IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Project Management for Managers

Lec – 51

Crashing of Networks

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Project Management for Managers

Lec – 52

Introduction to Project Cost Management

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Cost Estimating

.1 Inputs
- .1 Enterprise environmental factors
- .2 Organizational process assets
- .3 Project scope statement
- .4 Work breakdown structure
- .5 WBS dictionary
- .6 Project management plan
  - Schedule management plan
  - Staffing management plan
  - Risk register

.2 Tools and Techniques
- .1 Analogous estimating
- .2 Determine resource cost rates
- .3 Bottom-up estimating
- .4 Parametric estimating
- .5 Project management software
- .6 Vendor bid analysis
- .7 Reserve analysis
- .8 Cost of quality

.3 Outputs
- .1 Activity cost estimates
- .2 Activity cost estimate supporting detail
- .3 Requested changes
- .4 Cost management plan (updates)

Cost Budgeting

.1 Inputs
- .1 Project scope statement
- .2 Work breakdown structure
- .3 WBS dictionary
- .4 Activity cost estimates
- .5 Activity cost estimate supporting detail
- .6 Project schedule
- .7 Resource calendars
- .8 Contract
- .9 Cost management plan

.2 Tools and Techniques
- .1 Cost aggregation
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- .3 Parametric estimating
- .4 Funding limit reconciliation

.3 Outputs
- .1 Cost baseline
- .2 Project funding requirements
- .3 Cost management plan (updates)
- .4 Requested changes

Cost Control

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- .3 Performance reports
- .4 Work performance information
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- .6 Project management plan

.2 Tools and Techniques
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- .2 Performance measurement analysis
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- .3 Performance measurements
- .4 Forecasted completion
- .5 Requested changes
- .6 Recommended corrective actions
- .7 Organizational process assets (updates)
- .8 Project management plan (updates)

Project Cost Management is primarily concerned with the cost of the resources needed to complete schedule activities

Different stakeholders will measure project costs in different ways and at different times. (Purchase decision, placing order, arrived,)

Cost estimates are generally expressed in **units of currency** (dollars, euro, yen, etc.) to facilitate comparisons both within and across projects.

In some cases, the estimator can use units of measure to estimate cost, **such as staff hours (men hour) or staff days,** along with their cost estimates, to facilitate appropriate management control.

Cost estimates can benefit from **refinement during the course** of the project to reflect the additional detail available. Initially **Rough order of magnitude** (ROM) estimate may be -50% to 100% later -10 to 50%.

Cost included is not limited to, labor, materials, equipment, services, and facilities, as well as special categories such as an **inflation** allowance or a contingency cost.

Cost Estimating: Inputs

1 Enterprise Environmental Factors

Marketplace conditions. What products, services, and results are available in the marketplace, from whom, and under what terms and conditions .

Commercial databases. Info @ standard costs for material and equipment. **Published seller** price lists are another source.

3 Project Scope Statement: describes the business need, justification, requirements, and current boundaries for the project.

4 Work Breakdown Structure: the project's work breakdown structure (WBS) provides the **relationship among all the components of the project** and the project deliverables.

5 Project Management Plan: provides the **overall plan for executing, monitoring, and controlling the project, and includes subsidiary plans that provide guidance and direction for cost management planning and control**.

Cost Estimating: Tools and Techniques

1.Analogous Estimating: Analogous cost estimating means **using the actual cost of previous**, similar projects as the basis for estimating the cost of the current project. It uses **expert judgment**. It is **less costly** than other techniques, but it is also **generally less accurate.**

2. Determine Resource Cost Rates: The persons must know the unit cost rates, **such as staff cost per hour and bulk material cost per cubic yard**, for each resource to estimate schedule activity costs.

Cost Estimating: Tools and Techniques

3. Bottom-up Estimating??????????

4. Parametric Estimating: ??????????????

Cost Estimating: Tools and Techniques

3. Bottom-up Estimating: estimating the cost of individual work packages or individual schedule activities with the lowest level of detail. This detailed cost is then summarized or "**rolled up**" to higher levels for reporting and tracking purposes.

4. Parametric Estimating: Parametric estimating is a technique that uses a **statistical relationship between historical data and other variables** (e.g., square footage in construction, lines of code in software development, required labor hours) to calculate a **cost estimate** for a schedule activity resource.

5. **Project Management Software:** Project management software, **such as cost estimating software applications, computerized spreadsheets, and simulation and statistical tools**, are widely used to assist with cost estimating.
6. **Vendor Bid Analysis:** Other cost estimating methods include **vendor bid analysis** and an analysis of what the project should cost.
7. **Reserve Analysis:** Many cost estimators **include reserves**, also called **contingency allowances**, as costs in many schedule activity cost estimates.
8. **Cost of Quality:** Cost of quality can also be used to prepare the schedule activity cost estimate.

Cost Estimating: Outputs

1. Activity Cost Estimates: An activity cost estimate is a **quantitative assessment** of the likely **costs of the resources** required to complete schedule activities. This includes, but is not limited to, **labor, materials, equipment, services, facilities, information technology, and special categories such as an inflation allowance or cost contingency reserve.**

2. Activity Cost Estimate Supporting Detail: Regardless of the level of detail, the **supporting documentation should provide a clear, professional, and complete picture by which the cost estimate was derived**.

Supporting detail for the activity cost estimates should include:

- Description of the schedule activity's project scope of work
- Documentation of **the basis for the estimate** (i.e., how it was developed)
- Documentation of **any assumptions made**
- Documentation **of any constraints**
- Indication of the range **of possible estimates** (e.g., $10,000 (-10% / +15%) to indicate that the item is expected to cost between $9,000 and $11,500).

3. Requested Changes: The Cost Estimating process may **generate requested changes that may affect the cost management plan, activity resource requirements**, and **other components of the project management plan.**

4. Cost Management Plan (Updates): If approved change requests result from the Cost Estimating process, then the **cost management plan component of the project management plan is updated** if those approved changes impact the management of costs.

Cost Budgeting: Cost budgeting involves **aggregating the estimated costs of individual schedule activities** or work packages to establish a **total cost baseline for measuring project performance.**

Cost Budgeting: Inputs

1. Project Scope Statement

2. Work Breakdown Structure

3. WBS Dictionary: The WBS dictionary is a primary input to schedule activity definition.

4. Activity Cost Estimates: The **cost estimates for each schedule activity** within a work package are aggregated to obtain a cost estimate for each work package.

5. Activity Cost Estimate Supporting Detail

6. **Project Schedule:** The project schedule includes planned **start and finish dates for the project's schedule activities, schedule milestones, work packages, planning packages, and control accounts.** This information is used to aggregate costs to the calendar periods when the costs are planned to be incurred.
7. **Resource Calendars**
8. **Contract:** information related to what products, services, or results have been purchased — and their costs — are used in developing the budget.
9. **Cost Management Plan:** The cost management plan component of the project management plan and other subsidiary plans are considered during cost budgeting.

Cost Budgeting: Tools and Techniques

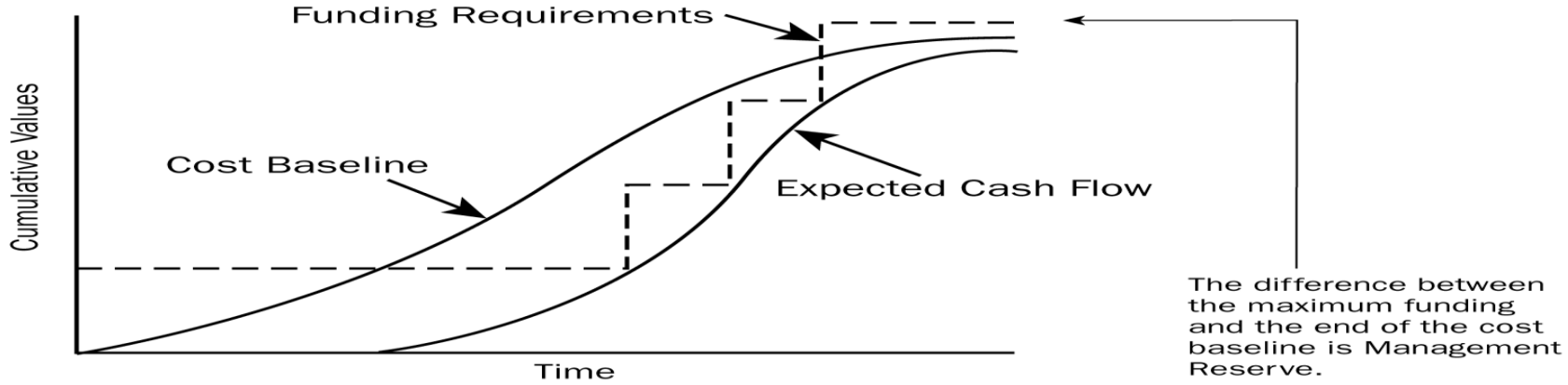
1. Cost Aggregation: Schedule activity cost estimates are aggregated by work packages in accordance with the WBS.

2. Reserve Analysis: Reserve analysis establishes contingency reserves, such as the management **contingency** reserve, that are allowances for **unplanned**, but potentially required, changes.

3. Parametric Estimating: The parametric estimating technique involves using project characteristics (parameters) in a **mathematical model** to predict total project costs. Both the cost and accuracy of parametric models vary widely.

Cost Budgeting: Outputs

1. **Cost Baseline:** The cost baseline is a time-phased **budget** that is used as a basis against which to measure, monitor, and control **overall cost performance** on the project. It is developed by **summing estimated costs by period and is usually displayed in the form of an S-curve,** as illustrated in Figure .
2. **Project Funding Requirements:** Funding requirements, total and periodic (e.g., annual or quarterly), are **derived from the cost baseline** and can be established to exceed, usually by a margin, to allow for either early progress or cost overruns. Funding usually occurs in incremental amounts that are not continuous, and, therefore, appears as a step function in Figure



3 . Cost Management Plan (Updates): If approved change requests result from the Cost Budgeting process, then the cost management plan component of the project management plan is updated if those approved changes impact the management of costs.

4 . Requested Changes: The Cost Budgeting process can generate requested changes that affect the cost management plan or other components of the project management plan. Requested changes are processed for review and disposition through the Integrated Change Control process.

Cost Control??????????????

Cost Control

Project cost control includes:

- Influencing **the factors that create changes** to the cost **baseline**
- Ensuring **requested changes are agreed** upon
- Managing the actual changes when and as they occur
- Assuring that potential **cost overruns do not exceed the authorized funding** periodically and in total for the project

- Monitoring cost performance **to detect and understand variances from the cost baseline**

- Recording all appropriate changes accurately **against the cost baseline**

- **Preventing incorrect, inappropriate, or unapproved changes from being included in the reported cost** or resource usage

- **Informing appropriate stakeholders of approved changes**

- **Acting to bring expected cost overruns within acceptable limits.**

Cost Control: Inputs

1 . Cost Baseline

2 . Project Funding Requirements

3. Performance Reports: Performance reports **provide information on cost and resource performance** as a **result of actual work progress.**

4. Work Performance Information: Work performance information pertaining to the **status and cost of project activities being performed is collected**. This information Includes, but is not limited to:

- **Deliverables that have been completed** and those not yet completed
- **Costs authorized and incurred**
- Estimates to complete the schedule activities
- **Percent physically complete** of the schedule activities.

5. Approved Change Requests

6. Project Management Plan

Cost Control: Tools and Techniques

1. **Cost Change Control System:** A cost change control system, documented in the cost management plan, defines the **procedures by which the cost baseline can be changed**. It includes the **forms, documentation, tracking systems, and approval levels** necessary for authorizing changes.

Cost Control: Tools and Techniques

2. **Performance Measurement Analysis:** Performance measurement techniques help to assess the **magnitude of any variances** that will invariably occur.

   The earned value technique (EVT) compares the value of the **budgeted cost of work performed** (earned) at the original allocated budget amount to both the **budgeted cost of work scheduled** (planned) and to the **actual cost of work performed** (actual). This technique is especially useful for cost control, resource management, and production.

An **important part of cost control is to determine** the **cause of a variance**, the **magnitude** of the variance, and to decide if the variance **requires corrective action.**

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Cost Control Tools and Techniques

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Cost Control: Tools and Techniques

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An **important part of cost control is to determine** the **cause of a variance**, the **magnitude** of the variance, and to decide if the variance **requires corrective action.**

The earned value technique involves developing these key values for each schedule activity, work package, or control account:

- **Planned value (PV):** PV is the **budgeted cost for the work scheduled to be completed** on an activity or WBS component.
- **Earned value (EV):** EV is the **budgeted amount for the work actually completed** on the schedule activity or WBS component.

•**Actual cost (AC):** AC is the **total cost incurred** in accomplishing work on the schedule activity or WBS component. This AC must correspond in definition and coverage to whatever was budgeted for the PV and the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs).

•**Budgeted cost at completion (BAC):** This represents the total budget for a project.

The **PV, EV, and AC** values are used in **combination to provide performance measures** of whether or not work is being **accomplished** as **planned** at any given point in time.

The most commonly used measures are **cost variance (CV) and schedule variance (SV).**

Cost variance (CV): CV equals earned value (EV) minus actual cost (AC). The cost variance at the end of the project will be the **difference between the budget at completion (BAC) and the actual amount spent.**

Formula: CV= EV – AC

• **Schedule variance (SV): SV equals earned value (EV) minus planned value (PV).** Schedule variance **will ultimately equal zero when the project is completed because all of the planned values will have been earned.**

Formula: SV = EV – PV

These two values, the CV and SV, can be **converted to efficiency indicators** to **reflect the cost and schedule performance of any project.**

Cost performance index (CPI): A CPI value less than 1.0 indicates a cost overrun of the estimates. A CPI value greater than 1.0 indicates a **cost underrun** of the estimates.

