Chapter- 1

* Software engineer need to be skilled in estimation and measurement means

1. Understanding software development activities and risks
2. Predicting and controlling activities
3. Managing the risks
4. Deliver reliability
5. Managing proactively to avoid crises

CMMI (capability Maturity Model Integration)

→ It is a framework for Identifying the level of maturity of an organization's process

two approach

1. Continous Representation
2. The staged Representation

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The stages Repnesentation has 5 level of organizational maturity

5 levels

1. Intial
2. Managed (Project plan, monitor + control)
3. Defined
4. Quantitavely managed (stability and Quality)
5. optimizing (continous development)

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Each level except Level 1, consists process areas (PAs) defining activites for that maturity level

Level 2 :- Project Planning
Project monitoring and control

Level 4 :- → Focus on qualitive view of software process
→ project stability and Quality

Level-5 :- continous measurable improvement

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chapter-2

what to measure

what is metric?

a metric is a quantifiable measure that provides insight into a specific aspect of software on software project.

It helps asses and track characteristic : size, complexity, reliability, quality, adherence to process and profibility.

GQM Goal Question Metric Apponach

① Identify the goal for the product / process / resource.
(This the goal that is your metric customer is trying to achive)

② Determine the Question's that will characterize the way achievement of the goal is going to be assessed

③ Define the metric(s) that will provide a quantitive answer to each Question

using GQM

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Software Product delivery :- The project manager

Metric customer :- Project Manager

Step1 (Goal) Deliver a software product that meet's customer's expectation

Step2 :- Questioning the characteristic How much does the software as delivered to customer deviate from customer requirement?

Step 3 :- Defining Metric Number of field software detects encountered

" The more specific requirement, the more objective the metric becomes

The first step defining a metric program is to answer the following Question

Key Question Defining a metric program

1. who is the customer for the metrics?
2. what are their goals regarding the product/process/resource being measured?
3. what metric, when collected, demonstrate whether the goal has been being met

Methods for selecting metrics

1. The goal Question Metric Approach / Method
2. Decision Maker model
3. Standards Driven Metrics

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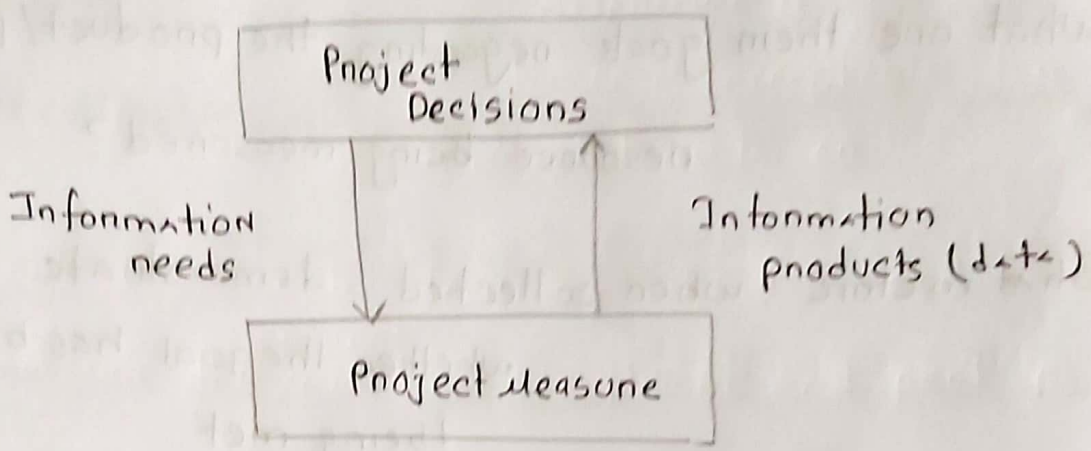
Decision Maker Model

consistent with GQM method & Focus on decision that must be made



→ Decision maker model emphasises the dynamic nature of decision making needs and the importance of aliging metrics with the envolving requirements of deision makers.

customer :- The decision maker

In this method → need to determine what the needs of design maker

→ recognizing that this will change overtime

standards driven metrics

software Engineering Institute software maturity model requires measurement of

1. System size
2. Project Duration
3. Effort
4. Defects
5. Productivity

GQMM or GQMM2 :- Goal Question Metrics Mechanism

1. Goal
2. Question
3. Metric
4. Mechanism :-

includes indentifying who will responsible for ensuring the collection and reporting of valid data, How frequently data will be collected, reported. what infrastune.

