incorrect dimensions								2
Adhesive failure								0
Masking insufficient								1
Spray failure								5
TOTAL		10	13	10	5	4		

Format

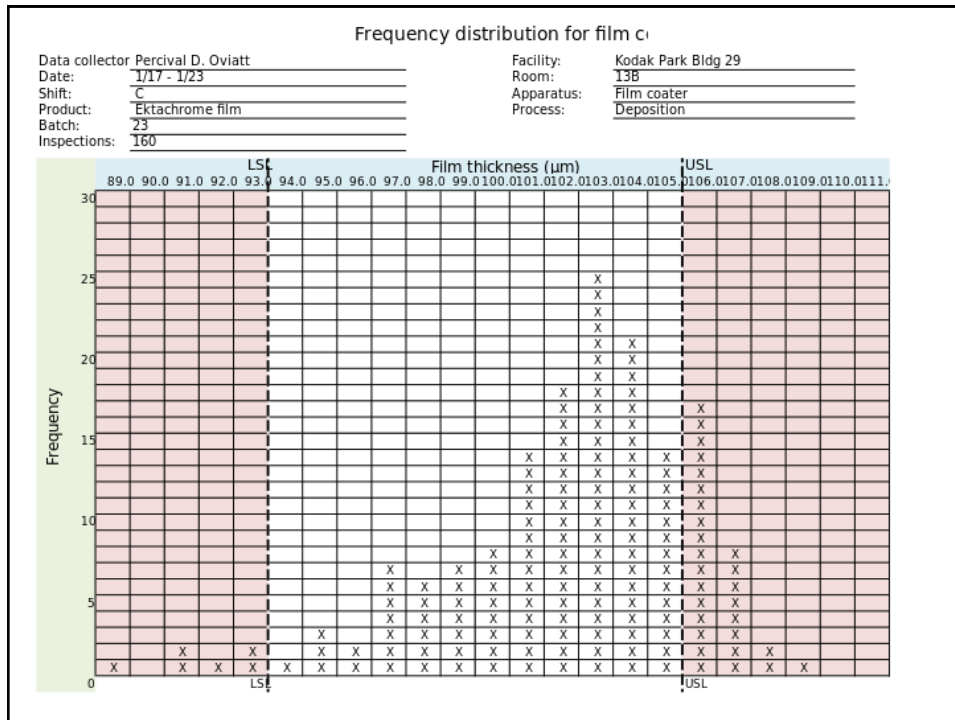
- A typical check sheet is divided into regions, and marks made in different regions have different significance. Data are read by observing the location and number of marks on the sheet.
- Check sheets typically employ a heading that answers the Five Ws:
 - Who filled out the check sheet
 - What was collected (what each check represents, an identifying batch or lot number)
 - Where the collection took place (facility, room, apparatus)
 - When the collection took place (hour, shift, day of the week)
 - Why the data were collected

Function

- To check the shape of the probability distribution of a process
- To quantify defects by type
- To quantify defects by location
- To quantify defects by cause (machine, worker)
- To keep track of the completion of steps in a multistep procedure (in other words, as a [checklist](#))

Check sheet to assess the shape of a process's probability distribution

- This type of check sheet consists of the following:
- A grid that captures
- The [histogram](#) bins in one dimension
- The count or frequency of process observations in the corresponding bin in the other dimension
- Lines that delineate the upper and lower [specification limits](#)



Check sheet for defect type

- This type of check sheet consists of the following:
- A single column listing each defect category
- One or more columns in which the observations for different machines, materials, methods, operators are to be recorded

Paint Job Quality Control Checklist

Job: 629555

Inspector: Al Kyder

Problem	Frequency
Chip	
Bubble	
Run	
Scrape or scratch	
Inadequate coverage	
Other	

Check sheet for defect location

- This type of check sheet consists of the following: A to-scale diagram of the object from each of its sides, optionally partitioned into equally-sized sections

Check sheet for defect cause

- This type of check sheet consists of the following:
- One or more columns listing each suspected cause (for example machine, material, method, environment, operator)
- One or more columns listing the period during which process outputs are to be observed (for example hour, shift, day)
- One or more symbols to represent the different types of defects to be recorded—these symbols take the place of the check marks of the other types of charts.

Checklist

- This type of check sheet consists of the following:
- An (optionally numbered) outline of the subtasks to be performed
- Boxes or spaces in which check marks may be entered to indicate when the subtask has been completed

Closing a Business Checklist

There are typical actions that are taken when closing a business. You must file an annual return for the year you go out of business. If you have employees, you must file the final employment tax returns, in addition to making final federal tax deposits of these taxes. Also attach a statement to your return showing the name of the person keeping the payroll records, and the address where those records will be kept.

The annual tax return for a partnership, corporation, S corporation, limited liability company or trust includes check boxes near the top front page just below the entity information. For the tax year in which your business ceases to exist, check the box that indicates this tax return is a final return. If there are Schedule K-1s, repeat the same procedure on the Schedule K-1.

You will also need to file returns to report disposing of business property, reporting the exchange of like-kind property, and/or changing the form of your business. If you do not have a pre-printed envelope in which to send your taxes, refer to the Where To File page for a list of addresses. Below is a list of typical actions to take when closing a business, depending on your type of business structure.

- ☐ Make final federal tax deposits
 - ☐ Electronic Federal Tax Paying System (EFTPS)
- ☐ File final quarterly or annual employment tax form.
 - ☐ Form 940, Employer's Annual Federal Unemployment (FUTA) Tax Return (PDF)
 - ☐ Form 941, Employer's Quarterly Federal Tax Return (PDF)
 - ☐ Form 943, Employer's Annual Tax Return for Agricultural Employees (PDF)
 - ☐ Form 943-A, Agricultural Employer's Record of Federal Tax Liability (PDF)
- ☐ Issue final wage and withholding information to employees
 - ☐ Form W-2, Wage and Tax Statement (PDF)
- ☐ Report information from W-2s issued.
 - ☐ Form W-3, Transmittal of Income and Tax Statements (PDF)
- ☐ File final tip income and allocated tips information return.
 - ☐ Form 8027, Employer's Annual Information Return of Tip Income and Allocated Tips (PDF)
- ☐ Report capital gains or losses.
 - ☐ Form 1040, U.S. Individual Income Tax Return (PDF)
 - ☐ Form 1065, U.S. Partnership Return of Income (PDF)
 - ☐ Form 1120 (Schedule D), Capital Gains and Losses (PDF)
- ☐ Report partner's/shareholder's shares.
 - ☐ Form 1065 (Schedule K-1), Partner's Share of Income, Credits, Deductions, etc. (PDF)
 - ☐ Form 1120S (Schedule K-1), Shareholder's Share of Income, Credits, Deductions, etc. (PDF)
- ☐ File final employee pension/benefit plan.
 - ☐ Form 5500, Annual Return/Report of Employee Benefit Plan
- ☐ Issue payment information to sub-contractors.
 - ☐ Form 1099-MISC, Miscellaneous Income (PDF)
- ☐ Report information from 1099s issued.
 - ☐ Form 1096, Annual Summary and Transmittal of U.S. Information Returns (PDF)
- ☐ Report corporate dissolution or liquidation.
 - ☐ Form 966, Corporate Dissolution or Liquidation (PDF)
- ☐ Consider allowing S corporation election to terminate.
 - ☐ Form 1120S, Instructions (PDF)
- ☐ Report business asset sales.
 - ☐ Form 8594, Asset Acquisition Statement (PDF)
- ☐ Report the sale or exchange of property used in your trade or business.
 - ☐ Form 4797, Sales of Business Property (PDF)