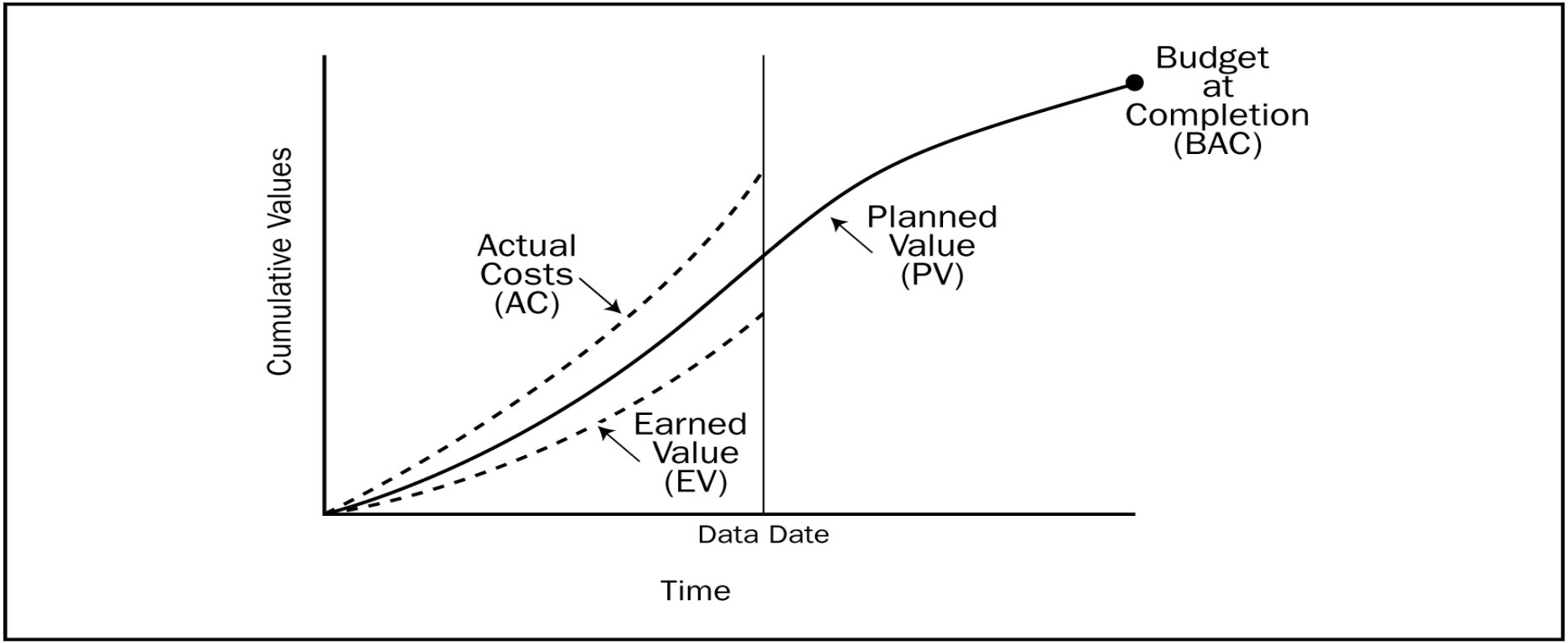
The CPI is the most **commonly used cost-efficiency indicator**.

Formula: **CPI = EV/AC**

Schedule performance index (SPI): The SPI is used, in addition to the schedule status, **to predict the completion date** and **is sometimes used in conjunction with the CPI to forecast the project completion estimates**.

Formula: **SPI = EV/PV**

Figure uses S-curves to display EV data for a project that is over budget and behind the work plan.



Cost Control: Tools and Techniques

3.Forecasting: Forecasting includes **making estimates or predictions of conditions in the project's future based on information** and knowledge available at the time of the forecast.

4.Project Performance Reviews: Performance reviews **compare cost performance over time, schedule activities or work packages overrunning and under running budget** (planned value), **milestones due, and milestones met**.

5. Project Management Software: Project management software, **such as computerized spreadsheets, is often used to monitor PV versus AC,** and to forecast the effects of changes or variances.

6. Variance Management: The cost management plan describes **how cost variances will be managed, for example, having different responses to major or minor problems**. The amount of variance tends to **decrease as more work is accomplished**.

Cost Control: Outputs

1 Cost Estimates (Updates)

2 Cost Baseline (Updates)

3 Performance Measurements

4 Forecasted Completion

5 Requested Changes

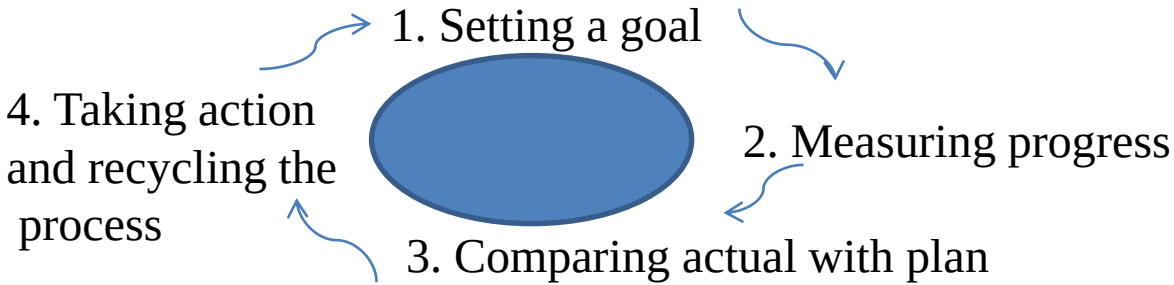
6 Recommended Corrective Actions

7 Organizational Process Assets (Updates)

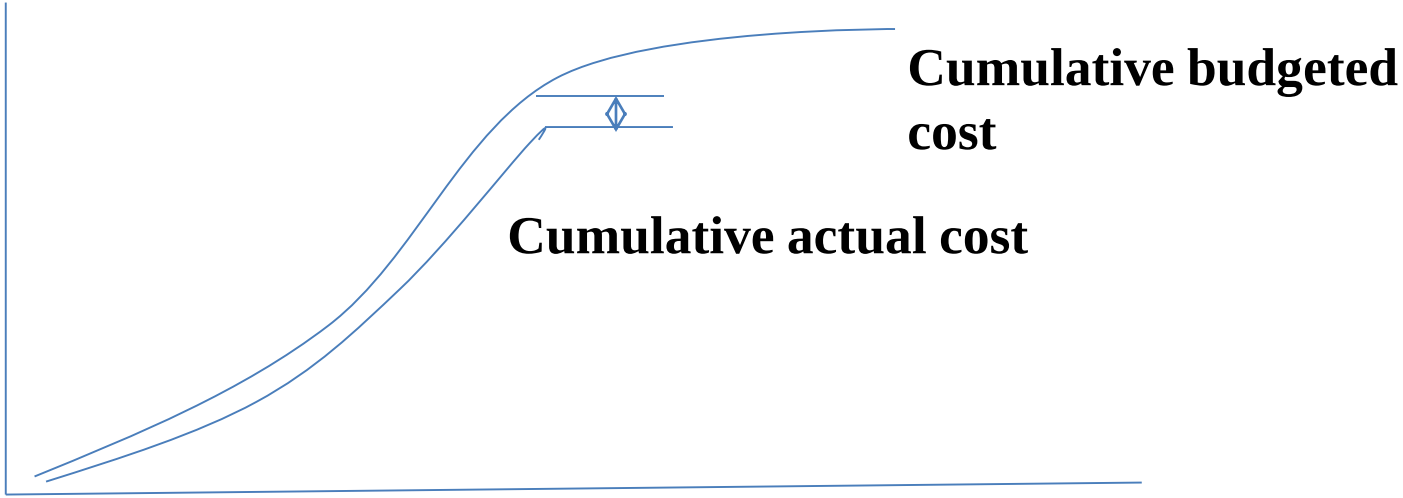
8 Project Management Plan (Updates)

For project control: What information concerning the project should be measured, and when are the best times to measure it.

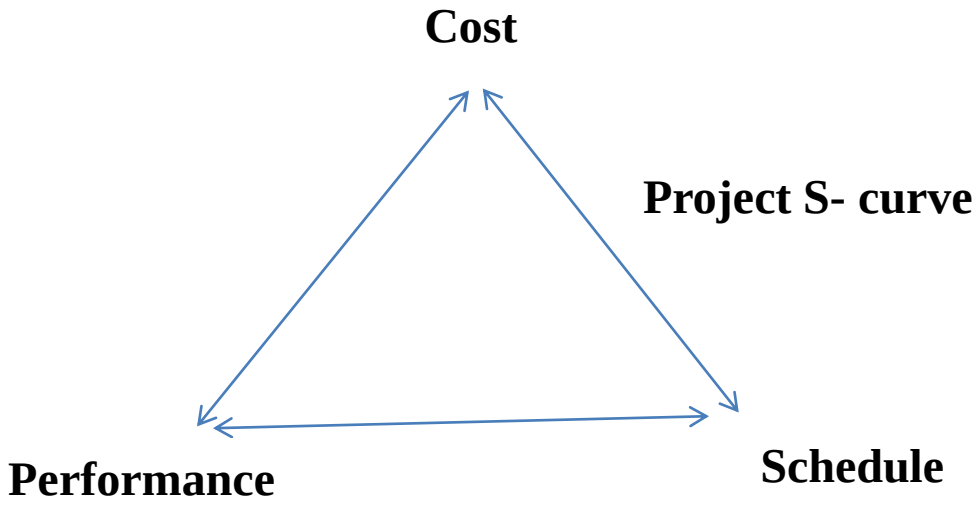
Project Control Cycle : A general model



The project S curve:



S- curve drawback : It does not give cause of variance.



Monitoring Project Performance

Another method of monitoring project progress **is millstone analysis**. **A milestone is an event or stage of the project that represents a significant accomplishment** on the road to the project's completion.

Completion of a deliverable, an **important activity on** the project's critical path, or even a **calendar date** can all be milestones.

They are reactive control system.

The tracking Gantt Chart: Future **projection of project's status** and **reasons of delay are not known** are the drawbacks of this method.

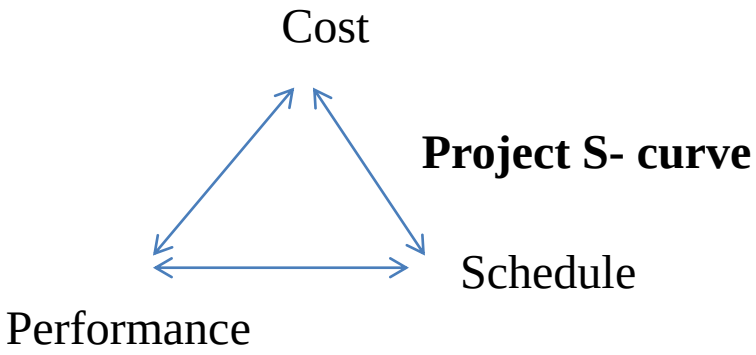
Earned Value Management: Unlike previous project tracking approaches **, EVM recognizes that it is necessary to jointly consider the impact of time, cost,** and **project performance** on any analysis of current project status.

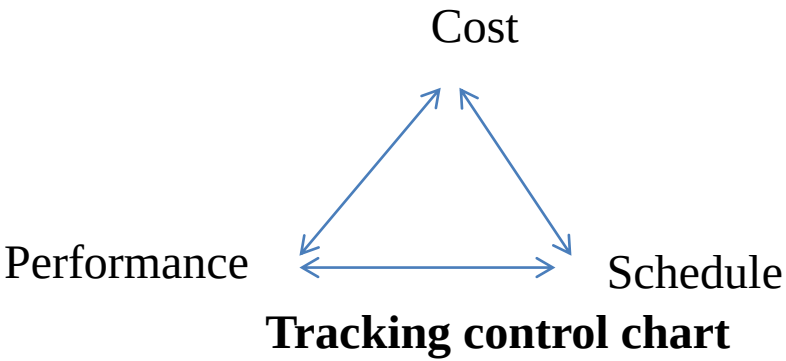
Put another way: Any monitoring system that **only compares actual against budget cost numbers** ignores the fact that the client is spending that money to accomplish something –create a project. Therefore, EVM reintroduces and stresses the importance of **analyzing the time element** in the project status updates.

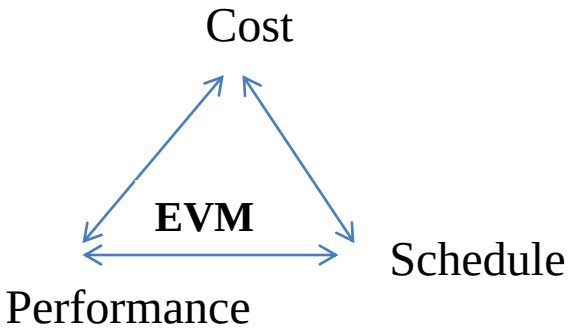
EVM also allows the project team to **make future projections of the project status** based on its current status.