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Decison maken model example

A Test managen → Goal
determine if the quality of sottwane is acceptable fon shipment to customen

To able to make this decision, he will need to measone the current quality of sottwane and penhaps a view of how that has changed oven time

Q :- Assume you ane the managen in change of usen training on Product A. if youn goal is to provide effective usen training with each nelease of product. what should be youn metric?

Ans:-

metric :- Training satisfaction scone

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what should be the metric of system Testing ?

1. Defect Density
2. Test covenage
3. Testing Efficiency
4. Escaped defects

Suppose you have a Question "How usen-friendly is youn system to usen"? Now design two metric

1. Usenfriendliness Rating
2. Task completion sucess Rate

#

Designing a metrics

1. Definition : - Usenfriendlinesssystem based on usen feedback
2. measunement : sunvey from usen (rate 0-5 scale)
3. calculation :- calculate avenage based on all nesponse
4. Punpose :- provide measune how usen pneeive thesystem's friendliness
5. Frequency :- neguanly, specially on new updates/neleas

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chapter:-

The key to making unmeasurable measurable is model. A model is an abstraction which strips away unnecessary details and views an entity or concept from a particular perspective.

Three Types of model

1. Text Model
2. Diagrammatic Model
3. Algorithmatic Model

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Text Model → give structure to abstract concept of software development

① **Effort** :- effort is a function of size and result in cost

② **Features** :- The requirements of products

③ **Size** :- The magnitude of product to be developed

Size = function of feature

④ **Defects** :- The incompleteness of product

Defects = a function of size and schedule

(if size change, defects will change)

⑤ **Schedule** :- The total development time

= is a function of effort and Resource

⑥ **Resource** :- The number of developer for product building

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Advantage

→ items leany defined

→ easy to understand

Disadvantage

→ difficult to visualize relationship between items

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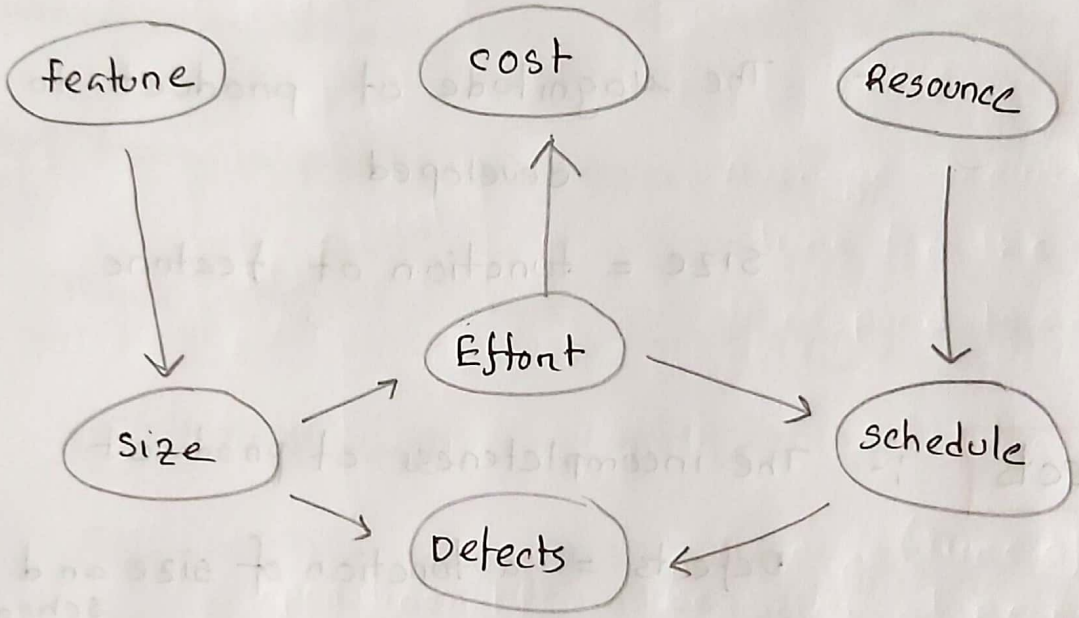
② Diagnamatic Model

→ allows to model entities, Relationship between them and thein dynamics



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Algorithmic Model (Parametric Model)