Exercise

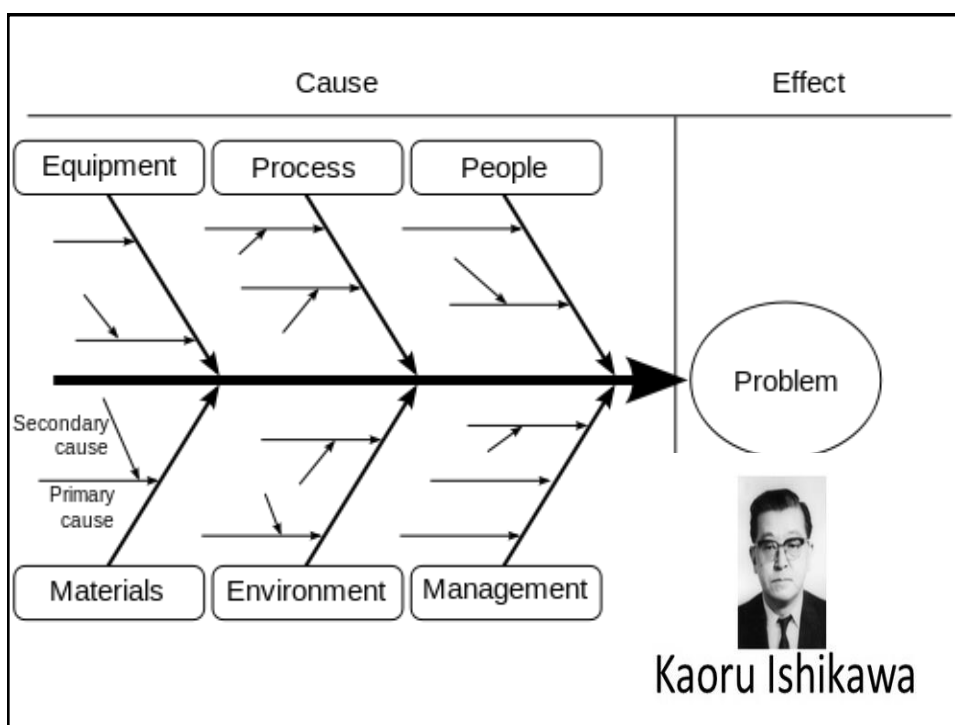
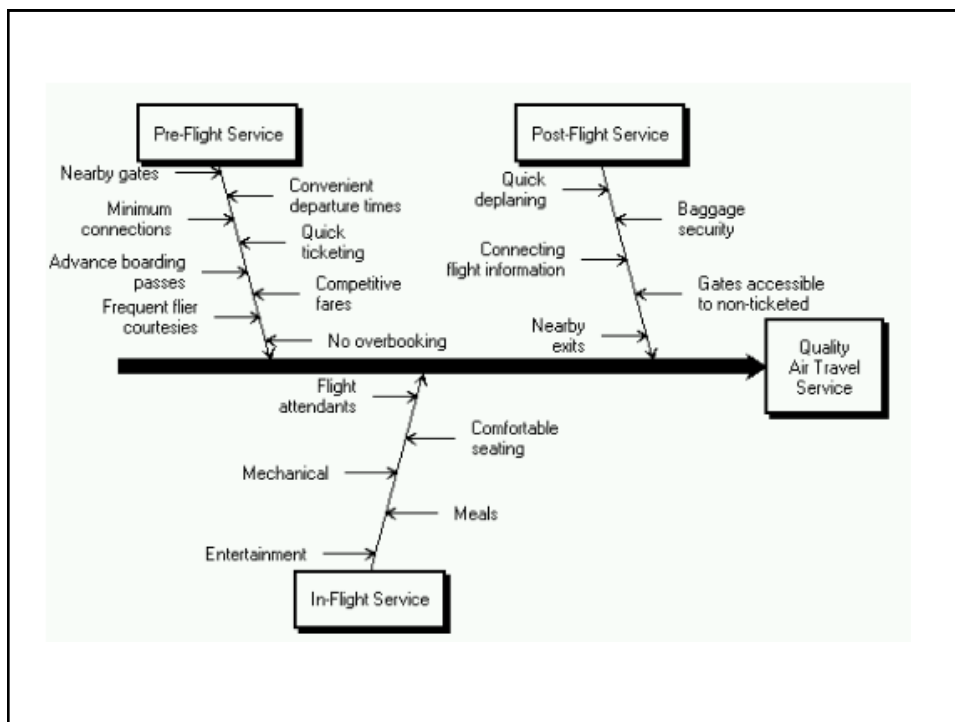
- Use Excel to create a check sheet
- See [Materials\bldefck.xls](#); [Materials\data-analysis.xls](#)

3.2 Ishikawa diagram

- Also called **fishbone diagrams, herringbone diagrams, cause-and-effect diagrams, or Fishikawa. (1968)**
- Show the [causes](#) of a specific [event](#).
- Use: [product design](#) and quality defect prevention to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation.

Categories

- People: Anyone involved with the process
- Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations and laws
- Machines: Any equipment, computers, tools, etc. required to accomplish the job
- Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
- Measurements: Data generated from the process that are used to evaluate its quality
- Environment: The conditions, such as location, time, temperature, and culture in which the process operates



Causes

- Causes in the diagram are often categorized, such as to the 6 M's, described below. Cause-and-effect diagrams can reveal key relationships among various variables, and the possible causes provide additional insight into process behavior.
- Causes can be derived from brainstorming sessions. These groups can then be labeled as categories of the fishbone. They will typically be one of the traditional categories mentioned above but may be something unique to the application in a specific case. Causes can be traced back to root causes with the [5 Whys](#) technique.

Example

- The following example demonstrates the basic process: The vehicle will not start. (the problem).
- *Why?* - The battery is dead. (first why)
- *Why?* - The alternator is not functioning. (second why)
- *Why?* - The alternator belt has broken. (third why)
- *Why?* - The alternator belt was well beyond its useful service life and not replaced. (fourth why)
- *Why?* - The vehicle was not maintained according to the recommended service schedule. (fifth why, a root cause)
- *Why?* - Replacement parts are not available because of the extreme age of the vehicle. (sixth why, optional footnote)
- Start maintaining the vehicle according to the recommended service schedule. (possible 5th Why solution)
- Purchase a different vehicle that is maintainable. (possible 6th Why solution)

The 6 Ms (used in manufacturing industry)

- Machine (technology)
- Method (process)
- Material (Includes Raw Material, Consumables and Information.)
- Man Power (physical work)/Mind Power (brain work): [Kaizens](#), Suggestions
- Measurement (Inspection)
- Milieu/Mother Nature (Environment)
- The original 6Ms used by the Toyota Production System have been expanded by some to include the following and are referred to as the 8Ms. However, this is not globally recognized. It has been suggested to return to the roots of the tools and to keep the teaching simple while recognizing the original intent; most programs do not address the 8Ms.
- Management/Money Power
- Maintenance

The 7 Ps (used in marketing industry)

- Product=Service
- Price
- Place
- Promotion
- People/personnel
- Process
- Physical Evidence

The 5 Ss (used in service industry)

- Surroundings
- Suppliers
- Systems
- Skills
- Safety

5 Ws

- Where
- What
- When
- Who
- Why

Creating the Diagram

- Step 1: Create a horizontal line in the center of your page or whiteboard with a circle at one end. The Ishikawa diagram is called the fishbone diagram because of this shape: The line is the fish's spine, and the circle is its head. Write down the problem, the known effect, at the head

- Step 2: Consider how many categories of causes add to that effect. This is where you may use the four Ps, six Ms or another set of categories. Create as many ribs as you have categories, drawing them at 60-degree angles to the spine. Write the category at the end of the rib.

- Step 3: List all the aspects under the categories. For example, if you used the four Ps, each P should have its aspects written down the rib. The “People” category might list all the employees in the organization.

- Step 4: Expand any aspects that can be discussed further. On the People rib, examine the employees that have some influence on the effect you are discussing.