Earned value, directly links **all three project success matrices** (cost, schedule, and performance)

Earned value, directly **links all three project success matrices** (cost, schedule, and performance) . This methodology allows for regular updating of a time phased budget to determine schedule and cost overruns

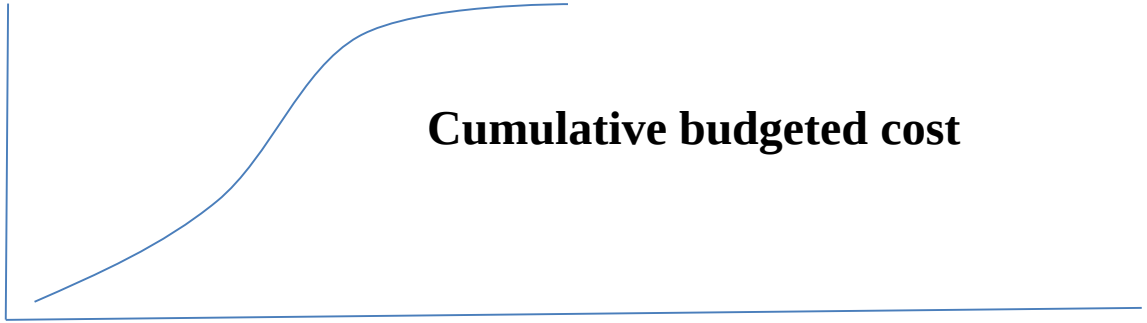






Budgeted cost for a project

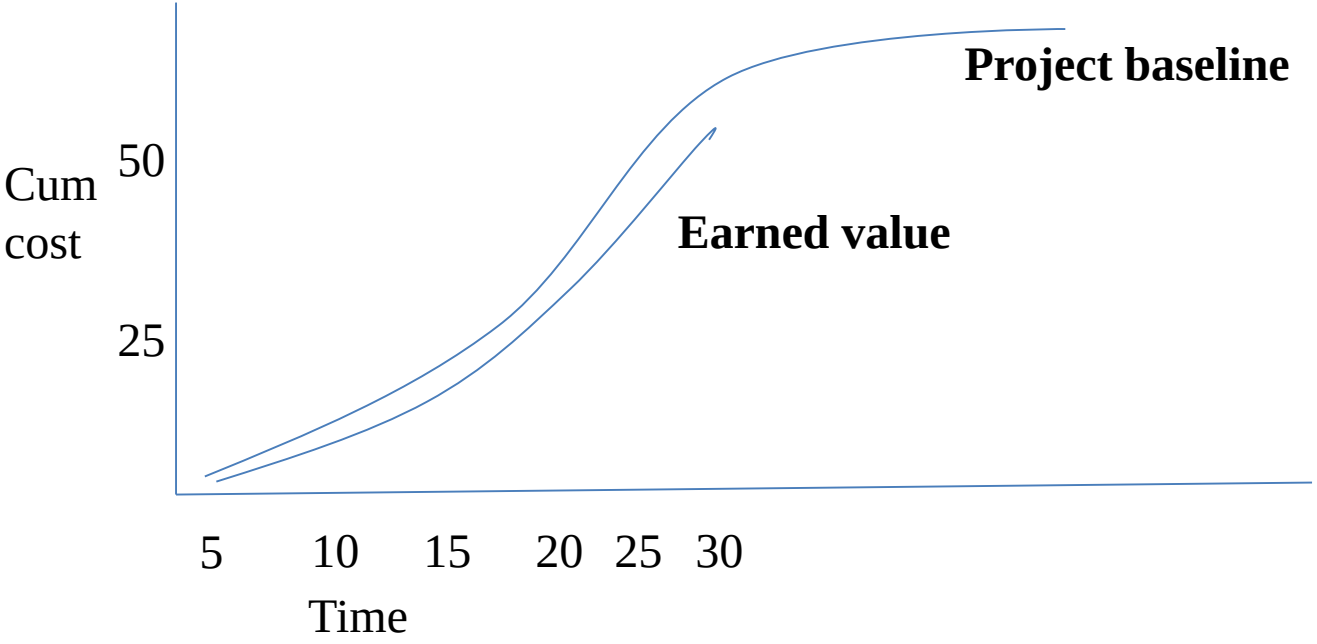
Duration (in weeks)									
	5	10	15	20	25	30	35	40	45
Design	6	2							
Engineering		4	8	8	8				
Installation				4	20	6			
Testing						2	6	4	2
Total	6	6	8	12	28	8	6	4	2
Cumulative	6	12	20	32	60	68	74	78	80



Percentage of tasks completed for above project: Suppose that on 30th week, design and engineering are 100% complete and installation is 50% complete.

Duration (in weeks)										
	5	10	15	20	25	**30**	35	40	45	% completed
Design	6	2								100
Engineering		4	8	8	8					100
Installation				4	20	**6**				50
Testing						**2**	6	4	2	0
Total	6	6	8	12	28	**8**	6	4	2	
Cumulative	6	12	20	32	60	**68**	74	78	80	

Duration (in weeks)			
	Planned	% complete	Earned value
Design	8	100	8
Engineering	28	100	28
Installation	30	50	15
Testing	14	0	0
Cumulative Earned value			51


Project baseline
Earned value
Cum cost
50
25
5
10
15
20
25
30
Time

The project has 8 months schedule and 118 budget. Calculate earned value at the end of June?.

Duration (in weeks)										
	Jan	Feb	Mar	Apr	May	**June**	July	**Plan**	**% Completed**	**Value**
Staffing	8	7						15	100	
Blueprint			4	6				10	80	
Prototype			2	8				10	60	
Full design				3	8	**10**		21	33	
Construction					2	**30**		32	25	
Transfer							10	10	0	
Punch list						**15**	5	20	0	
								∑ 118		
Monthly plan	8	7	6	17	10	**55**	15			
Monthly actual	8	11	8	11	10	**30**	0			

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	Jan	Feb	Mar	Apr	May	**June**	July	**Plan**	**% Completed**	**Value**
Staffing	8	7						15	100	15
Blueprint			4	6				10	80	8
Prototype			2	8				10	60	6
Full design				3	8	**10**		21	33	7
Construction					2	**30**		32	25	8
Transfer							10	10	0	0
Punch list						**15**	5	20	0	0
								∑ 118		**44**
Monthly plan	8	7	6	17	10	**55**	15			
Cumulative	8	15	21	38	48	**103**	118			
Monthly actual	8	11	8	11	10	**30**	0			
Cumulative actual	8	19	27	38	48	**78**				

Total planned budget is 118 and the value realized is 44.

Schedule variances	
Planned value (PV)	103
Earned value(EV)	44
Schedule performance index (SPI)	EV/PV =.43
Estimated time to completion	1/ (.43) * (8)=**18.60,** We are running 10 months behind schedule

Cost variances	
Actual cost of work performed (AC)	78
Earned value (EV)	44
Cost performance index (CPI)	EV/AC = .56
Estimated cost to completion	1/(.56) * 118=210

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Cost Estimation

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Cost management is extremely important for running successful projects. The management of costs, in many ways, reflects the project origination's strategic goals, mission statement, and business plan.

Some of the common sources of costs

Labor

Material

Subcontractors

Equipment and facilities

Travel

Common classification of costs

Direct and indirect (overhead costs; depreciation, health and retirements benefits, selling and general administrative expenses)

Recurring (labor, logistic, material, etc.) **and non recurring** (charges applied **once** at the beginning or end or project)

Fixed (when leasing capital equipment or other project hardware, the leasing price is likely **not to go up or down** with the amount of uses) **and Variable** (Metal cutting operation)

Normal and expedited

Costs	Type		Frequency		Adjustment		Schedule	
	Direct	Indirect	Recurring	Non-recurring	Fixed	Variable	Normal	Expedited
Direct labor								
Building lease								
Expedite costs								
Material								

Costs	Type		Frequency		Adjustment		Schedule	
	Direct	Indirect	Recurring	Non-recurring	Fixed	Variable	Normal	Expedited
Direct labor	x		x		x		x	
Building lease		x	x		x		x	
Expedite costs	x			x		x		x
Material	x		x			x	x	

Learning Curves in Cost Estimation

Let us assume, for example, **that the time necessary to code a particular software routine is estimated at 20 Hrs** of work for the first iteration. Doing the coding work **a second time requires only 15 hrs**. The **learning ratio** is 15/20 = **75%**. We can now apply that figure to estimates of cost for additional coding iterations.

When the output is doubled from the first two routines to the required four, the time needed to complete the exercise is now estimated to take

15*0.75 = 11.25 hrs.

Learning curves in cost estimation

These **time and cost estimates** follow a well defined formula, which is the time required to produce a unit of output, and is represented as:

$Yx = a\ (X)^b$

Where

Yx= Time required for x unit of output

a=the time required for the initial unit of out put

X =the number of units to be produced

b=the slope of the learning curve, represented as: **log decimal learning rate /log2**

Example: Worker must do 15 of these activities (fitting, riveting, and squaring). Also assume that the time estimated to perform the last iteration (steady state) is 1 hr., and we know from past experience the learning rate of this activity is 0.60.

In calculation the time necessary to complete the first activity , we would apply the above values to the formula to determine the value of “a”,.??????????????????????

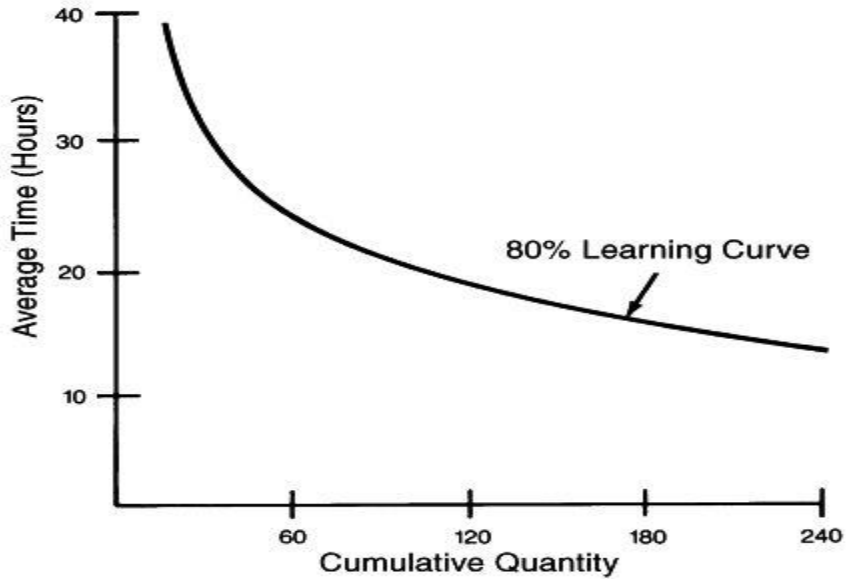
Example: Worker must do 15 of these activities (fitting, riveting, and squaring). Also assume that the time estimated to perform the last iteration (steady state) is 1 hr., and we know from past experience the learning rate of this activity is 0.60.

In calculation the time necessary to complete the first activity , we would apply the above values to the formula to determine the value of “a”,.

b=log 0.60/log2
= -0.5108/0.693
= -0.737

1 hr = $a(15)^{-0.737}$
a = 7.358 hrs.

Learning curves in cost estimation: As can be seen, as production quantities double, the average time per unit decreases by 20% of its immediate previous time.



Sample project budget

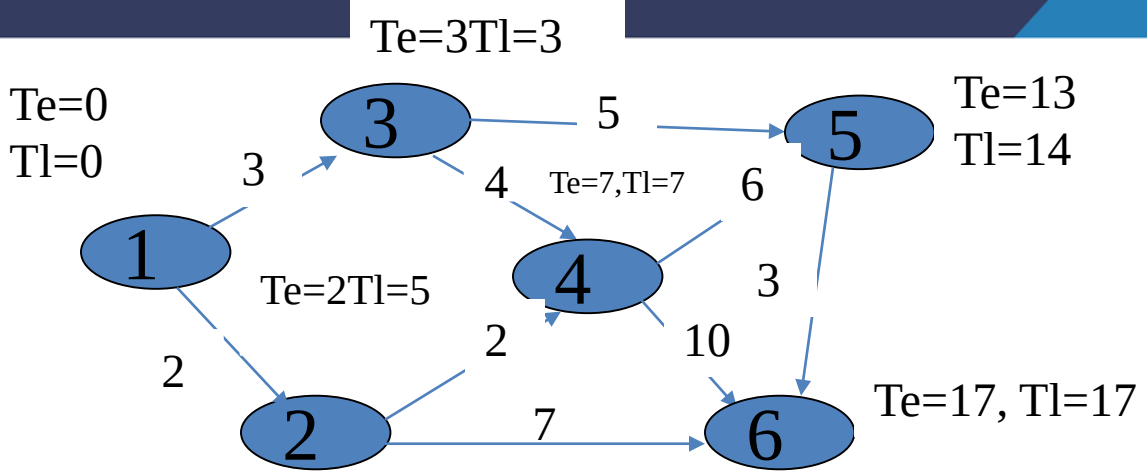
Activity	DC	Budget overhead	Total cost
Survey	3500	500	4000
Design	7000	1000	8000
Clear site	3500	500	4000
Foundation	6750	750	7500
Framing	8000	2000	10000
Plumb and wire	3750	1250	5000

Sample budget tacking planned and actual activity costs.

	Budget		
Activity	**Planned**	**Actual**	**variance**
Survey	4000	4250	250
Design	8000	8000	0
Clear site	4000	3500	-500
Foundation	7500	8500	1000
Framing	10000	11250	1250
Plumb and wire	5000	5150	150
Total	38500	40650	2150

Example of time phased budget

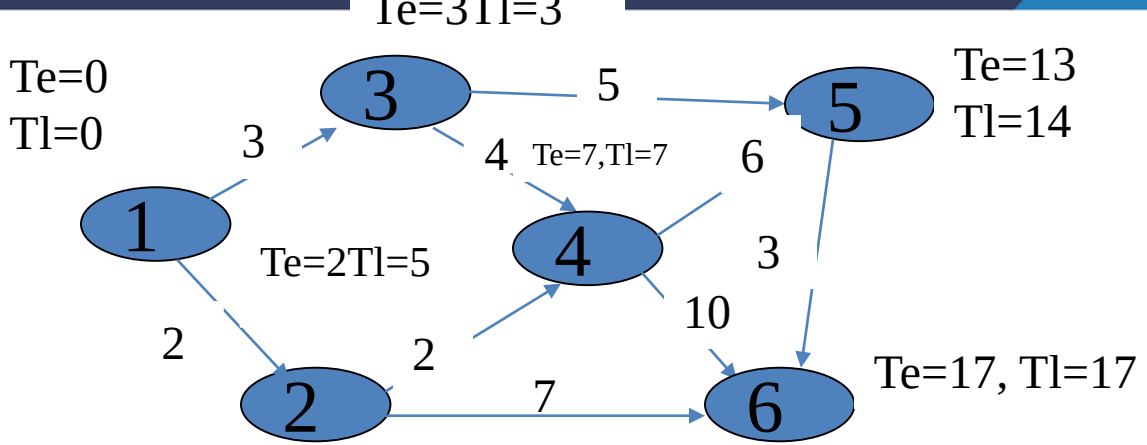
Month						
Activity	**Jan**	**Feb**	**March**	**April**	**May**	**Total by activity**
Survey	4000					**4000**
Design		5000	3000			**8000**
Clear site		4000				**4000**
Foundation			7500			**7500**
Framing				8000	2000	**10000**
Plumb and wire				1000	4000	**5000**
Monthly planned	4000	9000	10500	9000	6000	
Cumulative	4000	13000	23500	32500	38500	**38500**



Find cumulative cost by considering earliest start solution.