→ clearly describe the Relationship between entities

① Effort = schedule * Resource

② Effort = A * (size of Program)^B + C

A, B, C = empirically derived constants

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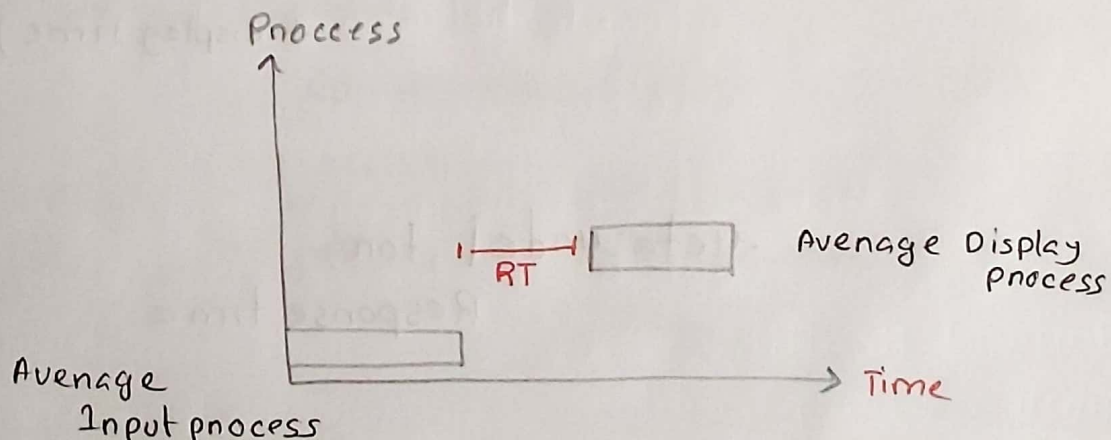
Response Time (RT)

Text model :- = is measured from the return key to first response

Algorithmic model : = Average (begining of Response - end of input)

Diagrammatic :



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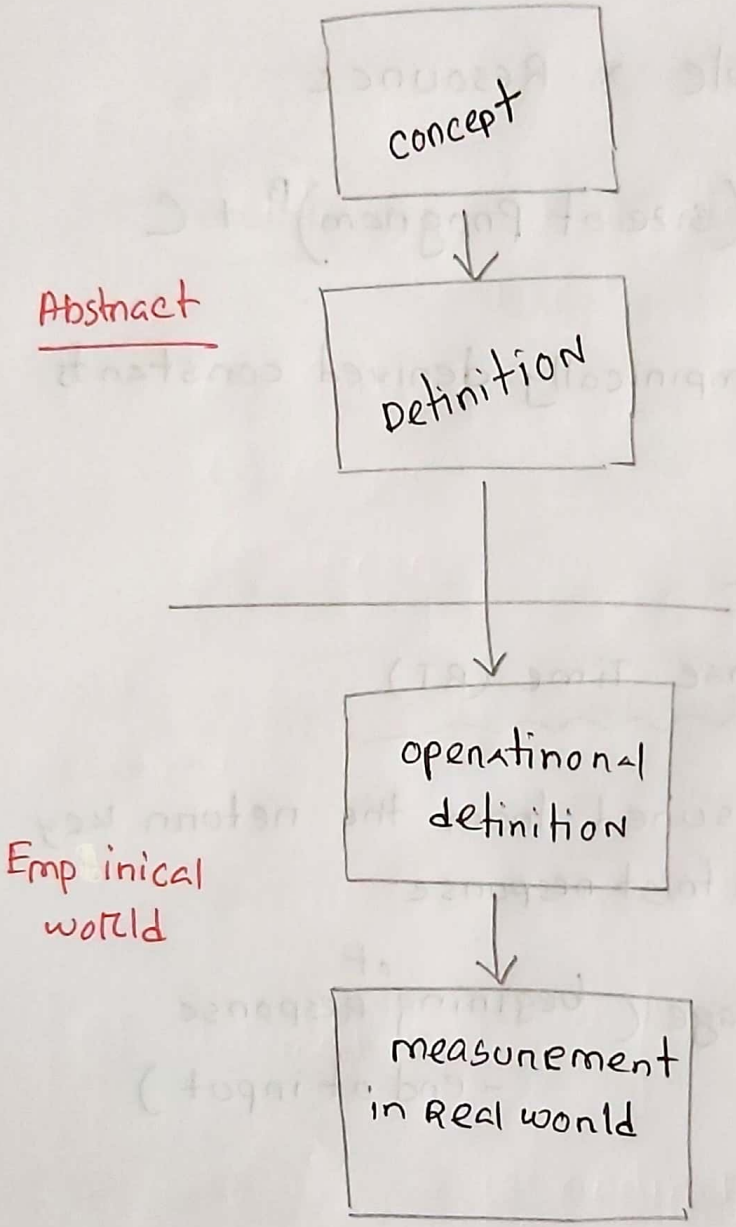
Q Define a four level model for software reliability using metric meta model ?