Analyzing the Diagram

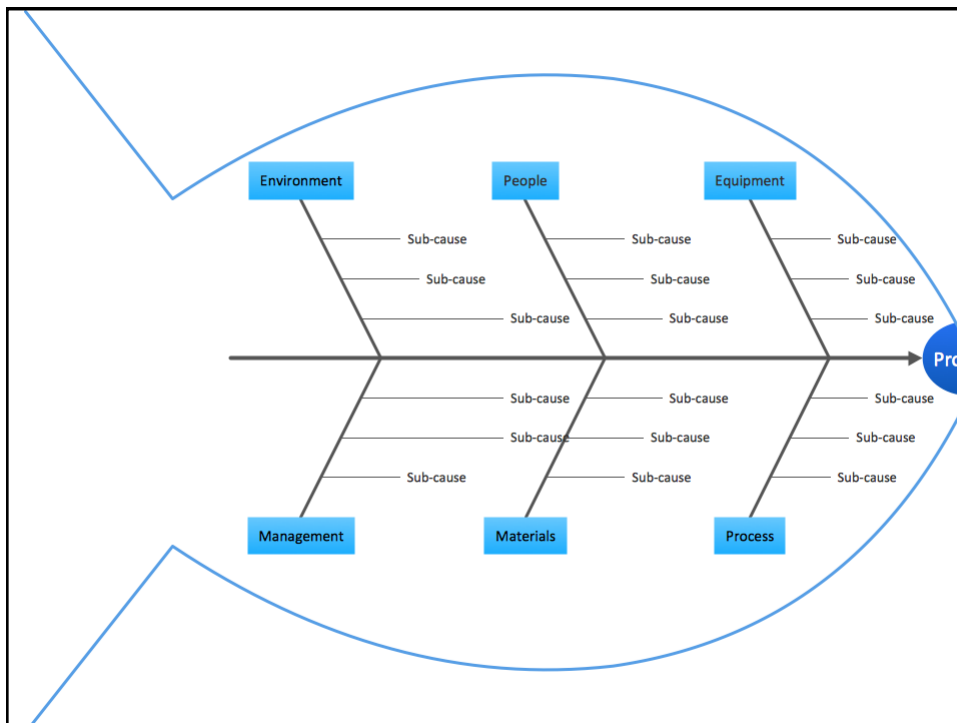
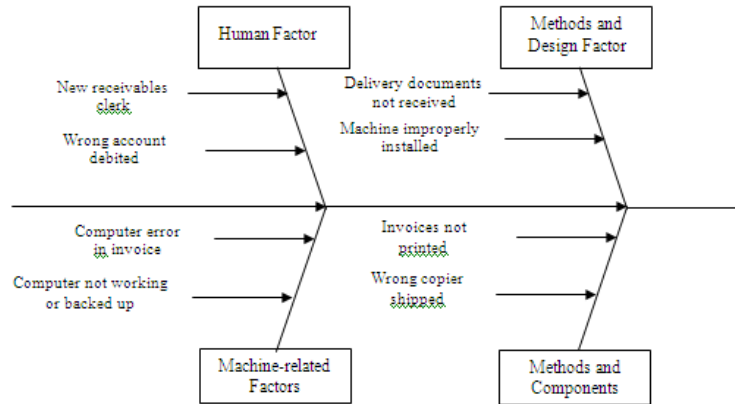
- Step 5: Focus on the ribs that are full. Are there serious problems that need to be addressed?
- Step 6: Discuss the most likely causes of your problem and conduct further research to see if those causes are valid.
- Step 7: Meet with your team to brainstorm creative solutions. Use the information from your research and all your team's ideas to address the problems that you identified.

EX see more [Materials\fishbone-cause-and-effect-diagram.xls](#)

- Use Excel to create a Ishikawa diagram about delaying to send the invoices to the customers in your company.

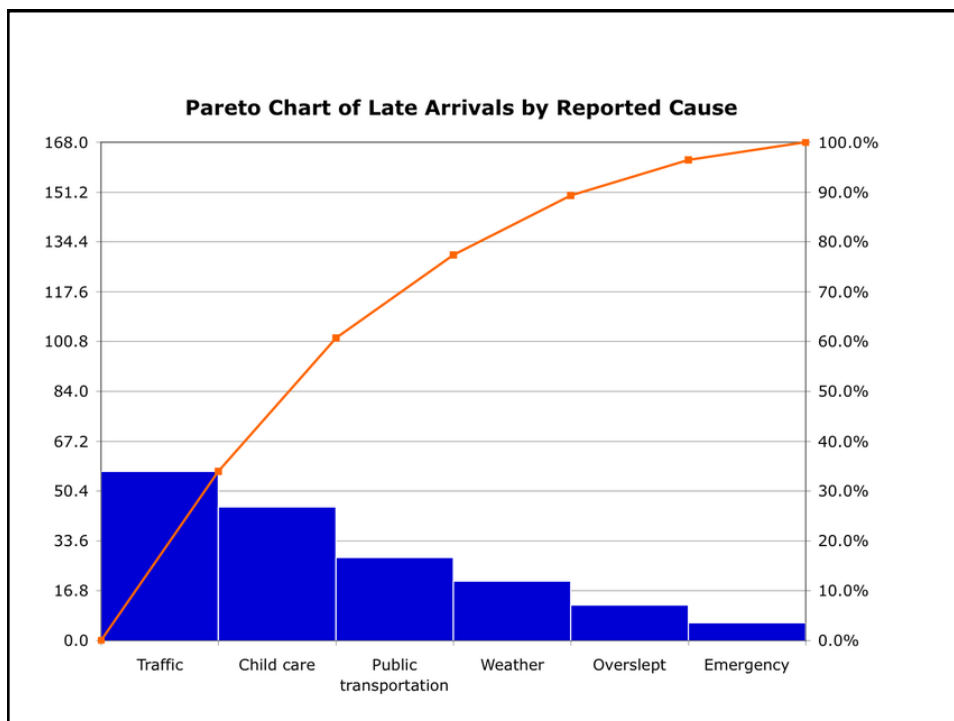
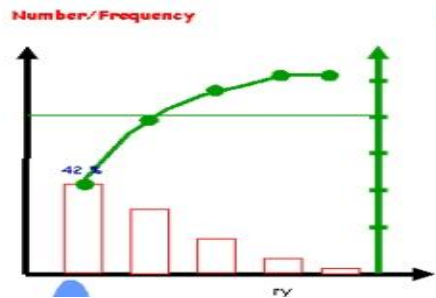
Example

For Problem of Delays in Sending Invoices at Murray Corporation



3.3. Perato Chart

- is a type of chart that contains both [bars](#) and a [line graph](#), where individual values are represented in descending order by bars, and the cumulative total is represented by the line.



- The Pareto diagram is a graphical overview of the process problems, in ranking order of the most frequent, down to the least frequent, in descending order from left to right.
- Thus, the Pareto diagram illustrates the frequency of fault types.
- Using a Pareto, you can decide which fault is the most serious or most frequent offender.

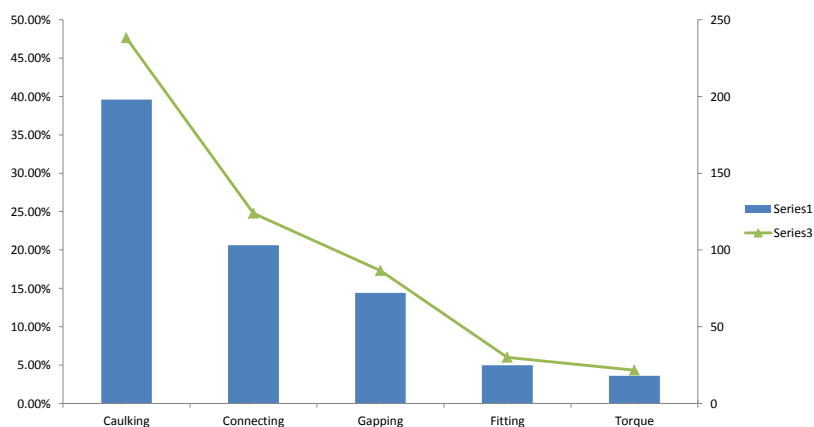
The basic underlying rule

- In almost every case, 80% of the total problems incurred are caused by 20% of the problem cause types; such as people, machines, parts, processes, and other factors related to the production of the product.
- Example:

A PARETO EXAMPLE

Date:		Number Inspected:	N = 2165
Defective Items	Number of Defectives	Percent of Defects	Percent Distribution of defectives
Caulking	198	9.15%	47.60%
Connecting	103	4.76%	24.76%
Gapping	72	3.33%	17.31%
Fitting	25	1.15%	6.01%
Torque	18	0.83%	4.33%
TOTAL	416	19.21%	100.00%

Chart



it is wise to ask

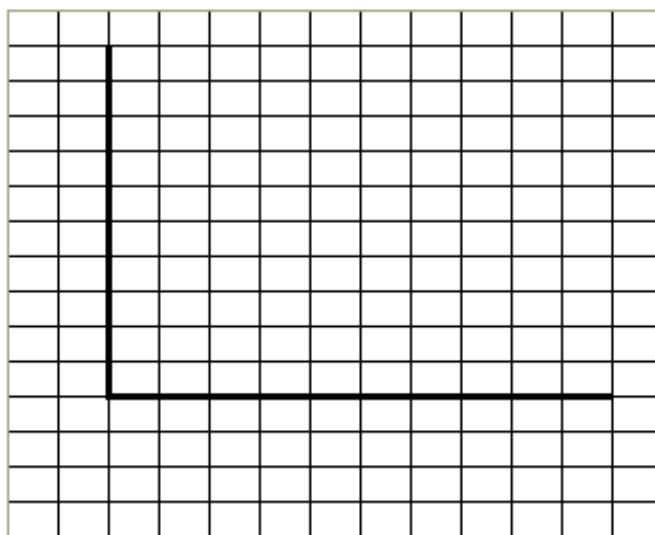
- "Does the Caulking problem have any impact on the other problems listed?"
- In some cases it might. If there was proper caulking, would part of the "Gapping" problem be eliminated?"
- If there were proper caulking, would the "Torque" have a better value and thus not be part of the defects?
- Sometimes your major problems have impact on the smaller problems. Several problem areas may all be attributed to ONE ROOT CAUSE, even though several failure modes are observed.
- → It is always wise to choose the most frequent problem first.