Activity	Duration (months)	ESij	LSij	Total cost (Rs 100)	Cost per month
1-2	2	0	3	1200	600
1-3	3	0	0	900	300
2-4	2	2	5	0	0
2-6	7	2	10	2800	400
3-4	5	3	3	2000	400
3-5	5	3	9	2000	400
4-5	6	7	8	3000	500
4-6	10	7	7	8000	800
5-6	3	13	14	2100	700

Day	1-2	1-3	2-4	2-6	3-4	3-5	4-5	4-6	5-6	Cum Cost
1	600	300								900
2	600	300								1800
3		300	0	400						2500
4			0	400	500	400				3800
5				400	500	400				5100
6				400	500	400				6400
7				400	500	400				7700
8				400		400	500	800		9800
9				400			500	800		11500
10							500	800		12800
11							500	800		14100
12							500	800		15400
13							500	800		16700
14								800	700	18200
15								800	700	19700
16								800	700	21200
17								800		22000

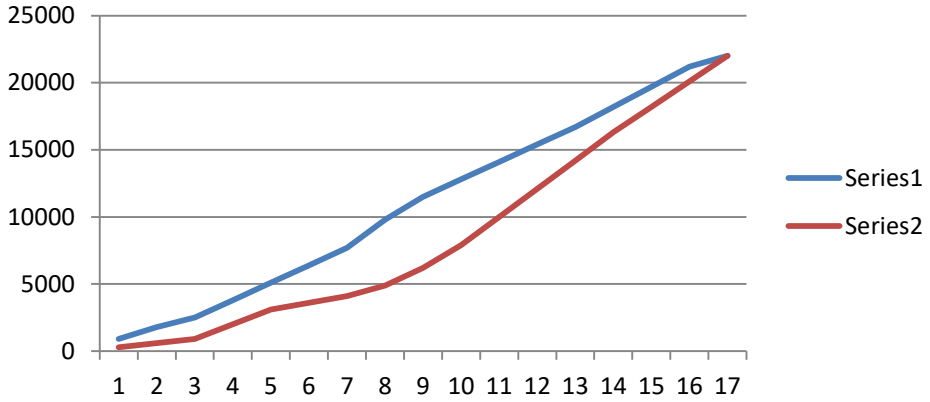


Find cumulative cost by considering latest start solution.

Activity	Duration	Esij	LSij	Total cost (Rs 100)	Cost per month
1-2	2	0	3	1200	600
1-3	3	0	0	900	300
2-4	2	2	5	0	0
2-6	7	2	10	2800	400
3-4	5	3	3	2000	400
3-5	5	3	9	2000	400
4-5	6	7	8	3000	500
4-6	10	7	7	8000	800
5-6	3	13	14	2100	700

Day	1-2	1-3	2-4	2-6	3-4	3-5	4-5	4-6	5-6	Cum Cost
1		300								300
2		300								600
3		300								900
4	600				500					2000
5	600				500					3100
6			0		500					3600
7			0		500					4100
8								800		4900
9							500	800		6200
10						400	500	800		7900
11				400		400	500	800		10000
12				400		400	500	800		12100
13				400		400	500	800		14200
14				400		400	500	800		16300
15				400				800	700	18200
16				400				800	700	20100
17				400				800	700	22000

Te	Tl
900	**300**
1800	600
2500	900
3800	2000
5100	3100
6400	3600
7700	4100
9800	4900
11500	6200
12800	7900
14100	10000
15400	12100
16700	14200
18200	16300
19700	18200
21200	20100
22000	22000



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Project Management for Managers

Lec – 55

Introduction to Quality Management

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Sugarcane extraction gears

Wrist watch gears

Airplane gears

Taguchi ????

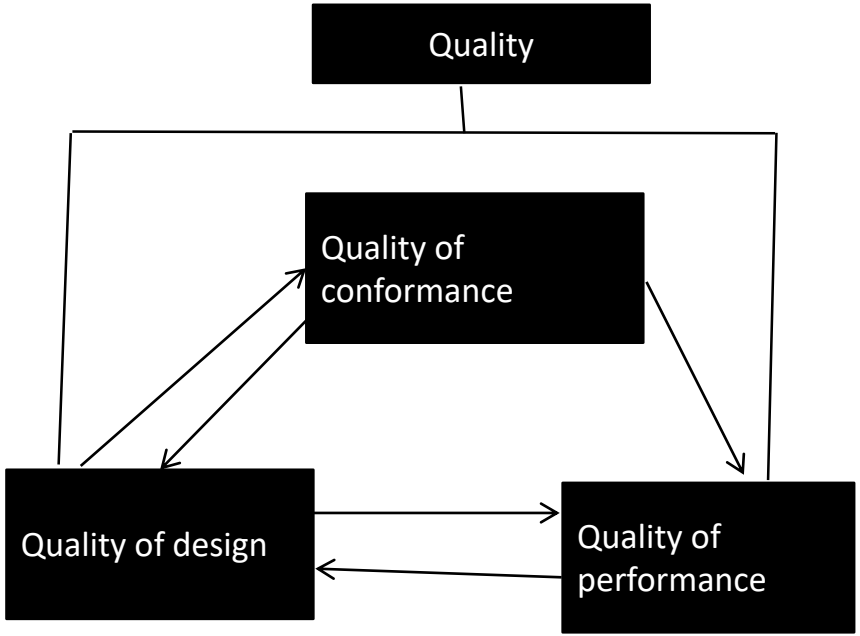
$$\text{Quality } \alpha \ \frac{1}{\text{Variability}}$$

Dimensions of Quality

- Performance (P-Power, S/N ratio, S- Time to process a/c)
- Reliability (P-MTTF, S-Variability of time to process req.)
- Durability (P-Useful life with repairs, S-Pace with technology)
- Serviceability (how easy to repair)
- Aesthetics
- Features
- Perceived Quality (reputation of the company)
- Conformance to standards (Design)

How to remember ????

The Three aspects of quality



There are several **reasons** why the cost of quality should be **explicitly** considered in an organization.

1. The **increase** in the **cost** of quality because of the increase in the **complexity** of manufactured products associated with advances in technology.
2. Increasing awareness of life cycle costs, including **maintenance, spare parts,** and the cost of field failures.
3. Quality **engineers** and **managers** can most effectively communicate quality issues in a way that **management** understands.

Prevention costs: Prevention of non conformity

1. Quality planning and engineering
2. New products review
3. Product or process review
4. Process control
5. Burn-in: The cost of pre-shipment operation of the product to prevent early-life failures in the field.
6. Training
7. Quality data acquisition and analysis

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Project Management for Managers

Lec – 56

Cost of Quality

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Appraisal Costs: Costs associated with measuring, evaluating or auditing products, components and purchased materials to ensure conformance to the standards that have been imposed.

1. Inspection and test of incoming material
2. Product inspection and test
3. Materials and services consumed
4. Maintaining accuracy of test equipment

Internal Failure Costs: Internal failure costs are incurred when products, components, materials and services **fail to meet** quality requirements and the failure is discovered **prior to delivery** of the product to customer.

1. Scrap
2. Rework
3. Retest
4. Failure analysis
5. Down time
6. Yield losses
7. Downgrading (off-specing): Price difference

External Failure Costs: External failure costs occur when the product does not perform satisfactory after it is delivered to the customer.

1.Complaint adjustment

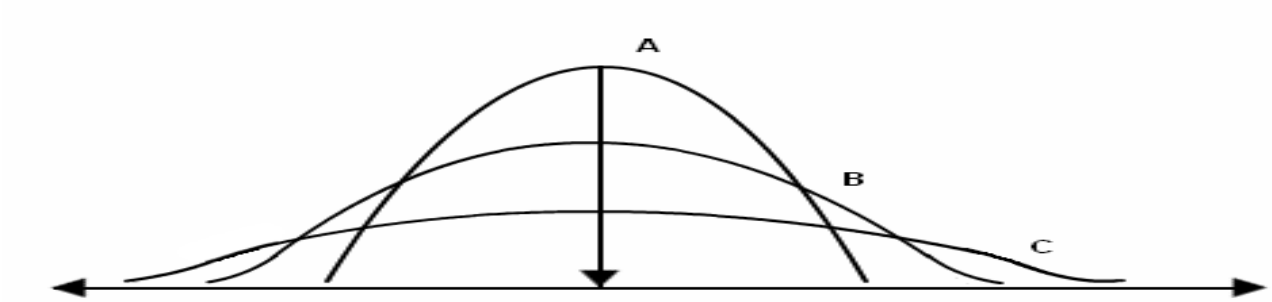
2. Returned product/material

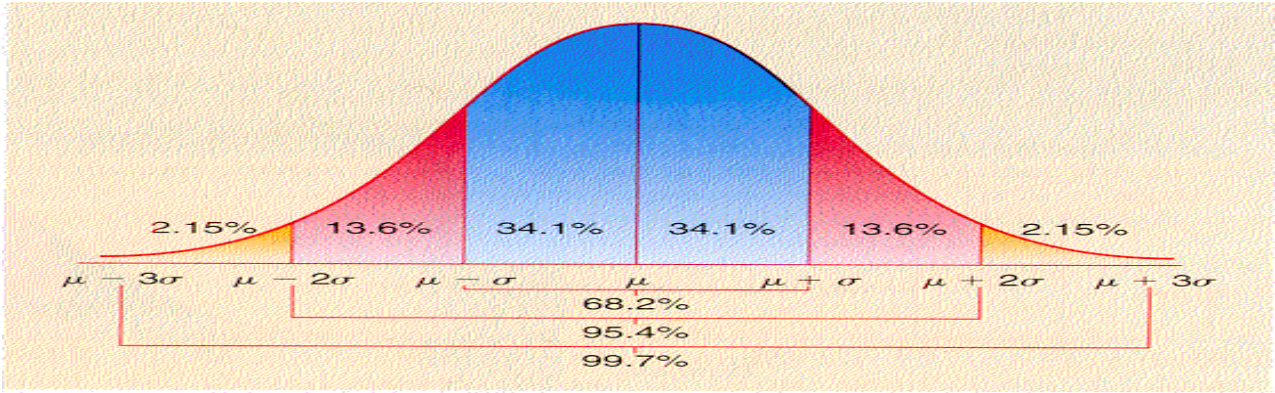
3. Warranty charges

4. Liability costs or awards incurred from product liability litigation.

5. Indirect costs: These are incurred because of customer dissatisfaction with the level of quality of delivered product.

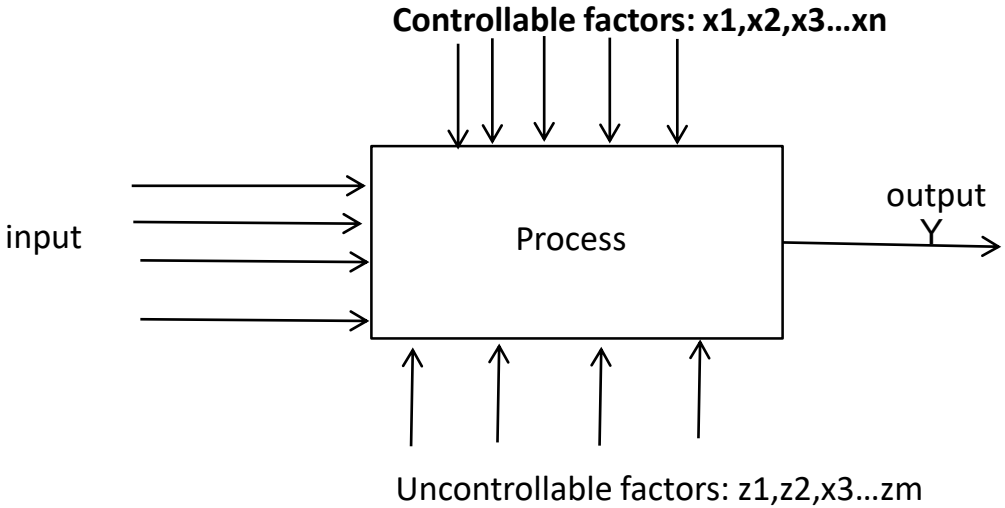
What is variability?





How to measure it : σ

Sources of variability



How to remove variability?

- Determine which variables (x's) are most influential on the response, y
- Determine where to set the influential x's so that y is near the nominal requirement
- Determine where to set the influential x's so that variability is small
- Determine where to set the influential x's so that the effects of the uncontrollable variables z are minimized

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Sources of Variability and Six Sigma

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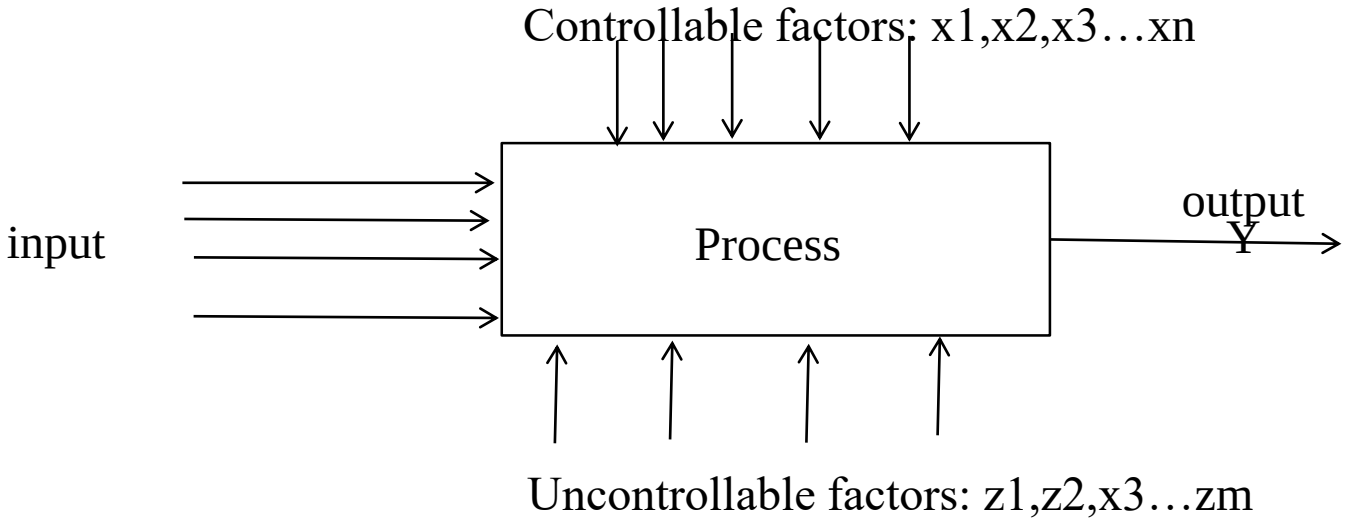
Sources of variability



How to remove variability?