Response time

Average amount of time for the system to respond to an input

Average (time of beggining of Response display - time of enter key

Average over typhical hour of (Transmission time + server time + display time)

meta model for Response time

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LOC → number of Lines of code

KLOC → Thousands Lines of code

measurement scale

5 type

① Nominal Scale :- → is an unordered set of named categories such that comparison that are valid are "belongs to"

Def :-

categorize items into distinct, unordered category or groups

→ purpose :- to create mapping Real world into a set of categories that has some meaning in terms of how you will use it

Example

Suppose we want to study in on different type of project and use nominal scale to categorize them

possible categories

(i) Commercial

(ii) Millitary

(iii) Management Information System

No ordering + No comparison which better

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② Ordinal scale :-

→ is linearly ordered set of categories such that comparisons such as "bigger than" or "better than"

Example :-

criticality of trouble reports using ordinal scale

Possible

① Critical
② Major
③ Minor

Ordered
+
Now we can compare
Critical > Major

But we can not compare 2 major with 4 minor Reports which are worse ?

③ Interval Scale :-

→ is ordinal scale with consistent intervals between points on the scale

→ Here addition/substraction makes sense but multipication/divison doesn't make sense

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Example:- Temperature (celsius , Farenhit)

80° in mimami

10° in Buffalo

Comparison

70° warmer in Miami → makes sense

8 times hotter in Miami → not valid
doesn't make any sense

(4) Ratio scale :-

→ is an ordered, interval scale where the intervals between points are constant and all arithmatic operations are valid

Example:- kelvin scale

70°K in miami

10°K in Egi

70K =

10K =

7 times hotter miami → now makes sense

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⑤ Absolute Scale

→ it is a ratio scale that is count of the number of occurences such as number of error detected

→ valid values are zero, postive integers

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Scale	mean	median	mode
Nominal scale	No	No noordening	Yes
Ordinal scale	No Irrelevant	Yes ordering	Yes
Interval scale	Yes meaningfull	Yes Relevant	Yes
Ratio scale	Yes	Yes	Yes
Absolute scale	Yes	Yes	Yes

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measure of central Tendency

① **mean** :- $\frac{\text{sum of all occurence}}{\text{number of occurence}}$

② **median** :- is the middle occurence in an ordened set

③ **mode** :- is most Frequent occurence

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measures of Variability

① Range

② Deviation

③ Variance

④ Standard Deviation (SD)

⑤ Index of Variation (IV)

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① **Range:-** is calculated by subtracting the smallest from langest

∴ Assume

A = 10KLOC

B = 24KLOC

C = 50KLOC

∴ Range of KLOC per module

= 50 - 10

= 40KLOC

$\boxed{\text{large} - \text{small}}$

② **Deviation** The distant away from mean of measurement

∴ mean $= \frac{10+24+50}{3} = 28K$LOC

Deviation of module $\boxed{(|x_i - \bar{x}|)}$

A = |10 - 28| = 18

B = |24 - 28| = 4

C = |50 - 28| = 22

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Variance — a measurement of spread which calculated differently if it is for a full population or sample of population

$$\text{Variance} = \left(\sum (\text{Deviation})^2\right) / N$$

Here Variance $= \dfrac{18^2 + 4^2 + 22^2}{3} = 275$

Standard Deviations — "typical" distance from mean

$$SD = \sqrt{\text{variance}}$$

$$= \sqrt{275}$$

$$= 16.6$$

Index of Variation — indicates the reliability of measurement

$$ID = \frac{SD}{\text{mean}}$$

$$= \frac{16.6}{28} = 0.59$$

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Q You decide to measure productivity by lines of code produced per month. but you donot count comments. what do you think what will happen?

→ removing comment,

increase productivity] higher

but less documentation
less code readibility
less maintability

] but scarifice all this which is not good

Q :- You can measure any thing in material world

→ False

Q :- models are nice to have but not crucial to software measurement

→ False

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Q:- Algorithmic models are preffered because they are precise

False:- precision alone cannot gurnante accuracy / relevant

The choice of model depends on the nature of problem and data

So sometimes simpler models canbe sometimes more effective

Q Number of defect in different module

10, 20, 22, 15, 18

$$\text{mean} = \frac{10+20+22+15+18}{5} = 17$$

$$SD = \sqrt{\text{variance}}$$

$$=$$

$$IV = \frac{SD}{\text{mean}} =$$

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Q mean is vaild measure in Ordinal scale

→ False

Q Higher IV indicates a more reliable metric

→ False

IV is not a standard metric for reliability

Q If there is a error in measurement

SD will be greater than true value being measured?

→ False

Q Precision is more important than accuracy in metric

→ False

both are important

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