How To Make A Pareto Diagram

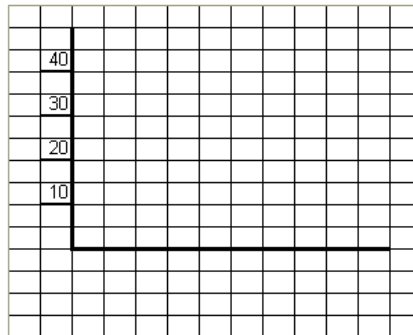
- STEP #1 - Determine the category classifications that you are going to use to group your defect data by.
- Use your check sheets to collect the data for the Pareto.
- STEP #2 - Decide on the time period to be used to record your information. One week, a month, etc.
- It is best to be consistent so that you have a standard to compare to if the data collection exercise is to be repeated again. You can't measure results achieved accurately without consistent measurement periods.

- **STEP #3** - From the Check Sheet, total the occurrence of each item for the period measured. Each total will be represented by the length of a vertical bar, much like the Pareto chart example above.
- **STEP #4** - (It is easier to keep your scale accuracy correct if you use graph paper). Draw horizontal and vertical axes on graph paper; or if no graph paper available, use a ruler to measure and draw evenly scaled vertical and horizontal lines that meet evenly

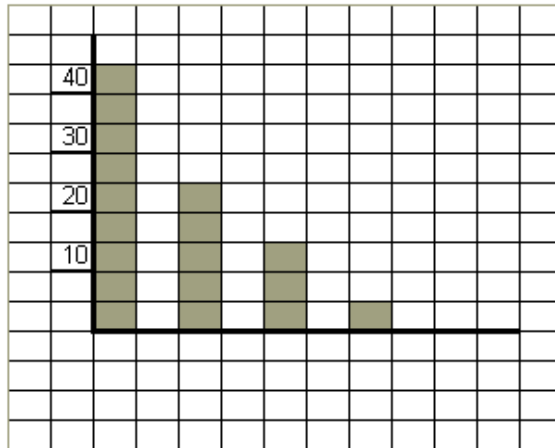
Example



- **STEP #5** - Make your scale units at even multiples, such as 10, 20, etc. so as to have an even scale system

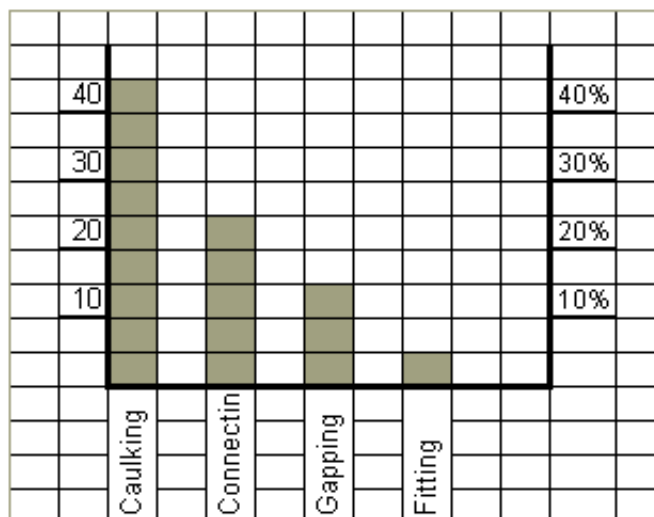


- **STEP #6** - Draw in the bars that correspond to the total numbers collected from your Check Sheet, starting on the far left, with the most frequent (highest number recorded) defective item. It is recommended that you leave a gap between each item bar for reading clarity. (Note: If you have several defective items with very small quantities, you can group them together in a category called "other", as long as their total is less than the previous bar height).



- **STEP #7** - Under the horizontal axis (line), label each of the bars so that you know which defect is represented by which bar.

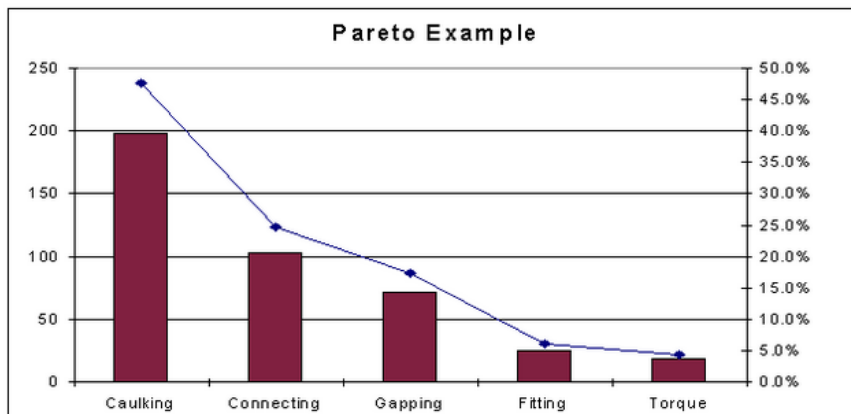
STEP #8 - Draw another vertical line and label the percentage scale in the same manner that you did on the left side



- **STEP #9** - Plot a dot for each item on the graph, starting from the left side, on or above the bar corresponding to the related percentage of defectives for each item. Once each dot is plotted, use a ruler and connect the line graph from dot-to-dot, as shown in the "Pareto example" up above.

•

STEP #10 - Title the graph and briefly write the source of the data below the graph, that describes the data and method used to gather. Include all pertinent facts which will define the method of observation (for example, time period, production line, and whether this was before or after any modifications to the line). Recording this data on the bottom of your chart, will help further analysis as well as to provide a record of what was done on this date, for consideration in future studies.



Do it in Excel

- **Data Preparation**
 - Organize the data in three columns, the first column containing the categories (or events), the second column containing frequency and the third column containing relative priority (e.g., percentage of total events). Sort the data in order of increasing frequency so that a combination chart can be prepared to analyze the impact of the events and provide insight about each event's relative importance.
- Select the columns and sort the data. Make sure to select the second column in the drop-down menu for the first criterion and specify the sort in "Descending" order. Click "OK" to perform the sort function.

- **Combination Chart**

- To create a combination chart, first create a basic chart from the data and then format the second series of data for the secondary or z axis with a different chart type. Select the data (three columns) and then select "Chart" under "Insert" in the top menu bar to activate the Chart Wizard. Select a column chart as the primary chart type for a Pareto chart and click the "Next" button. Continue through the Chart Wizard and type the desired information in the fields (such as "Chart title" and "Category (X) axis") and select the chart options (such as legend, data labels and gridlines). Choose whether to place the chart on the data page or on a separate sheet in the workbook.

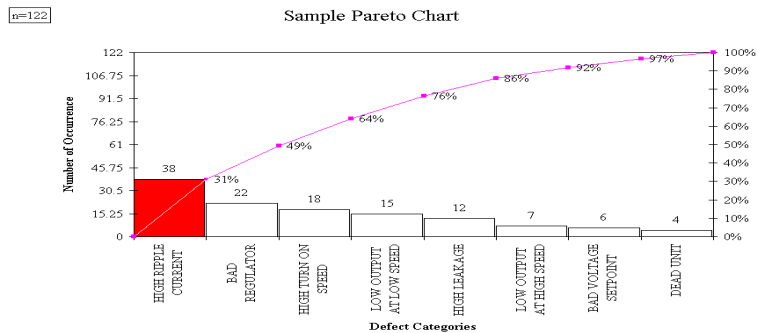
- Right-click the second data series (second set of colored bars) and select "Format Data Series." Specify this series as the secondary axis under the "Axis" tab in the dialog box before clicking "OK" to save the settings. Apply a different chart type to this series by selecting "Chart Type" under "Chart" in the top menu bar. Select "Line" as the chart type to complete the Pareto chart

Test Your Learning - Class Exercise

- From the Production Defect Check Sheet [Materials\defecsamp.doc](#) you will need to total the number of occurrences (N) then divide each individual defect by (N) to determine the percentage of overall defects, that each defective item represents.
- When you are finished, check your answers against "Check Your Work" below.