- Determine which **variables** (x's) are most **influential** on the response, y
- Determine where **to set** the influential x's so that y is near the nominal requirement
- Determine where to set the influential x's so that **variability** is **small**
- Determine where to set the influential x's so that the effects of the **uncontrollable variables "z" are minimized**

Number of confirming products at 3 σ : 99.73

Ex. A product consists of 100 parts assembly, the probability that any specific unit of product is confirming.

Ex. A product consists of 100 parts assembly, the probability that any specific unit of product is confirming.

Solution: $(0.9973)^{100} = 0.7631 = 76.31\%$

If we go by 3 sigma:

20,000 wrong drug prescription each year.

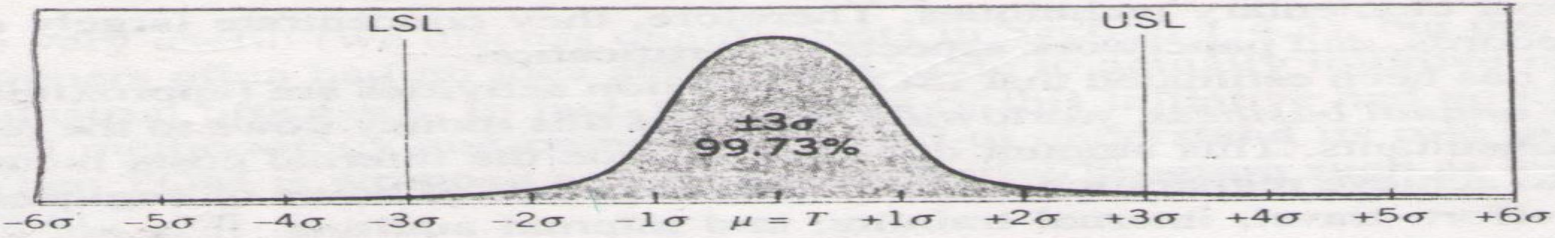
More than 15,000 babies accidently dropped by nurses and doctors each year.

500 incorrect surgical operations per week.

2000 lost pieces of mail each hour.

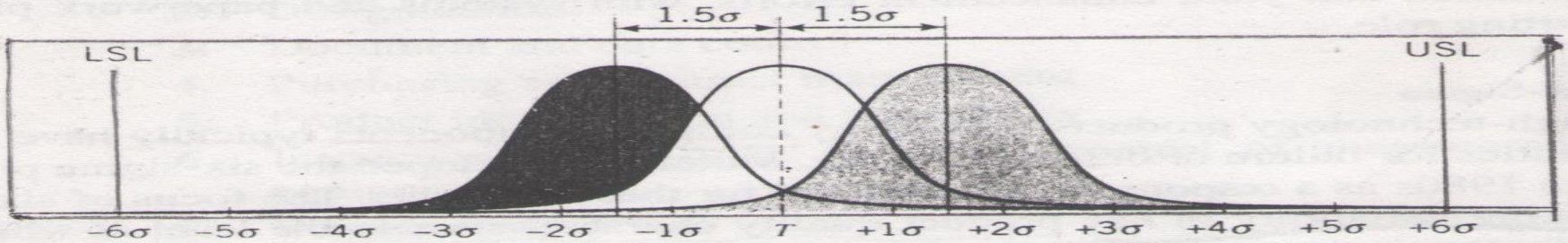
Six Sigma

The Motorola SS concept is to reduce the **variability** in the process so that specific limits are **six standard deviations away from the mean.**



Spec. Limit	Percent Inside Specs	ppm Defective
±1 Sigma	68.27	317300
±2 Sigma	95.45	45500
±3 Sigma	99.73	2700
±4 Sigma	99.9937	63
±5 Sigma	99.999943	0.57
±6 Sigma	99.9999998	0.002

(*a*) Normal distribution centered at the target (*T*)



Spec. Limit	Percent Inside Specs	ppm Defective
±1 Sigma	30.23	697700
±2 Sigma	69.13	608700
±3 Sigma	93.32	66810
±4 Sigma	99.3790	6210
±5 Sigma	99.97670	233
±6 Sigma	99.999660	3.4

(*b*) Normal distribution with the mean shifted by 1.5σ from the target

The Motorola six-sigma concept.

Deming's PDCA cycle

Six Sigma Process

Six Sigma Quality

$\pm 3\sigma$

- A philosophy and set of methods companies use to eliminate defects in their products and processes
- Seeks to reduce variation in the processes that lead to product defects
- The name, “six sigma” refers to the variation that exists within plus or minus three standard deviations of the process outputs

Six Sigma Quality (Continued)

- **Six Sigma allows managers to readily describe process performance using a common metric: Defects Per Million Opportunities (DPMO)**

$$DPMO = \frac{\text{Number of defects}}{\left[\begin{array}{l}\text{Number of}\\ \text{opportunities}\\ \text{for error per}\\ \text{unit}\end{array}\right] \times \text{No. of units}} \times 1{,}000{,}000$$

Six Sigma Quality (Continued)

Example of Defects Per Million Opportunities (DPMO) calculation.

Suppose we observe 200 letters delivered incorrectly to the wrong addresses in a small city during a single day when a total of 200,000 letters were delivered. What is the DPMO in this situation?

Six Sigma Quality (Continued)

Example of Defects Per Million Opportunities (DPMO) calculation. Suppose we observe 200 letters delivered incorrectly to the wrong addresses in a small city during a single day when a total of 200,000 letters were delivered. What is the DPMO in this situation?

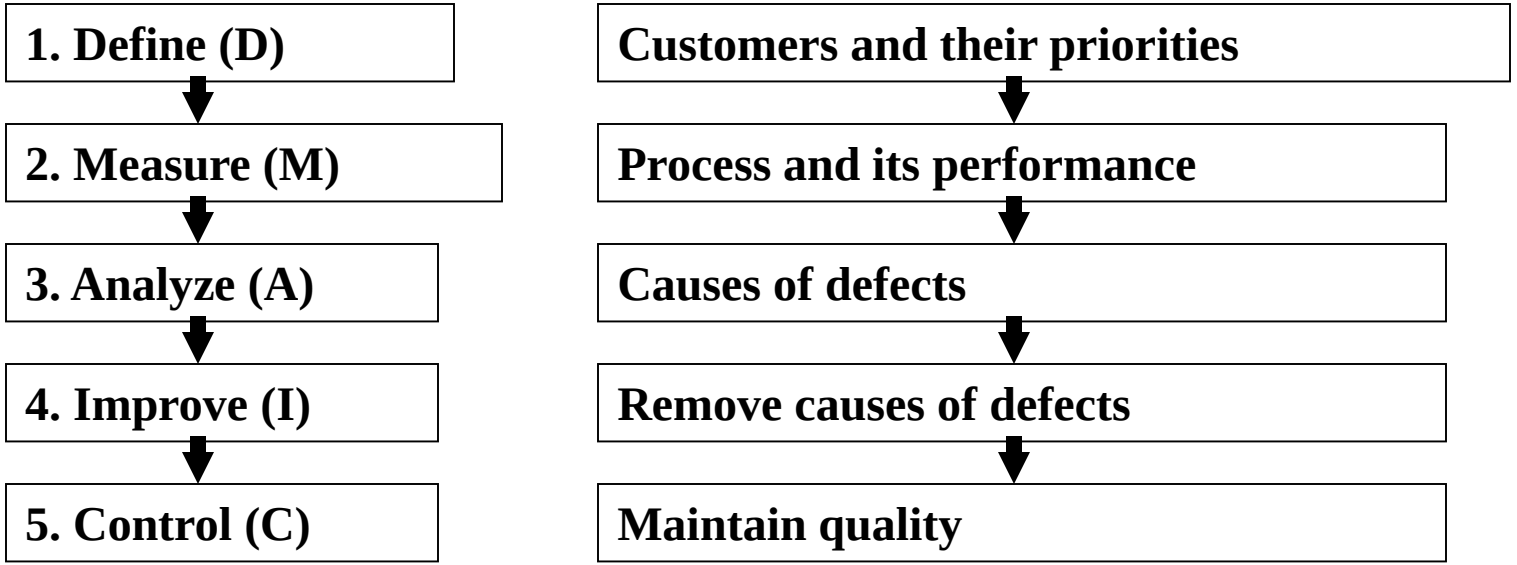
$$DPMO = \frac{200}{[1]\ x200{,}000} x1{,}000{,}000 = 1{,}000$$

So, for every one million letters delivered this city's postal managers can expect to have 1,000 letters incorrectly sent to the wrong address.

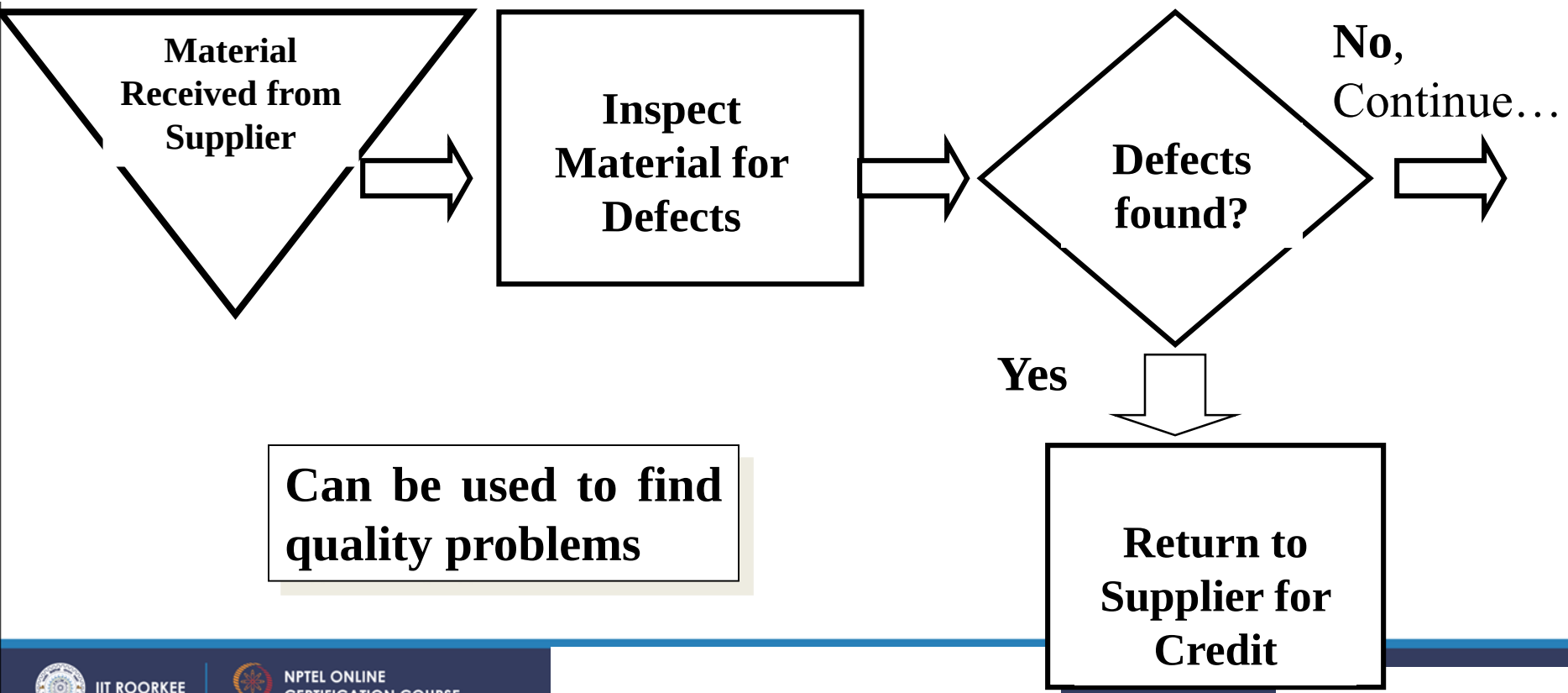
Six Sigma Quality: DMAIC Cycle

- **Define, Measure, Analyze, Improve, and Control (DMAIC)**
- **Developed by General Electric as a means of focusing effort on quality using a methodological approach**
- **Overall focus of the methodology is to understand and achieve what the customer wants**
- **DMAIC consists of five steps….**

Six Sigma Quality: DMAIC Cycle (Continued)

