

Chapter 32

■ Process and Project Metrics

Slide Set to accompany

Software Engineering: A Practitioner's Approach, 8/e

by Roger S. Pressman

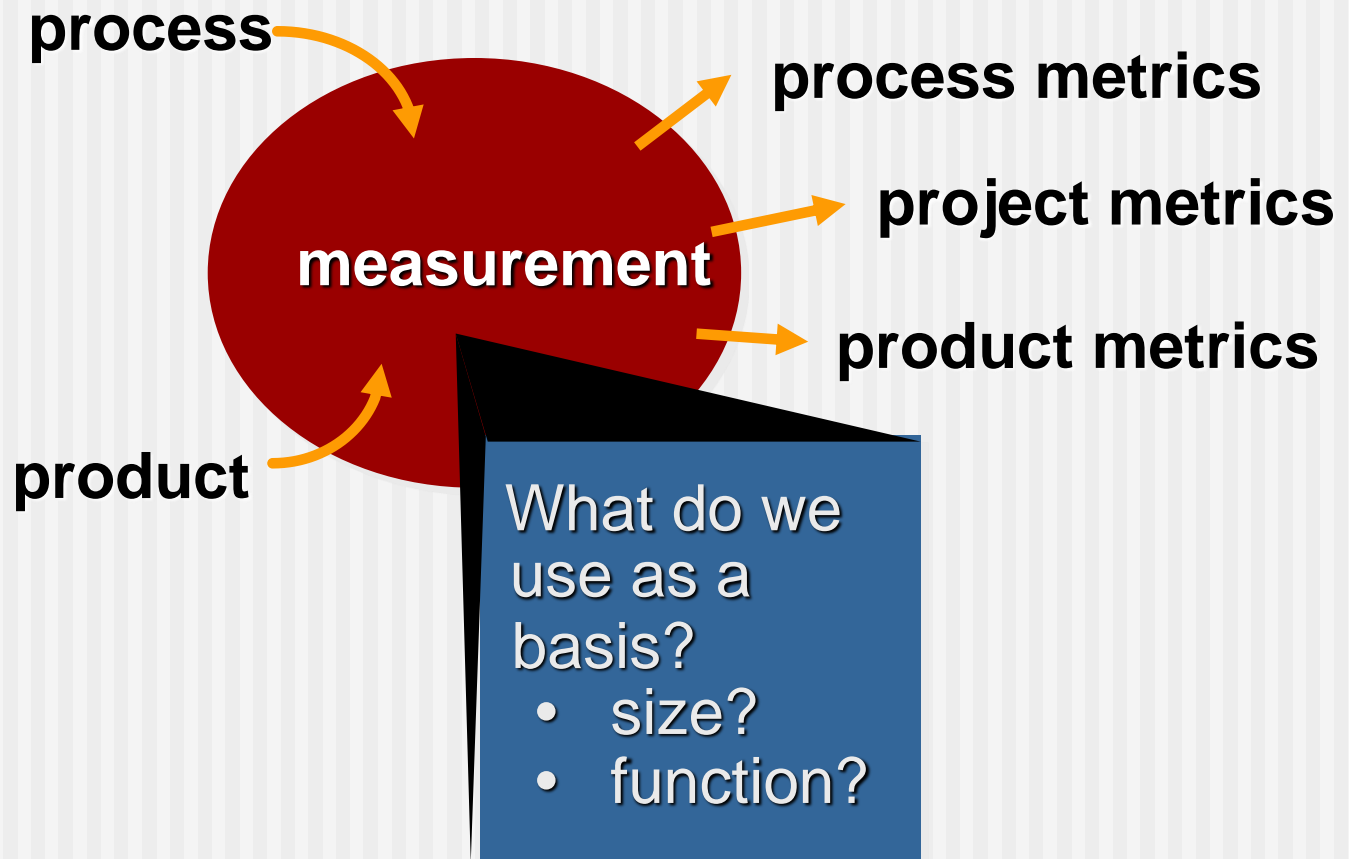
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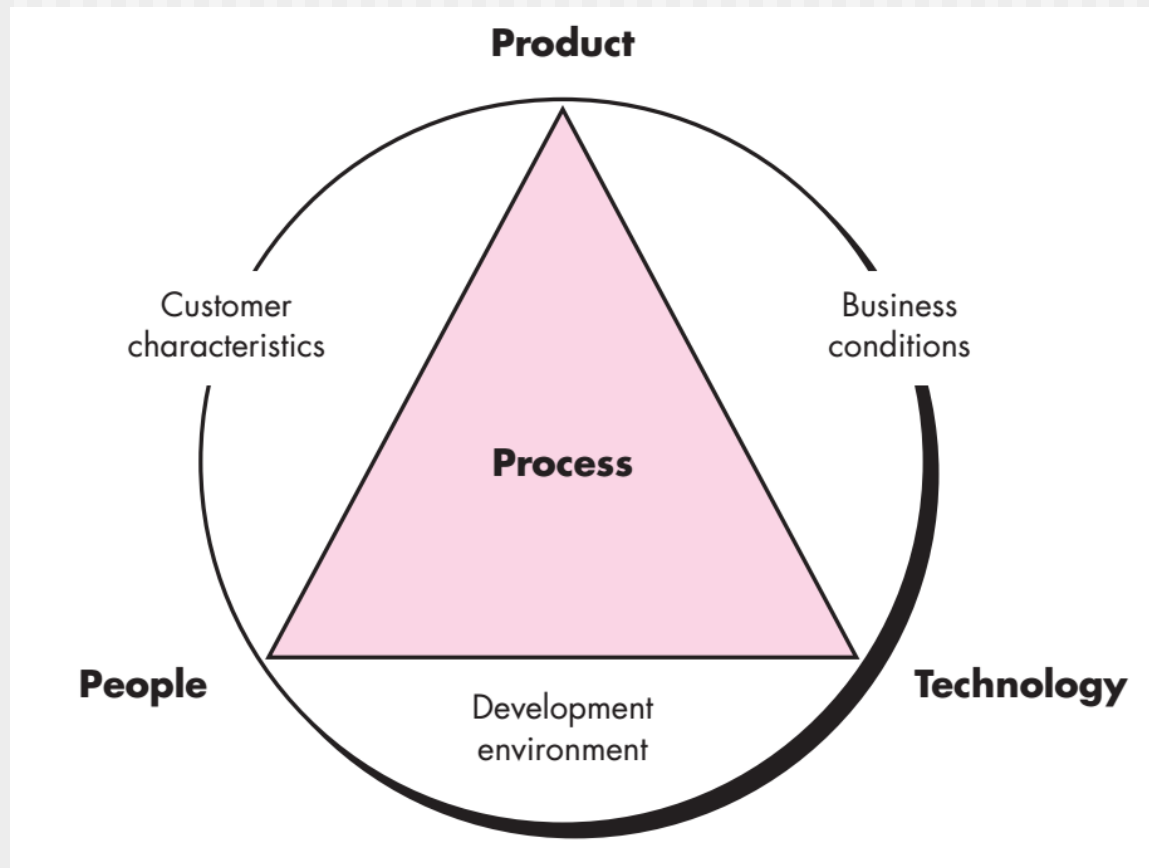
A Good Manager Measures