Defect Category	Number of occurrences	Percent of Total	Accum. Percent
High Turn On Speed	18	14.75%	14.75
High Ripple Current	38	31.15%	45.90%
High Leakage	12	9.84%	55.74%
Low Output at Low Speed	15	12.30%	68.03%
Low Output at High Speed	7	5.74%	73.77%
Dead Unit	4	3.28%	77.05%
Bad Regulator	22	18.03%	95.08%
Bad Voltage Set Point	6	4.92%	100.00%
Total Defects (N)	122	100.00%	

Chart result



3.4 Control Chart

- Control charts are generally used in a production or manufacturing environment and are used to control, monitor and IMPROVE a process.
- Common causes are always present and generally attributed to machines, material and time vs. temperature.

- There are basically three kinds of control lines:
- the upper control limit (UCL),
- the central line (actual nominal size of product),
- the lower control limit (LCL).

Steps In Making the Xbar and R Chart

- STEP #1 - Collect the data. It is best to have at least 100 samples.
- STEP #2 - Divide the data into sub groups, it is recommended the subgroups be of 4 or 5 data points each. The number of samples is represented by the letter " n " and the number of subgroups is represented by the letter " k ". The data should be divided into subgroups in keeping with the following conditions:
 - The data obtained should be from the same grouping of products produced.
 - A sub group should not include data from a different lot or different process.
- STEP #3 - Record the data on a data sheet. Design the sheet so that it is easy to compute the values of X bar and R for each sub group (see the page in the class example).
- STEP #4 - Find the mean value (Xbar). Use the following formula for each subgroup:

$$\bar{X} = \frac{X_1 + X_2 + X_3 + X_4 + X_5}{N} = \frac{65.0}{5} = 13.0$$

STEP #5 - Find the range, R. Use the following formula for each subgroup. R = X (largest value) - X (smallest value) Example 14.0 - 12.1 = 1.9

- **CLASS EXERCISE** [Materials\control exercise.xls](#)
- **STEP #6 - Find the overall mean, or X double bar . Total the mean values of Xbar, for each subgroup and divide by the number of subgroups (k).**

$$\bar{\bar{X}} = \frac{13.0 + 12.94 + 12.90 \dots + 12.72}{25} = \frac{323.50}{25} = 12.94$$

- **STEP #7 - Compute the average value of the range (R). Total R for all the groups and divide by the number of subgroups (k).**

$$\bar{R} = \frac{R1 + R2 + R3 \dots Rk}{k}$$

$$\bar{R} = \frac{1.9 + 1.3 + 1.1 \dots + 1.1}{25} = \frac{33.8}{25} = 1.35$$

Other exercise

- **On the same Work Sheet that you just computed the X double bar figures, now compute the R bar explained above.**
- **STEP #8 - Compute the Control Limit Lines. Use the following formulas for Xbar and R Control Charts. The coefficients for calculating the control lines are A2, D4, and D3 are located on the bottom of the Work Sheet you are presently using, and presented here:**

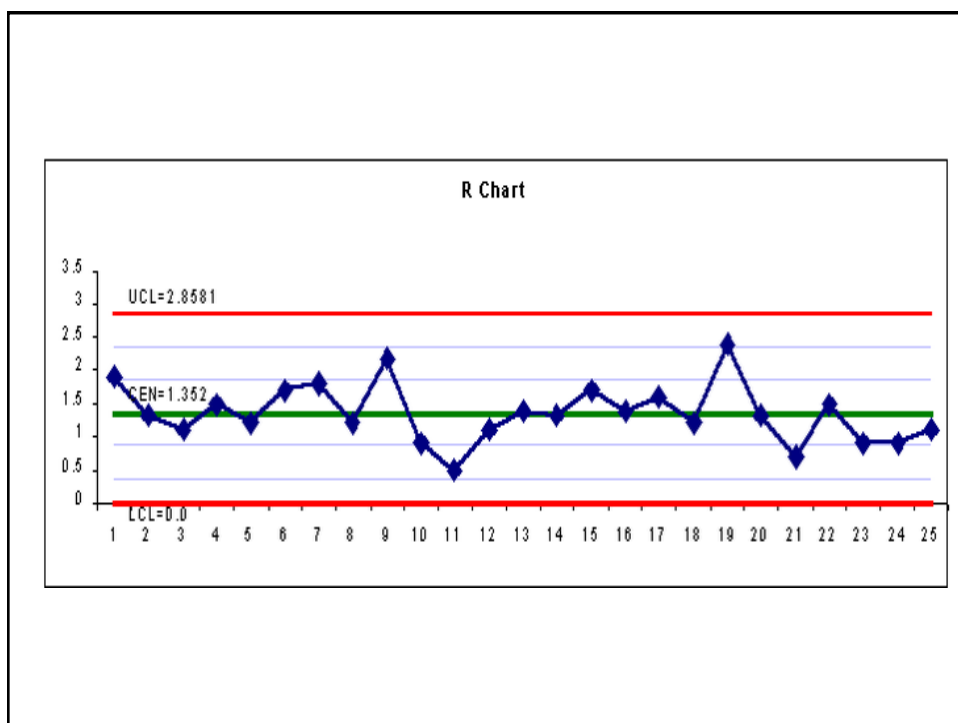
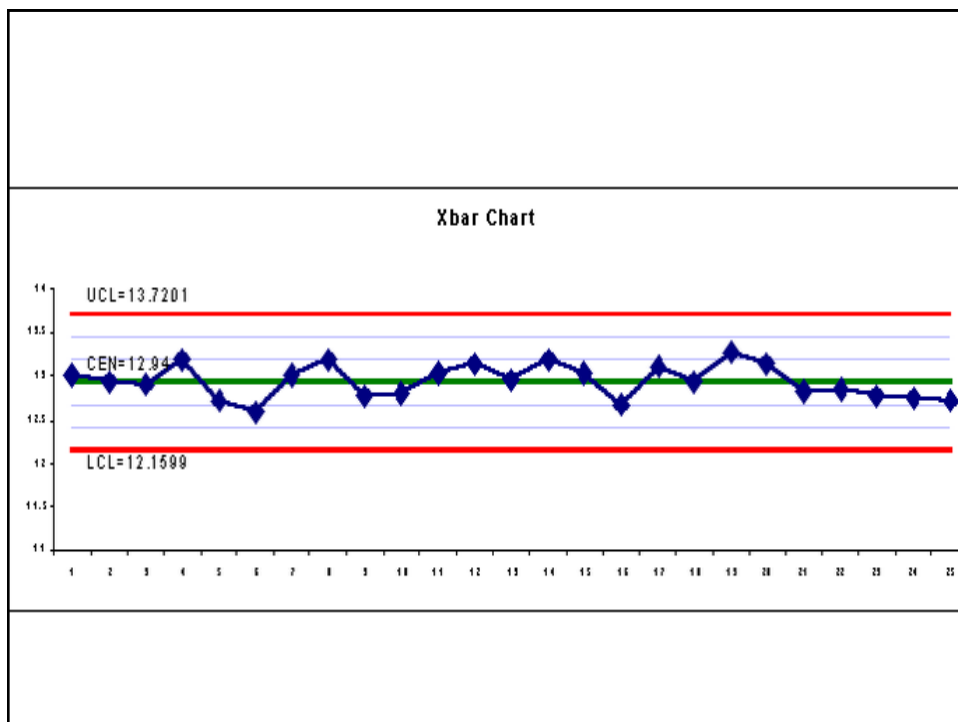
<i>n</i>	<i>A2</i>	<i>D4</i>	<i>D3</i>
2	1.88	3.267	---
3	1.023	2.575	---
4	0.729	2.282	---
5	0.577	2.115	---
6	0.483	2.004	---
7	0.419	1.924	0.076
8	0.373	1.864	0.136
9	0.337	1.816	0.184
10	0.308	1.777	0.223

- **Xbar Control Chart:**
- Central Line (CL) = \bar{X} double bar figure you calculated.
- Upper Control Limit (UCL) = \bar{X} double bar + $A2 * \bar{R}$ bar.
- Lower Control Limit (LCL) = \bar{X} double bar - $A2 * \bar{R}$ bar.
- **R Control Chart:**
- Central Line (CL) = \bar{R} bar figure you calculated.
- Upper Control Limit (UCL) = $D4 * \bar{R}$ bar.
- Lower Control Limit (LCL) = $D3 * \bar{R}$ bar.