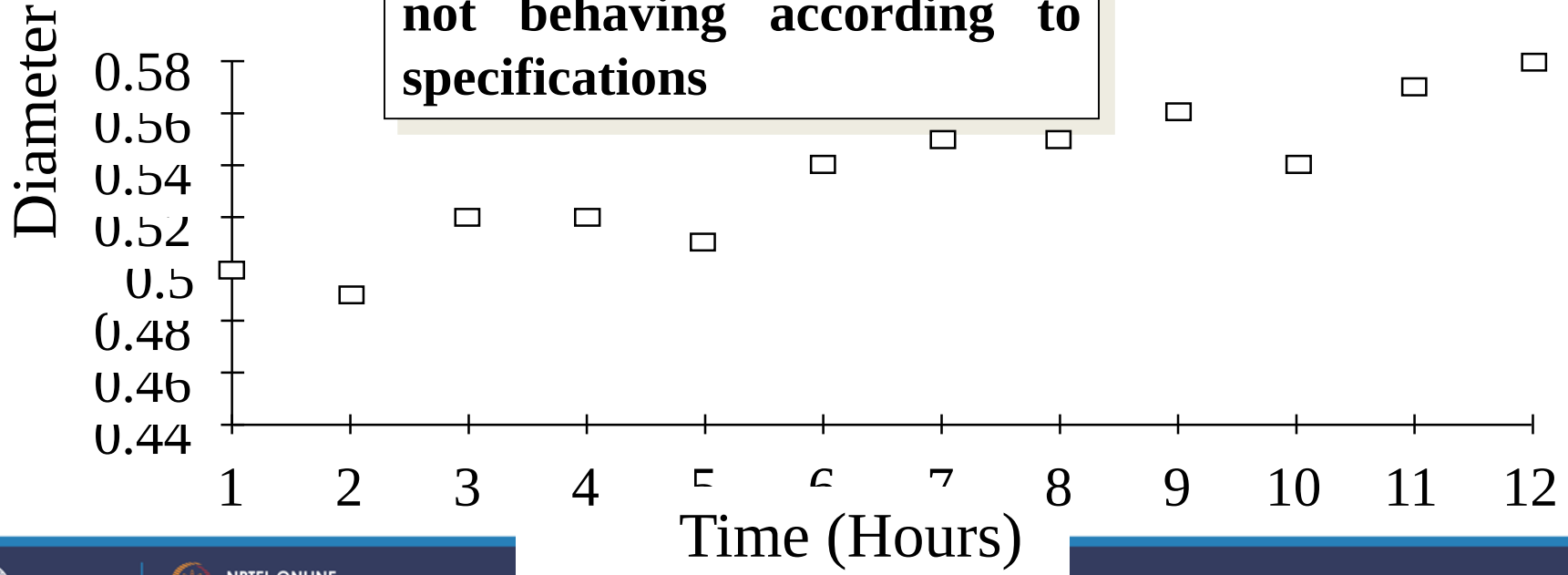


Analytical Tools for Six Sigma and Continuous Improvement: Flow Chart



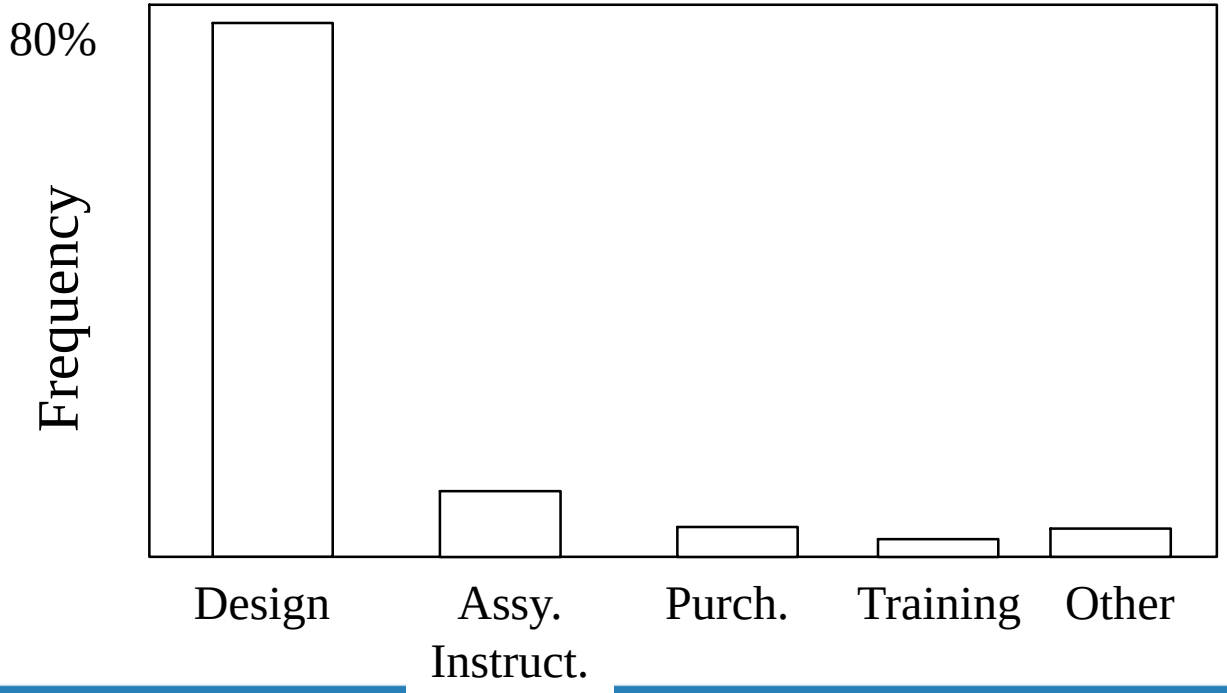
Analytical Tools for Six Sigma and Continuous Improvement: Run Chart

Can be used to identify when equipment or processes are not behaving according to specifications



Analytical Tools for Six Sigma and Continuous Improvement: Pareto Analysis

Can be used to find when 80% of the problems may be attributed to 20% of the causes



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Lec – 58

Six Sigma Tools

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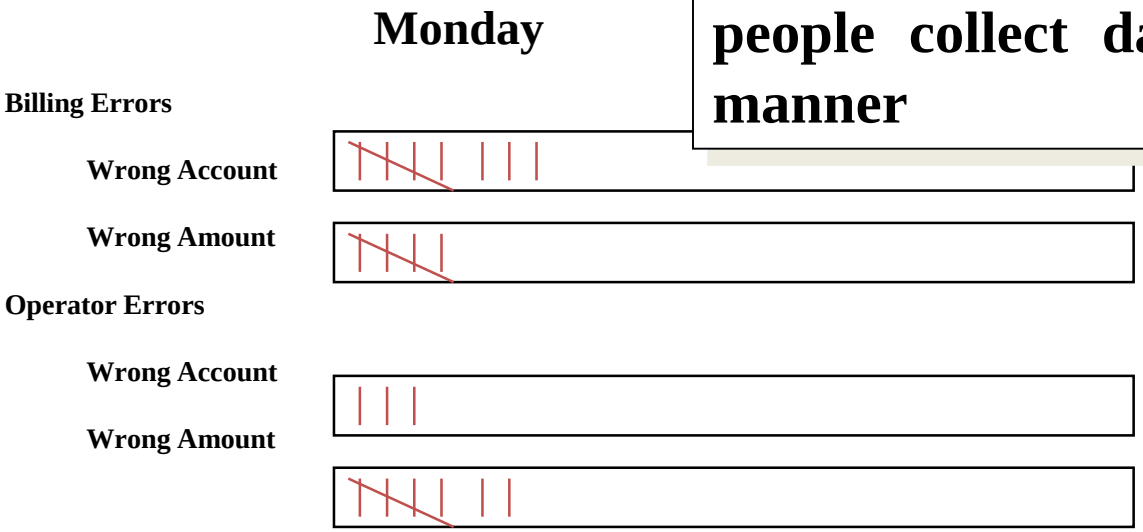
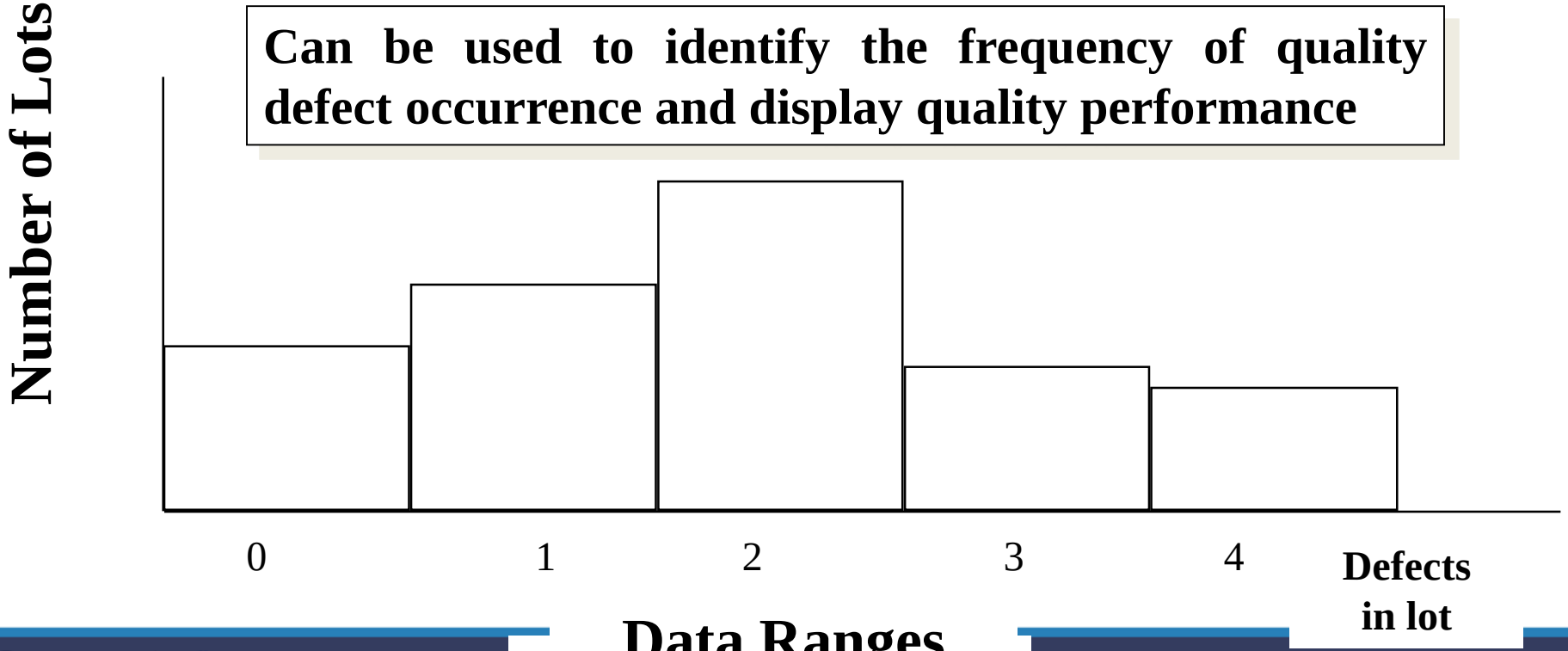
Analytical Tools for Six Sigma and Continuous Improvement: Checksheet

Can be used to keep track of defects or used to make sure people collect data in a correct manner



Analytical Tools for Six Sigma and Continuous Improvement: Histogram

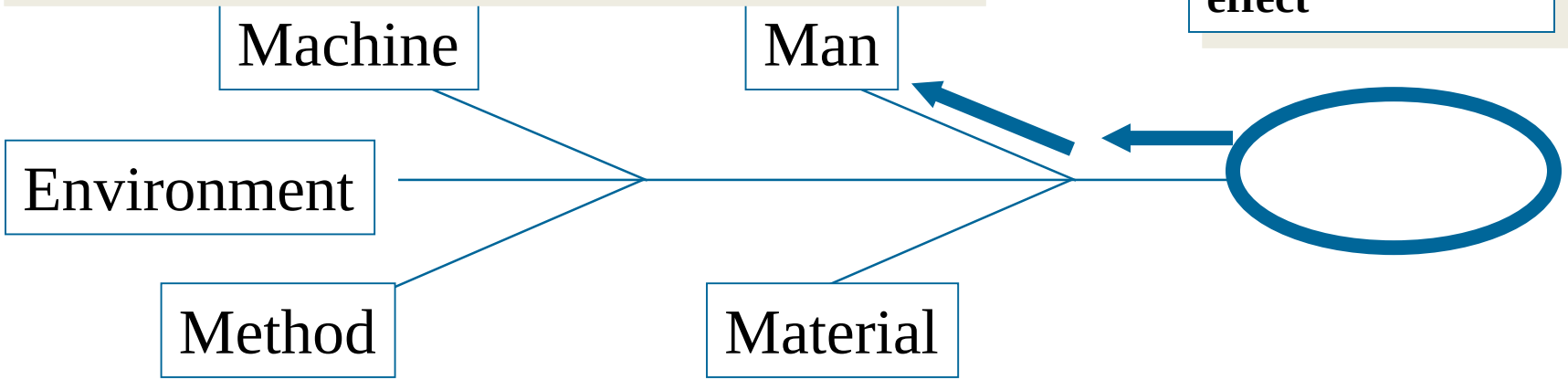
Can be used to identify the frequency of quality defect occurrence and display quality performance



Analytical Tools for Six Sigma and Continuous Improvement: Cause & Effect Diagram

Possible causes:

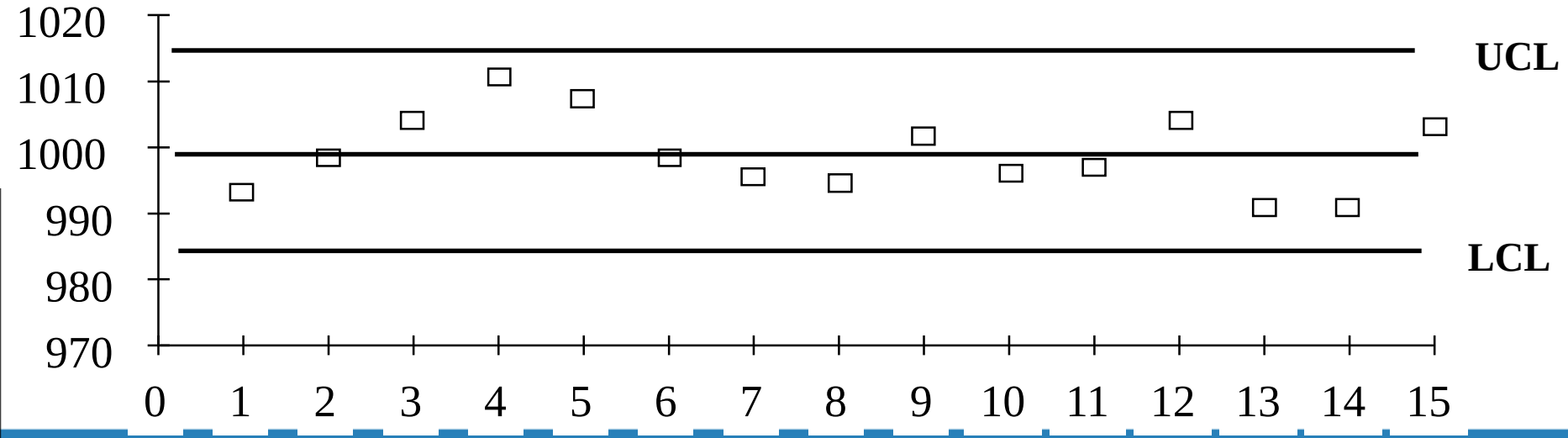
The results or effect



Can be used to systematically track backwards to find a possible cause of a quality problem (or effect)

Analytical Tools for Six Sigma and Continuous Improvement: Control Charts

Can be used to monitor ongoing production process quality and quality conformance to stated standards of quality