Why Do We Measure Project?

- assess the status of an ongoing project
- track potential risks
- uncover problem areas before they go “critical,”
- adjust work flow or tasks,
- evaluate the project team’s ability to control quality of software work products.

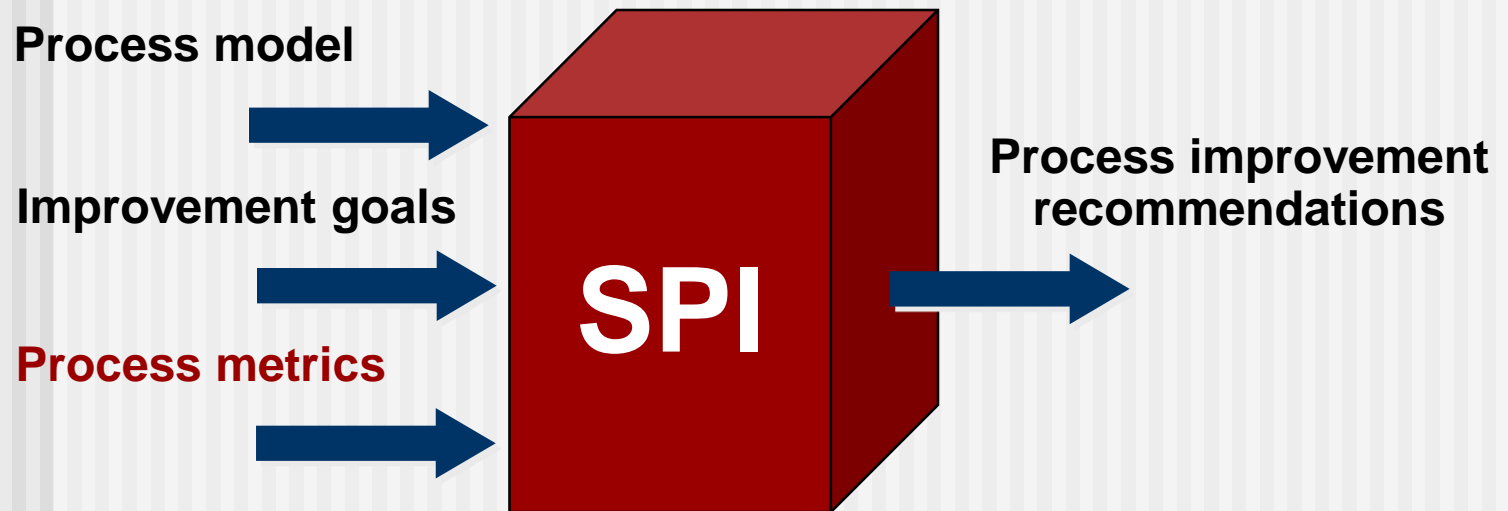
Determinants for software quality and organizational effectiveness



Process Measurement

- We measure the efficacy of a software process indirectly.
 - That is, we derive a set of metrics based on the outcomes that can be derived from the process.
 - Outcomes include
 - measures of errors uncovered before release of the software
 - defects delivered to and reported by end-users
 - work products delivered (productivity)
 - human effort expended
 - calendar time expended
 - schedule conformance
 - other measures.
- We also derive process metrics by measuring the characteristics of specific software engineering tasks.

Software Process Improvement



Process Metrics

- **Quality-related**
 - focus on quality of work products and deliverables
- **Productivity-related**
 - Production of work-products related to effort expended
- **Statistical SQA data**
 - error categorization & analysis
- **Defect removal efficiency**
 - propagation of errors from process activity to activity
- **Reuse data**
 - The number of components produced and their degree of reusability

Project Metrics

- used to minimize the development schedule by making the adjustments necessary to avoid delays and mitigate potential problems and risks
- used to assess product quality on an ongoing basis and, when necessary, modify the technical approach to improve quality.
- every project should measure:
 - *inputs*—measures of the resources (e.g., people, tools) required to do the work.
 - *outputs*—measures of the deliverables or work products created during the software engineering process.
 - *results*—measures that indicate the effectiveness of the deliverables.

Typical Project Metrics

- Effort/time per software engineering task
- Errors uncovered per review hour
- Scheduled vs. actual milestone dates
- Changes (number) and their characteristics
- Distribution of effort on software engineering tasks

Metrics Guidelines

- Use common sense and organizational sensitivity when interpreting metrics data.
- Provide regular feedback to the individuals and teams who have worked to collect measures and metrics.
- Don't use metrics to appraise individuals.
- Work with practitioners and teams to set clear goals and metrics that will be used to achieve them.
- Never use metrics to threaten individuals or teams.
- Metrics data that indicate a problem area should not be considered "negative." These data are merely an indicator for process improvement.
- Don't obsess on a single metric to the exclusion of other important metrics.