**For our Class Exercise, the details are
as follows:**

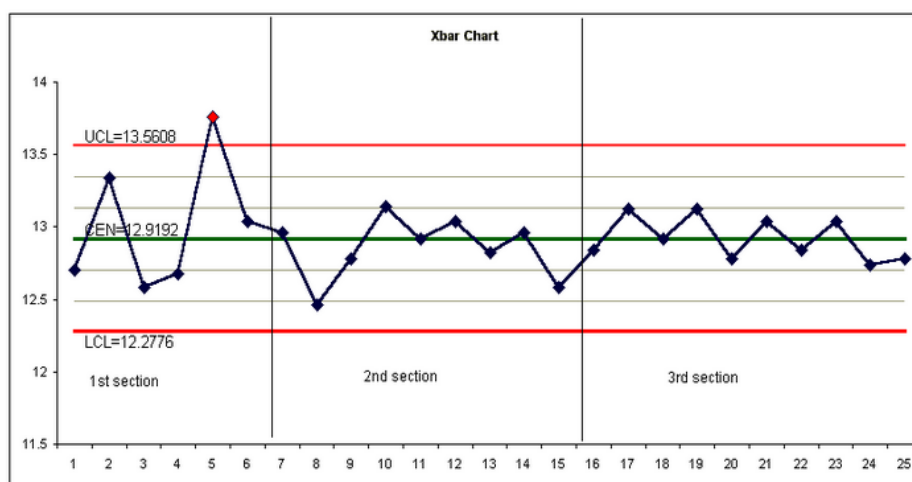
- X Control Chart CL = \bar{X} = 12.94
- UCL = $12.94 + .577 * 1.35 = 13.719$ Note that we are using 5 subgroups, so on the chart $n = 5$, and under the A2 column, $5 = 0.577$. 1.35 is the figure you calculated for \bar{R} .
- LCL = $12.94 - .577 * 1.35 = 12.161$
- R Control Chart CL = $\bar{R} = 1.35$
- UCL = $2.115 * 1.35 = 2.86$ Note that we are using 5 subgroups, so on the chart $n = 5$, and under the D4 column, $5 = 2.115$.
- LCL = Since our subgroups equal 5, if you look under the D3 column, there is no calculation coefficient to apply, thus there is no LCL.

- STEP #9 - Construct the Control Chart. Using graph paper or Control Chart paper, set the index so that the upper and lower control limits will be separated by 20 to 30 mm (units). Draw in the Control lines CL, UCL and LCL, and label them with their appropriate numerical values. It is recommended that you use a blue or black line for the CL, and a red line for the UCL and LCL. The central line is a solid line. The Upper and Lower control limits are usually drawn as broken lines.
- STEP #10 - Plot the \bar{X} and R values as computed for each subgroup. For the \bar{X} values, use a dot (.), and for the R values, use an (x). Circle any points that lie outside the control limit lines so that you can distinguish them from the others. The plotted points should be about 2 to 5 mm apart. Below is what our \bar{X} chart looks like when plotted.



- **STEP #11 - Write in the necessary information. On the top center of the control charts write the Xbar and R chart, and the R Chart so that you (and others) will know which chart is which. On the upper left hand corner of the Xbar control chart, write the n value to indicate the subgroup size; in this case $n = 5$.**

ANALYSIS OF THE CONTROL CHART



Do it in excel

- Step 1: Collect information to identify the data to be recorded. Attributes data is recorded as a count of occurrences. An example of attributes data could be the number of parts exhibiting a specific characteristic defect produced during a specific time frame. Variables data is recorded by a value, such as temperature readings recorded at set intervals while the process is in operation.

- Step 2: Collect information to set upper and lower control limits for each data type to be recorded. Control limits are set based on historical data of process capability and are typically three standard deviations above or below the center line for processes exhibiting normal probability distribution. Data with normal distribution is that which can be graphically depicted as a bell curve peaking at the statistical mean

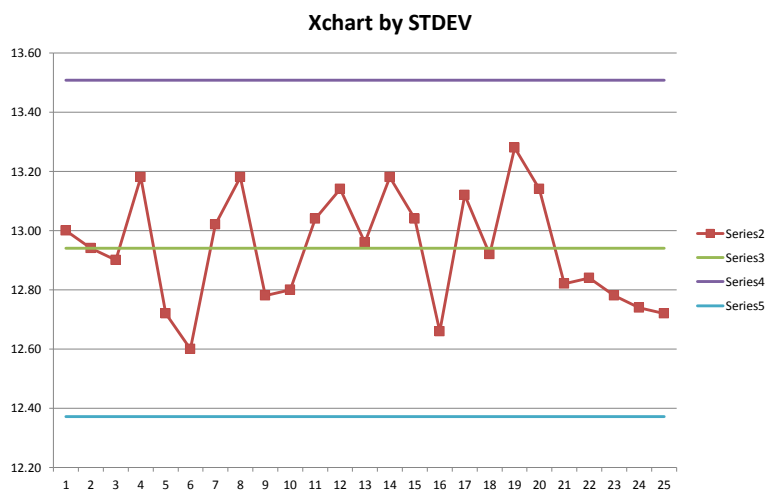
- Create a template. A control chart template will typically contain four sections, as follows:
- 1. A title.
- 2. A legend, identifying specifics about data recordings, including how and when (at what intervals) the data is collected.
- 3. A section to collect data recordings. In an MS Excel spreadsheet, this is often captured as two, paired cells per data point, with the first cell identifying a group or subgroup number and the second cell blank, ready to receive the data to be collected.
- 4. Plotting areas, where the data that has been collected will be graphically displayed.

Excel Detail

- 1. Distribute your data to revolve around a mean (average). Ensure your measurements are independent of each other. Create a subgroup for each data point and measurement number.
- 2. Add all your measurements in the subgroup and divide by your number of measurements. Calculate the mean of all the means; this will determine your over all mean. Determine the standard deviation of your data points by using this command: "Standard deviation: =STDEV(data points)."

- 3. Tally the upper and lower control limits (UCL, LCL). Enter this formula: " $UCL = CL + 3 \cdot S$ ", " $LCL = CL - 3 \cdot S$." This conveys 3 standard deviations above and below your mean. This will process your 1, 2 and 3 sigma lines. Draw a line at each deviation you've calculated. Diagram the subgroup means "x-axis" counter to the "y-axis." Confirm that your points do not fall off any of your sigma lines. This can help you determine whether your data is "in-control" or "out-of-control."

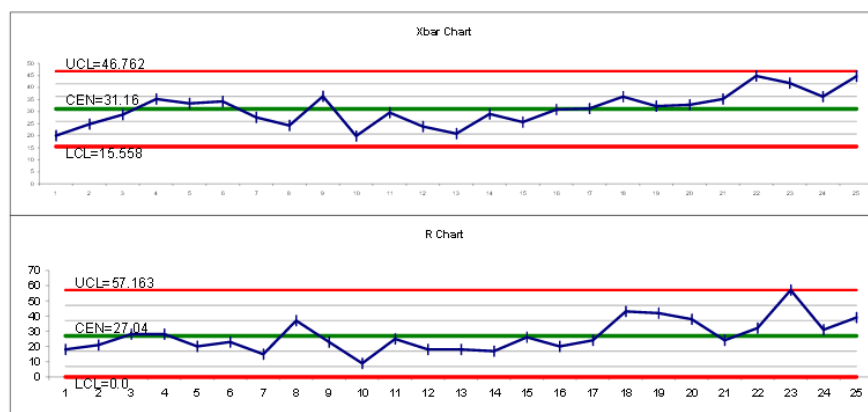
Result



CLASS EXERCISE

- **The Blank Variable Control Chart is available:**
[Materials\varchart control chart.doc](#)
- **Your Completed Data Sheet for this Exercise**
is available [Materials\control exercise 2.xls](#)

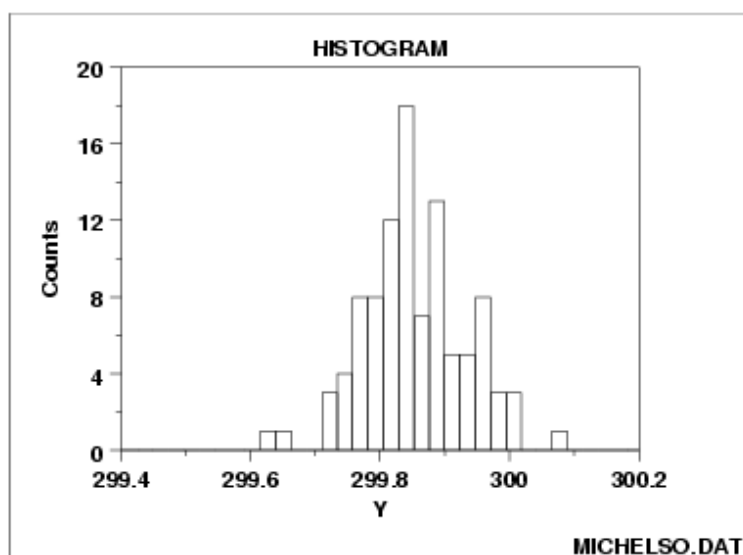
Result



3.5 Histogram

- The purpose of a Histogram is to take the data that is collected from a process and then display it graphically to view how the distribution of the data, centers itself around the mean, or main specification.
- Will show:
 - The center of the data.
 - The spread of the data.
 - Any data skewness (slant, bias or run at an angle).
 - The presence of outliers (product outside the specification range).
 - The presence of multiple modes (or peaks) within the data.