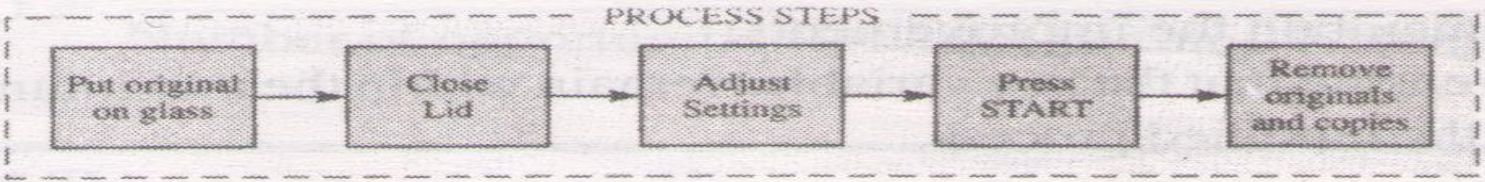
Other Six Sigma Tools

- Opportunity Flow Diagram used to graphically show those activities that add value from those that are performed (and maybe could be reduced or removed) that do not add value to the finished product
- Failure Mode and Effect Analysis (FMEA) is a structured approach to identify, estimate, prioritize, and evaluate risk of possible failures at each stage in the process
- Design of Experiments (DOE) a statistical test to determine cause-and-effect relationships between process variables and output

Define

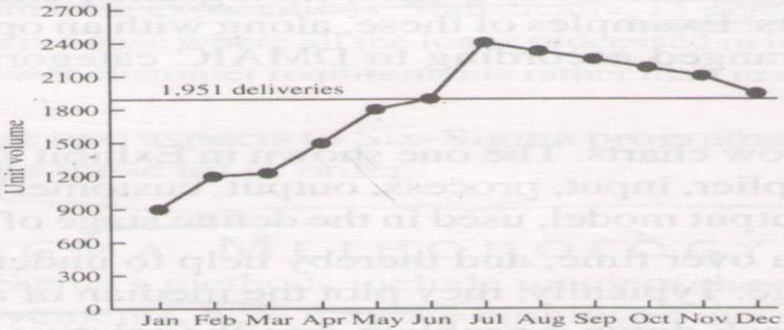
Flow Chart of Major Steps in a Process*

SUPPLIERS	INPUTS	PROCESSES	OUTPUTS	CUSTOMERS
Manufacturer	Copier		Copies	You
Office Supply Company	Paper			File
	Toner	Making a Photocopy		Others
Yourself	Original			
Power Company	Electricity			



Run Chart**

Average monthly volume of deliveries
(per shop)



DATA COLLECTION FORMS*

Checksheets are basic forms that help standardize data collection by providing specific spaces where people should record data.

Defines what data are being collected → **Machine Downtime (Line 13)**

Operator: Wendy Date: May 19

Reason	Frequency	Comments
Carton Transport	𝍸 𝍸 II	
Metal Check	IIII	
No Product	𝍸 I	
Sealing Unit	II	
Barcoding	III	
Conveyor Belt		
Bad Product	𝍸	Burned flakes III Low weight II
Other	II	

Lists the characteristics or conditions of interest

Includes place to put the data

May want to add space for tracking stratification factors

Has room for comments

Measure

Pareto Chart**

Types of customer complaints
Total = 2520 October—December
(across 6 shops)

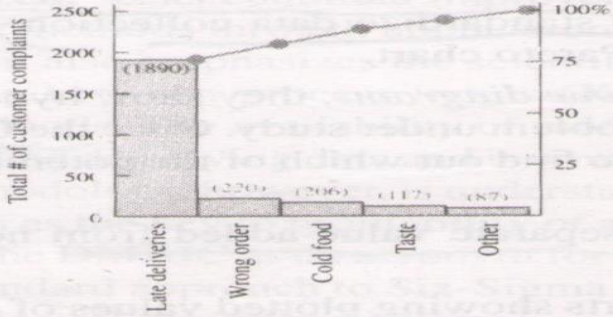
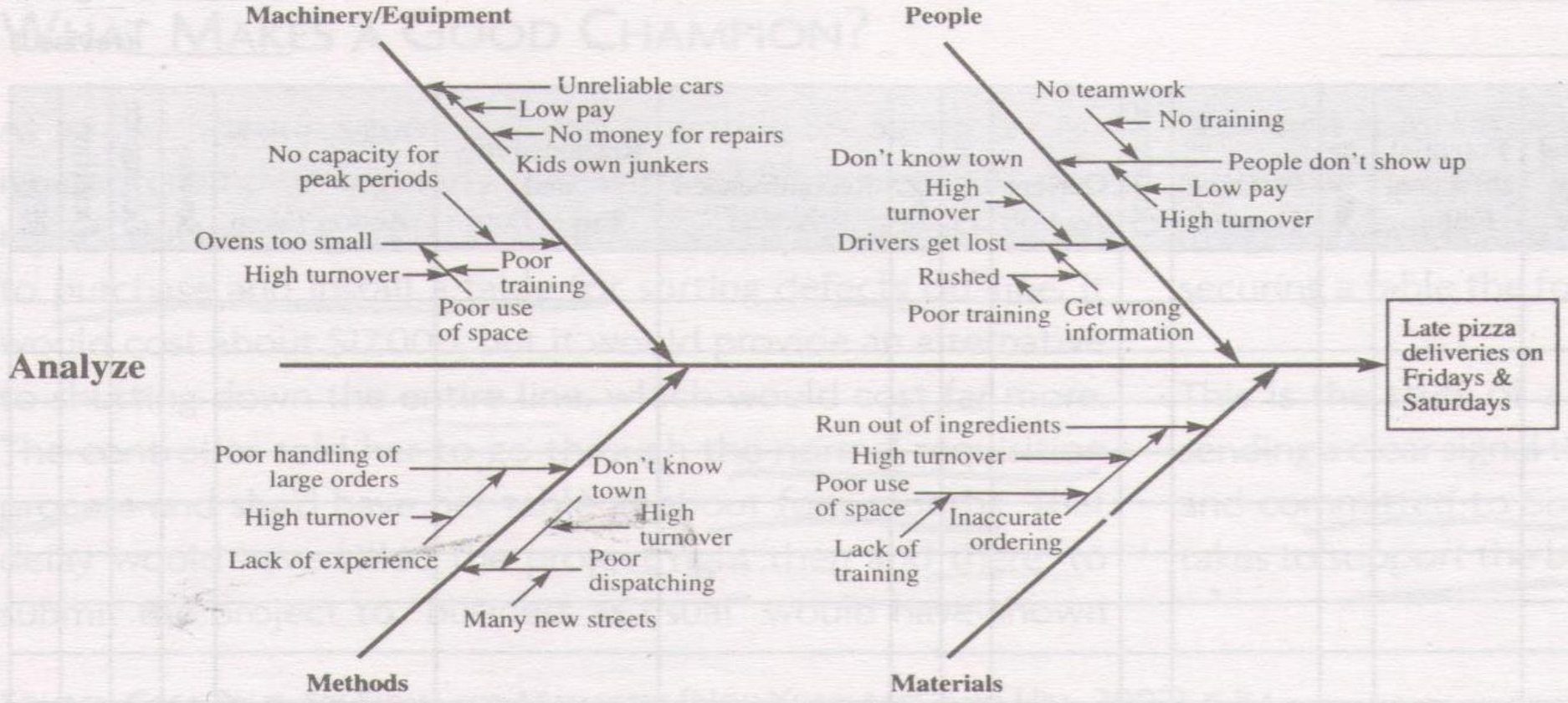


Illustration note: Delivery time was defined by the total time from when the order was placed to when the customer received it.

C & E/Fishbone Diagram**

Reasons for late pizza deliveries



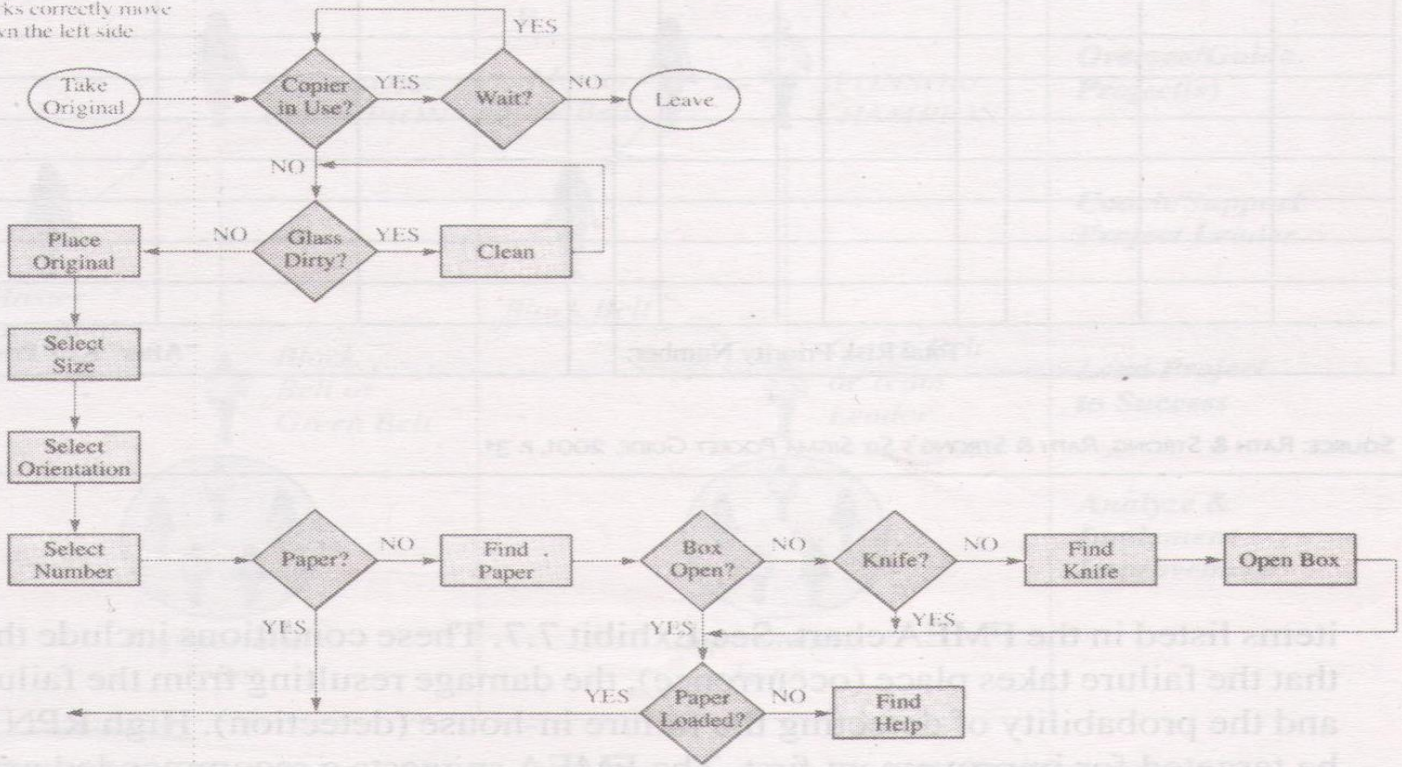
Opportunity Flow Diagram*

Organized to separate value-added steps from non-value-added steps.

Value-Added
Steps that are essential even when everything works correctly move down the left side

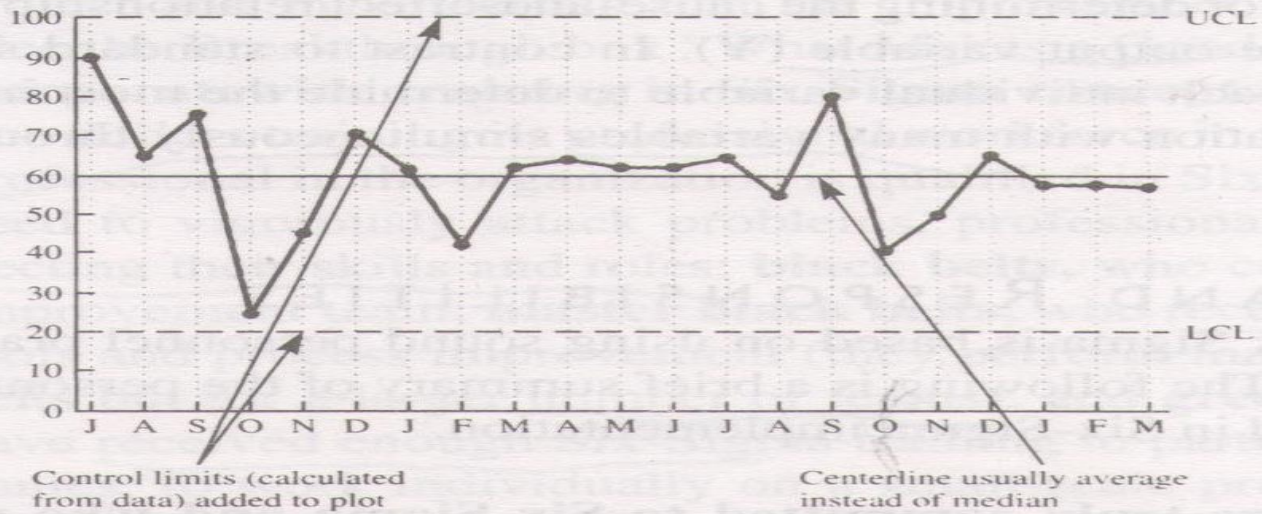
Non-Value-Added
Steps that would not be needed if everything worked right the first time move horizontally across the right side

Improve



Control Chart Features*

Basic features same as a time plot



Control

Six Sigma Roles and Responsibilities

1. Executive leaders must champion the process of improvement: Executives and managers
2. Corporation-wide training in Six Sigma concepts and tools

   Black belt: who coach or leads SS improvement team

   Master black belt: Who receive in depth training on statistical tools process improvement(larger teams)

Green belt: who have received enough SS training to participate in a team or, in some companies, to work individually on a small scale project related to their own jobs.