Size-Oriented Metrics

Project	LOC	Effort	\$(000)	Pp. doc.	Errors	Defects	People
alpha	12,100	24	168	365	134	29	3
beta	27,200	62	440	1224	321	86	5
gamma	20,200	43	314	1050	256	64	6
•	•	•	•	•	•		
•	•	•	•	•	•		
•	•	•	•	•	•		

Typical Size-Oriented Metrics

- errors per KLOC (thousand lines of code)
- defects per KLOC
- \$ per LOC
- pages of documentation per KLOC
- errors per person-month
- errors per review hour
- LOC per person-month
- \$ per page of documentation

Typical Function-Oriented Metrics

- errors per FP (thousand lines of code)
- defects per FP
- \$ per FP
- pages of documentation per FP
- FP per person-month

Comparing LOC and FP

Programming Language	LOC per Function point			
	avg.	median	low	high
Ada	154	-	104	205
Assembler	337	315	91	694
C	162	109	33	704
C++	66	53	29	178
COBOL	77	77	14	400
Java	63	53	77	-
JavaScript	58	63	42	75
Perl	60	-	-	-
PL/1	78	67	22	263
Power builder	32	31	11	105
SAS	40	41	33	49
Smalltalk	26	19	10	55
SQL	40	37	7	110
Visual Basic	47	42	16	158

Representative values developed by QSM

Why Opt for FP?

- Programming language independent
- Used readily countable characteristics that are determined early in the software process
- Does not “penalize” inventive (short) implementations that use fewer LOC than other more clumsy versions
- Makes it easier to measure the impact of reusable components

Object-Oriented Metrics

- Number of **scenario scripts** (use-cases)
- Number of **Key Classes**
- Number of **support classes** (required to implement the system but are not immediately related to the problem domain)
- Average number of **support classes per key class** (analysis class)
- Number of **subsystems** (an aggregation of classes that support a function that is visible to the end-user of a system)

WebApp Project Metrics

- Number of **static Web pages** (the end-user has no control over the content displayed on the page)
- Number of **dynamic Web pages** (end-user actions result in customized content displayed on the page)
- Number of **internal page links** (internal page links are pointers that provide a hyperlink to some other Web page within the WebApp)
- Number of **persistent data objects**
- Number of **external systems interfaced**
- Number of **static content objects**
- Number of **dynamic content objects**
- Number of **executable functions**

Measuring Quality

- **Correctness** — the degree to which a program operates according to specification
 - Metric : Defect /KLOC
- **Maintainability**—the degree to which a program is amenable to change
 - Metric: Mean time to change
- **Integrity**—the degree to which a program is impervious to outside attack
 - Metric: $\sum[1 - (threat * (1 - security))]$
- **Usability**—the degree to which a program is easy to use

Defect Removal Efficiency

$$DRE = E / (E + D)$$

where:

E is the number of errors found before delivery of the software to the end-user

D is the number of defects found after delivery.

Metrics for Small Organizations

- time (hours or days) elapsed from the time a request is made until evaluation is complete, t_{queue} .
- effort (person-hours) to perform the evaluation, W_{eval} .
- time (hours or days) elapsed from completion of evaluation to assignment of change order to personnel, t_{eval} .
- effort (person-hours) required to make the change, W_{change} .
- time required (hours or days) to make the change, t_{change} .
- errors uncovered during work to make change, E_{change} .
- defects uncovered after change is released to the customer base, D_{change} .

Establishing a Metrics Program

- Identify your business goals.
- Identify what you want to know or learn.
- Identify your subgoals.
- Identify the entities and attributes related to your subgoals.
- Formalize your measurement goals.
- Identify quantifiable questions and the related indicators that you will use to help you achieve your measurement goals.
- Identify the data elements that you will collect to construct the indicators that help answer your questions.
- Define the measures to be used, and make these definitions operational.
- Identify the actions that you will take to implement the measures.
- Prepare a plan for implementing the measures.