Example



Steps To Make A Histogram

- **STEP #1** - Count the data, in this case $N=60$.

STEP #2 - On the data in figure 6 above, looking only at Line A right now, find the largest value and call that X_L , and then find the smallest value, calling that X_S . On Line A, the largest value is "7" and the smallest is "- 2".

STEP #3 - Next, find the range of the data. $R = X_L - X_S$, or $7 - (- 2)$,
or $R = 9$.

- **STEP #4** - Determine the width of the class. The total data measurements equals 60 (N), the measurement unit is 1, and the range is 9 (R). There is a formula table listed below that will help you determine the number of classes to be used:

Number of Data (N)	Number of Classes (K)
Under 50	5 - 7
50 - 100	6 - 10
100 - 250	7 - 12
Over 250	10 - 20

- **STEP #5** - The class interval (h), which is used as the horizontal graduation unit for the histogram, is determined by dividing the range (R) by the number of classes. For simplicity sake, since the range is 9, and from our table in figure 7, we can have 6 - 10 classes, we will choose 9 classes; thus $9 \text{ divided by } 9 = 1$. Each class value will be worth 1.

CLASS EXERCISE

- [Materials\histotry1.xls](#)
- In this first exercise, I want you to put an "X" or "1" in the manual graph for Line A data above in the left side of the form under the column "Tally". Make a mark in the appropriate row for every data point in Line A, and then do the same for Line B. Then I want you to put the same mark for Line B data above in the right side of the form under the column "Tally". Total the number of occurrence for each number in the column marked "Frequency", and then add the frequency for A and B and put that number in the column marked A + B frequency.

result

- Putted data: [Materials\histocheck1.pdf](#)
- Line A, B

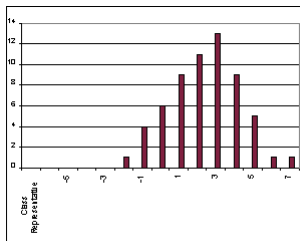


Figure 9 - Line A Histogram

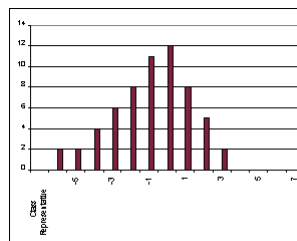


Figure 10 - Line B Histogram

CLASS EXERCISE 2

- To take the total of Line A & B and plot that histogram. From your first exercise sheet, you added $A + B$ and put that number in the far right column.
- Use the attached [Materials\histocheck2.pdf](#) to make your plots, put a "X" in each square. I have already put the totals from your first sheet in the Frequency column.

Result

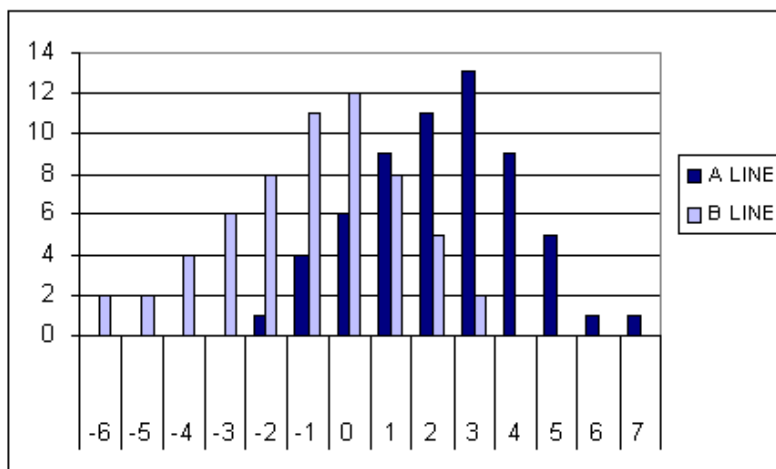


Figure 11 - Combined Histogram of Line A & B

UNDERSTANDING THE HISTOGRAM

- **LINE A** - If we review the histogram for Line A, you will see that the most recorded value is 3, or +3 (150.3mm); further, that all 60 data points are from - 2 to +7, or from 149.8 to 150.7mm. There is a shift toward the (+) side of 150.0, and we have two parts that are out of specification range (larger than +5mm).
- **LINE B** - If we review the histogram for Line B, you will see that most of the values are at either 0 (150.0) or at - 1 (149.9mm). Line B also has a shift, but it is more toward the (-) side of the spec, or less than 150.0mm. There are also two parts out of specification range (beyond the -5 specification).

Now when we look at the combined run of parts of the two lines, you can see a more even distribution spread across the specification tolerance range (that is, between the range of 149.5 and 150.5mm). Since there is such a wide dispersion of parts, there is no smooth "bell curve" appearance like there was in the sample histogram at the start of this lesson. As a matter of fact, this chart reveals a multi-peaked histogram that strongly indicates the process is not centered, if all these parts were produced on the same line. Since these parts were produced on two separate lines, we can actually see that Line A needs an adjustment to bring it more to the center of the spec by decreasing the process value. Line B needs an adjustment to center the spec by increasing the process value.

COMPUTING THE MEAN AND THE STANDARD DEVIATION

- To calculate the mean (\bar{X}), or average value, and the standard deviation to be used for further statistical computations, we will use the below chart for Line A.
- The standard deviation is a measure of variability. Data is always scattered around the zone of central tendency, and the extent of this scatter is called dispersion or variation. Range is a simple method of measuring variance, but the most important measure is the Standard Deviation. The Standard Deviation is the square root of the population variance.

Table for Computing Line A

Class representative value	Frequency f_i	u_i	$f_i \cdot u_i$	$f_i \cdot u_i^2$
-2 (149.8)	1	-2	-2	4
-1 (149.9)	4	-1	-4	4
0 (150)	6	0	0	0
+1 (150.1)	9	1	9	9
+2 (150.2)	11	2	22	44
+3 (150.3)	13	3	39	117
+4 (150.4)	9	4	36	144
+5 (150.5)	5	5	25	125
+6 (150.6)	1	6	6	36
+7 (150.7)	1	7	7	49
TOTALS	60		138	532

- To understand the chart, the left column is the actual value recorded on the right, and the " u_i " factor on the left of the measurement.
 - The next column (f_i) indicates how many times each value was recorded from the data taken.
 - The third column (u_i) is the value indicated in the first column, to the left of the actual measurement, or the class representative value in converted form.
 - The fourth column is the second column multiplied by the third column, ($f_i \cdot u_i$). For example, 1 times -2 = -2.
 - The fifth column is a little tricky. You take the " f_i " value and multiply it by the square of " u_i " (for example -2 * -2 = 4, times 1 = 4).
- Once you have all those values calculated, you add the totals for each column of f_i , $f_i \cdot u_i$, and the $f_i \cdot u_i^2$ (squared).

CLASS EXERCISE 3:

- I have done Line A for you. Now, you need to practice by doing Line B, and then also by computing the values for the combined Line A & Line B. Use the following [Materials\histotry2.pdf](#) to do your calculations. I have provided the initial numbers for you. After you have completed the exercise, you may select Exercise 3 below (see Check Your Work) and compare your results.

- Now to compute Xbar and the Standard Deviation (s) from the table of Line A, we use the following formula:

$$\bar{X} = 150 + \left(\frac{138}{60} \right) * 0.1 = 150.23$$

$$s = 0.1 \sqrt{\frac{532}{60} - \frac{(138)^2}{60}} = 1.891 * .1 = .189$$

- to COMPUTE THE MEAN and STANDARD DEVIATION for LINE B and for the combined LINE A & B.