3.Setting stretch objectives for improvement

4. Continuous reinforcement and rewards

The Shingo System: Fail-Safe Design

- **Shingo's argument:(Successive, self, source checks)**
  - **SQC methods do not prevent defects**
  - **Defects arise when people make errors**
  - **Defects can be prevented by providing workers with feedback on errors**
  - **SMED – to cut set up time**

- **Poka-Yoke includes:**
  - **Checklists**
  - **Special tooling that prevents workers from making errors**

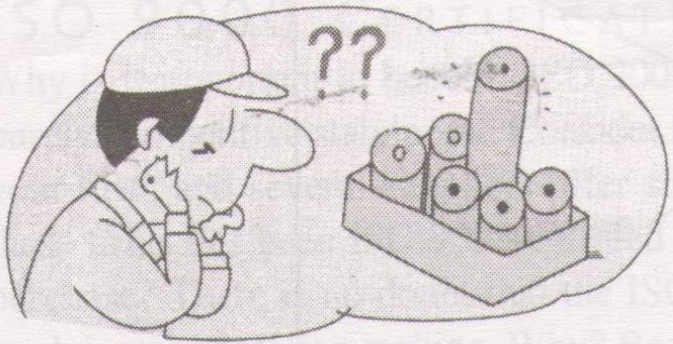
What Are the Sources of Defects?

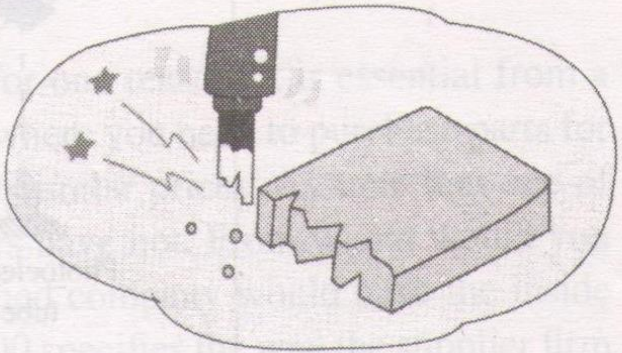
There are various types of defects. In order of importance these are

1. Omitted processing
2. Processing errors
3. Errors setting up workpieces
4. Missing parts
5. Wrong parts
6. Processing wrong workpiece
7. Misoperation
8. Adjustment error
9. Equipment not set up properly
10. Tools and jigs improperly prepared

What are the connections between these defects and the mistakes people make?

☆ Causal connections between defects and human errors





◎ Strongly connected ○ Connected

Causes of Defects \ Human Errors	Intentional	Mis-understanding	Forgetful	Mis-identification	Amateurs	Willfull	Inadvertent	Slowness	Non-supervision	Surprise
Omitted processing	○	○	○	○	○	○	○	○	○	
Processing errors	○	○	○	○	○	◎	○	○	○	
Errors setting up workpieces	○	○	○	○	○		○	○	○	
Missing parts	○	○	○		○	○	○		○	
Wrong parts	○	○	○	○	○	○	○		○	
Processing wrong workpiece	○	○	○	○	○	○	○		○	
Misoperation			○				○		○	○
Adjustment error	○	○	○	◎	○	◎	○	○	○	○
Improper equipment setup			○				○			○
Improper tools and jigs			○				○			○

SOURCE: N. K. SHIMBUN, LTD./FACTORY MAGAZINE (ED.), *POKA-YOKE: IMPROVING PRODUCT QUALITY BY PREVENTING DEFECTS* (CAMBRIDGE, MA: PRODUCTIVITY PRESS, 1989), P. 14. FROM *POKA-YOKE: IMPROVING PRODUCT QUALITY BY PREVENTING DEFECTS*, EDITED BY NKS/FACTORY MAGAZINE.

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Project Management for Managers

Lec – 59

Procurement Management- Part 1

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SELECTIVE INVENTORY CONTROL

classifying items into different categories.

ABC analysis (Annual consumption value)

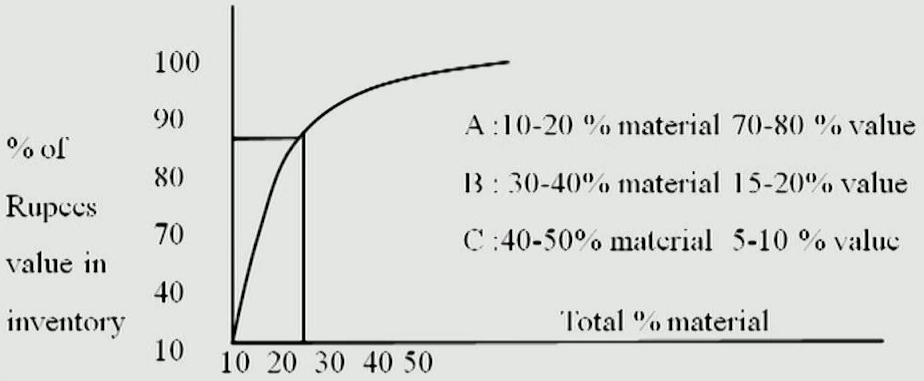
SOS

VED

GOLF

FSN

SDE (Depending on lead time- Scares (Abroad), Difficult, Easy)



Item	Annual consumption (unit)	Price / unit (Rs.)
1	4000	10 /lit
2	600	10/kg
3	2000	16/pc
4	3500	1/kg
5	50	8/kg
6	6000	6/kg
7	2400	5/kg
8	4200	1/lit
9	50	10/kg
10	100	7/kg
11	80	40/kg
12	50	8/kg
13	20	10/kg
14	2000	.15/pc
15	30	6/kg
16	80	.25/kg
17	200	.50/kg
18	750	4/kg
19	350	6/kg
20	20	10/kg

Item	Annual consumption (unit)	Price / unit (Rs.)	Annual consumption (Rs)	Rank	Cum	%
1	4000	10 /lit	40000	40000	40000	27
2	600	10/kg	6000	36000	76000	51
3	2000	16/pc	32000	32000	108000	73
4	3500	1/kg	3500	12000	120000	
5	50	8/kg	400	6000		
6	6000	6/kg	36000	4200		
7	2400	5/kg	12000	3500		
8	4200	1/lit	4200	3200		
9	50	10/kg	500	3000		
10	100	7/kg	700	2100		
11	80	40/kg	3200	700		
12	50	8/kg	400	500		
13	20	10/kg	200	400		
14	2000	.15/pc	300	400		
15	30	6/kg	180	300		
16	80	.25/kg	20	200		
17	200	.50/kg	100	200		
18	750	4/kg	3000	100		
19	350	6/kg	2100	80		
20	20	10/kg	200	20	147000	

A
15%

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A
15%

Purchasing: Is the procuring of materials, supplies, machine tools and services required for the equipment, maintenance and operation of the manufacturing plant.

Growing importance of purchasing: earlier it was activity of production management.

-Higher cost of goods and services – 50 to 70% raw material, component, services in total cost.

-Escalating cost of stock outs

-Higher present day cost of capital : fixed and working capital – 60:40, around 80% of working capital is locked up in inventory of RM, WIP, FG. Interest rates are very high.

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Purchasing is not mere act of buying: it includes

- market research,
- vendor rating,
- standardisation and verity reduction,
- codification,
- indent control,
- pre-purchasing value analysis,
- price negotiation,
- inventory control,
- surplus disposal,
- purchase budget,
- import substitution,
- purchase system design.

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Objectives of scientific purchasing

- Procure material at **competitive price**
- Maintain **continuity** in supply
- Ensure **production** of goods of better quality
- Suggest better **substitution** of materials
- Assist in **standardisation**, **variety reduction**, **cost reduction**, etc
- Advice on prices
- Create **goodwill**

Functions of purchase department

Primary duties:

- **Receipt**, scrutiny of purchase intend and determination of method of buying.
- **Search** for suppliers
- Acquisition and analysis of suppliers' proposal
- **Selection** of suppliers
- **Follow-up** for timely receipt
- Performance evaluation and **feedback**
- Disposal of **surplus obsolete, and scrap material**

Purchase as profit centre:

It should be looked as a profit centre not as a cost centre.

- To earn a rupee- increase sale by Rs10
- Good to save one rupee in purchasing through **skilful negotiation**
- Purchasing and **capital** release: reduce RM, WIP and FG
- Purchasing **and life cycle** cost:
- Purchasing **and transportation** cost: Select mode of transportation carefully

IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Project Management for Managers

Lec – 60

Procurement Management- Part 2 and Project Termination

Dr. M.K. Barua

Department of Management

Indian Institute of Technology Roorkee

Purchasing policies include

Sourcing policies: help in to select suppliers **indigenous vs. Foreign**, **local vs distinct supplier**, purchase from **sister concern**.

Internal policies: petty cash purchase, cash discount, **payment for the samples**, **disposal** of defective goods, system of rejection allowance for subcontracting items.

Suppliers' relationship policies: help in **fair trading and professionalism** on part of the purchase staff e.g. Gifts

Policies and general principles:

Speculative buying: Buying objective to buy at **least cost** to prevent production hold-up, in forward buying– the intention is to **resale for profit**.

Purchase of **goods from own employees:**

Employee's purchase: Cooperative society of the company

Sale of goods to employees: surplus and obsolete items, cartons, wooden box, gunny bags, etc.

Ethics in buying:

Word ethics meaning **character or conduct** is that branch of philosophy which deals with **rightness or wrongness, goodness or badness** of human conduct.

Needed in **all functions** of the organisation.

Ethics: may be defined as little finest complications of **do's and don't resulting** from conflict of mind as to what a **person is tempted to do and what he ought to do .**

Typical unethical acts

Misrepresentation of facts:

- Vendor may give **wrong estimate** of requirement to buyer, he may quote **low prices to get order.**
- **Buyer** may give vendor a rosy picture of future prospects and press him to **go for small volumes/price**.
- Buyer rejects material on **flimsy** grounds, false competitive information to the sellers.

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Improprieties of bids: Buyer should not allow vendor to **submit more than one bid,** no **rebidding**, submission of bid after **due dates**, all bidders must be **appraised**.

Price disclosure: Competitive price information should be treated confidential.

Unearned discounts: Buyers make payment through cheques even after the due dates .

Cancellation of orders : without valid reasons

Thrusting decisions on suppliers: thrust prices on smaller vendors , forcing vendors to mfg products in a way not interested buy seller.

Personal Requirements: ex-get materials for home/vehicle.

Samples and estimates: buyer asks to prepare drawings, samples, but does not pay for it.

Development work at the cost of vendor: Gives orders to others on the basis of learning of first vendor.

Discourteous behaviour:

There are code of conduct by Indian Association of Material Management (AIMM).

What does a supplier want form buyer:??????

Timely payment

Non-cancellation of orders:

Minimisation of unscheduled deliveries and rush orders:

Avoidance of force price reductions:

Avoidance of unnecessary rejections:

Avoidance of harassment:

Right quantity: EOQ, Replenishment system and buying methods.

Right quality: design, material, chemical composition, properties like mechanical electrical , etc.

Quality of design, conformance, performance.

Right price: right price does not mean lowest price but the price which **minimises** the **overall cost**. The techniques are negotiation tendering , and learning curve.

Right Time:

Right source: only right source can give other 4 Rs

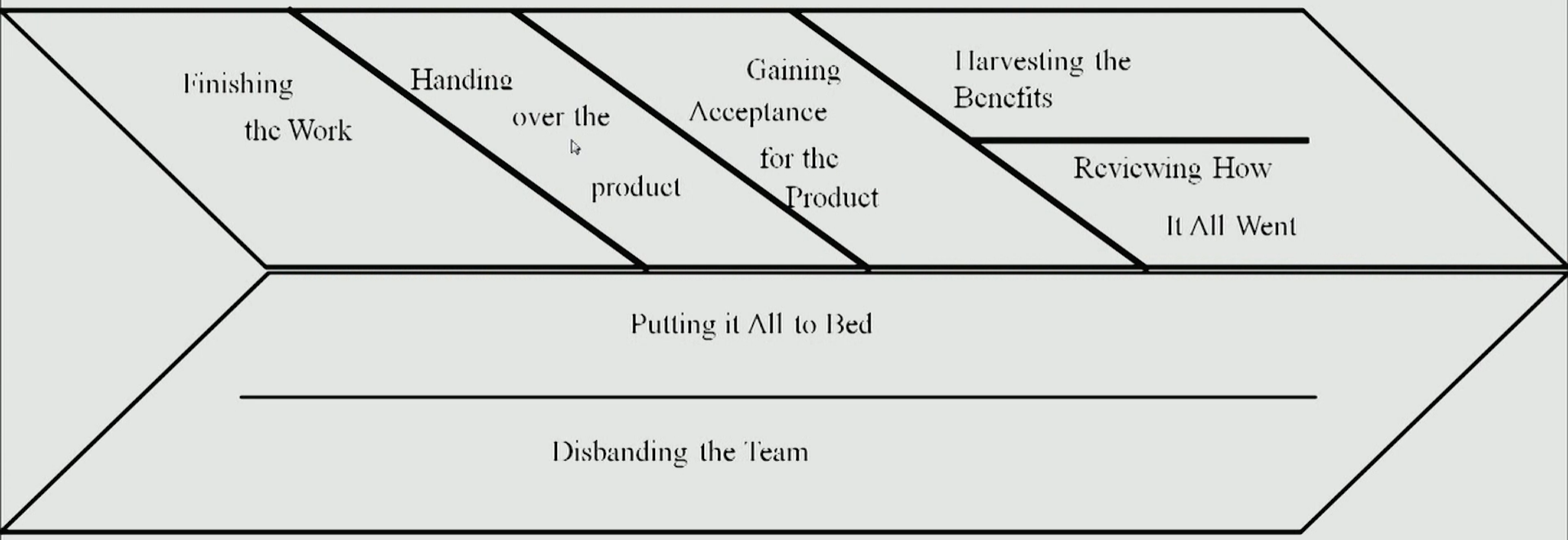
Project Termination

All **activities consistent with closing out the project**. Acceptance of project by sponsor, completion of records, final revision and issue of documentation to reflect its final condition.

Types of project termination

- **Extinction :** Project is **stopped** due to either its **successful or unsuccessful conclusion**. Auditing, team on new assignment, assets transferred as per policy.
- **Addition :** Success of the project is added to organization structure.
- **Integration**: Resources and team members are **reintegrated** within the organization's existing structure. Team members leave parent originations.
- **Starvation:** Due to budget or any other reasons.

Elements of Project Closeout Management



Finishing the work: Final "polish". Members loose focus, think of new assignment, challenge is to keep the team "zeroed in".

Handing over the project: Transferring project to client with **technical details and drawings, training**, etc.

Gaining acceptance: Over a period of **time** projects get acceptance from clients.

Harvesting Benefits: Project are initiated to **find or solve problems/ find opportunities**. Increased productivity, higher market share or profit, etc.