LINE	A	B	A & B
Data Number N	60	60	120
Mean Value Xbar	150.23	149.9	150.1
Standard Deviation s	0.19	0.21	0.26

THE PROCESS CAPABILITY

- With the specification of 150 ± 0.5 mm, the width of the class, or class interval, is 1 mm. This is five times the standard deviation (s) of Line A and five times the standard deviation (s) of Line B; four times the standard deviation (s) of A & B combined. In order for products to remain within specification, the width of a class should be at least SIX TIMES the Standard Deviation (s).
- The Process Capability Index (C_p), is a value indicating how capable a process is of producing product without many defects. The higher the process capability index, the better the process is centered around the mean specification and the less possibility of defects. With reference to the process capability index (C_p), it can be expressed as follows:
- $C_p = \frac{\text{width of class}}{6s}$ For Line A $C_p = 1.0 / 6 * .19 = 1.0 / 1.14 = .87 C_p$.
 For Line B $C_p = 1.0 / 6 * .21 = 1.0 / 1.25 = .79 C_p$.
 For Line A & B Combined $C_p = 1.0 / 6 * .26 = 1.0 / 1.56 = .64 C_p$.
 While both lines exhibit that the products produced are close to the center of the specification, both of the indexes are less than 1, so this indicates that there will be defectives produced. Notice that when you combine both Line A and Line B, you have defectives on both sides of the specification, and thus the defectives produced actually increases, therefore the C_p drops even lower.

- For a process to be suitable, it should have a C_p greater than 1.0. The higher the number, the better the process is centered. In the chart below, you can see the C_p , or Process Capability Index relative to the total product outside the two-sided specification limits, or +/- tolerance.

Process Capability Index (Cp)	Total product outside the Limits
0.50	13.36%
0.67	4.55%
1.00	0.30%
1.33	64 PPM
1.63	1 PPM
2.00	0.00%

- **What can we do to eliminate the defectives and improve the process capability?**
- **Find out the reason for the difference in production between A & B lines, and try to eliminate or standardize the production in both lines.**
- **Determine how to get Lines A & B to produce more towards the center of the specification center.**
- **Determine how to center the specification and decrease the dispersion. Check machinery, materials, workers, work methods, and measurement methods.**

Result

Table for Computing Line B

Class representative value	Frequency f_i	u_i	$f_i \cdot u_i$	$f_i \cdot u_i^2$
-6 (149.4)	2	-6	-12	72
-5 (149.5)	2	-5	-10	50
-4 (149.6)	4	-4	-16	64
-3 (149.7)	6	-3	-18	54
-2 (149.8)	8	-2	-16	32
-1 (149.9)	11	-1	-11	11
0 (150.0)	12	0	0	0
+1 (150.1)	8	1	8	8
+2 (150.2)	5	2	10	20
+3 (150.3)	2	3	6	18
TOTALS	60		-59	329

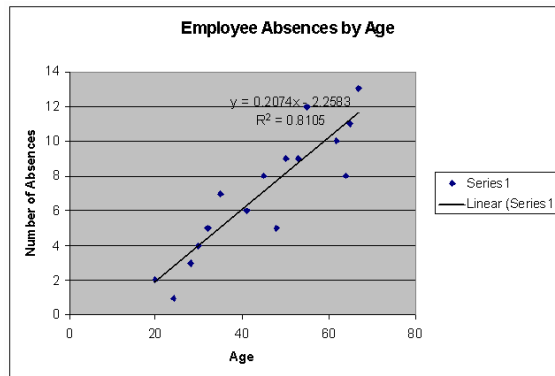
Table for Computing Line A & B

Class representative value	Frequency f_i	u_i	$f_i \cdot u_i$	$f_i \cdot u_i^2$
-6 (149.4)	2	-6	-12	72
-5 (149.5)	2	-5	-10	50
-4 (149.6)	4	-4	-16	64
-3 (149.7)	6	-3	-18	54
-2 (149.8)	9	-2	-18	36
-1 (149.9)	15	-1	-15	15
0 (150.0)	18	0	0	0
+1 (150.1)	17	1	17	17
+2 (150.2)	16	2	32	64
+3 (150.3)	15	3	45	135
+4 (150.4)	9	4	36	144
+5 (150.5)	5	5	25	125
+6 (150.6)	1	6	6	36
+7 (150.7)	1	7	7	49
TOTALS	60		79	861

3.6. Creating a Scatter Plot

- (1) Highlight the data. Note: The first column will become the X-Axis and the second column will be the Y-Axis.
- (2) From the Excel menu, click on INSERT, click on SCATTER, then click on ALL CHART TYPES this will make the chart options box bigger.
- (3) Click on XY (Scatter) – it should be on the left.
- (4) Click OK. The Scatter Plot should be on the same page as your data.
- (5) If you wish, you can change the size of the chart window and drag it anywhere you want on the worksheet.
- (6) To make changes to the chart, you can use DESIGN, LAYOUT, and/or FORMAT on the chart tools menu.

Example



Equation of a Regression Line

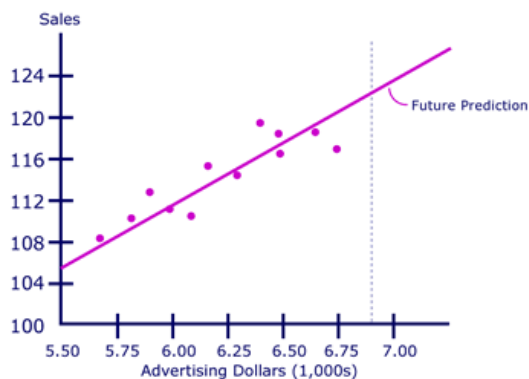
- Variables, constants, and $f(x) = mx + b$ represented in the equation of a line as
- x represents the independent variable $f(x)$ represents the dependent variable the constant b denotes the y -intercept—this will be the value of the dependent variable if the independent variable is equal to zero
- The coefficient m describes the movement in the dependent variable as a result of a given movement in the independent variable

Exercise

- The following table lists the monthly sales and advertising expenditures for all of last year by a digital electronics company.
- Draw a Scatter Diagram to show the correlation between Sale and Advertising

	A	B	C
1	Month	Sale (in 1000s)	Advertising Dollars (1000s)
2	Jan	100	5.5
3	Feb	110	5.8
4	Mar	112	6
5	Apr	115	5.9
6	May	117	6.2
7	Jun	116	6.3
8	Jul	118	6.5
9	Aug	120	6.6
10	Sep	121	6.4
11	Oct	120	6.5
12	Nov	117	6.7
13	Dec	123	6.8

Trend Prediction



Stratification

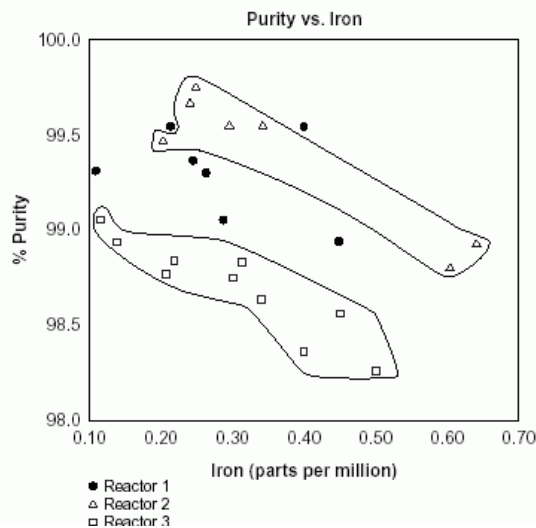
- Is a technique used in combination with other data analysis tools.
- When data from a variety of sources or categories have been lumped together, the meaning of the data can be impossible to see. This technique separates the data so that patterns can be seen.

- **When to Use Stratification**
- Before collecting data.
- When data come from several sources or conditions, such as shifts, days of the week, suppliers or population groups.
- When data analysis may require separating different sources or conditions.

Stratification Procedure

- Before collecting data, consider which information about the sources of the data might have an effect on the results.
- When plotting or graphing the collected data on a scatter diagram, control chart, histogram or other analysis tool, use different marks or colors to distinguish data from various sources. Data that are distinguished in this way are said to be “stratified.”
- Analyze the subsets of stratified data separately.
- For example, on a scatter diagram where data are stratified into data from source 1 and data from source 2, draw quadrants, count points and determine the critical value only for the data from source 1, then only for the data from source 2.

Stratification Example



Exercise

- Assume we have

	A	B	C	D	E	F	G	H
1	Machine 1			Machine 2			Machine 3	
2	Input (x)	Output (y)		Input (x)	Output (y)		Input (x)	Output (y)
3	1.5	98.25		1.6	98.85		1.45	98.95
4	1.4	98.35		1.63	98.55		1.27	99.05
5	1.45	98.6		1.21	99.45		1.26	99.1
6	1.34	98.65		1.29	99.55		1.1	99.3
7	1.29	98.75		1.34	99.44		1.24	99.4
8	1.21	98.65		1.24	99.65		1.4	99.01
9	1.31	98.85		1.25	99.75		1.22	99.55
10	1.22	98.65						
11	1.13	98.95						
12	1.11	99.05						

To analyze the relationship between the inputs to a process and the resulting outputs from that process

Result

