

# Chapter 25

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## ■ Process and Project Metrics

*Slide Set to accompany*

*Software Engineering: A Practitioner's Approach, 7/e*

**by Roger S. Pressman**

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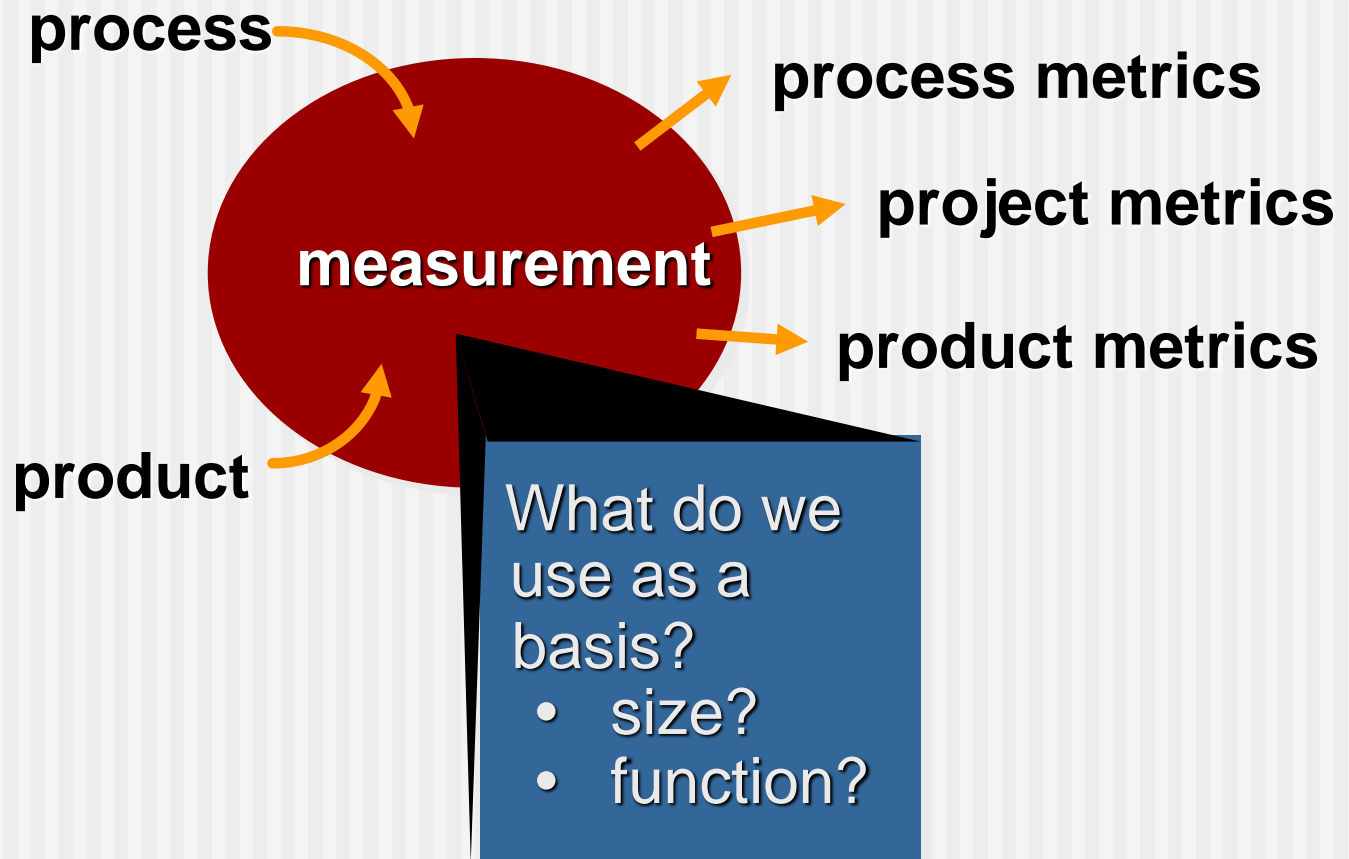
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# A Good Manager Measures

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# Why Do We Measure?

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- 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.

# Process Measurement

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- 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.

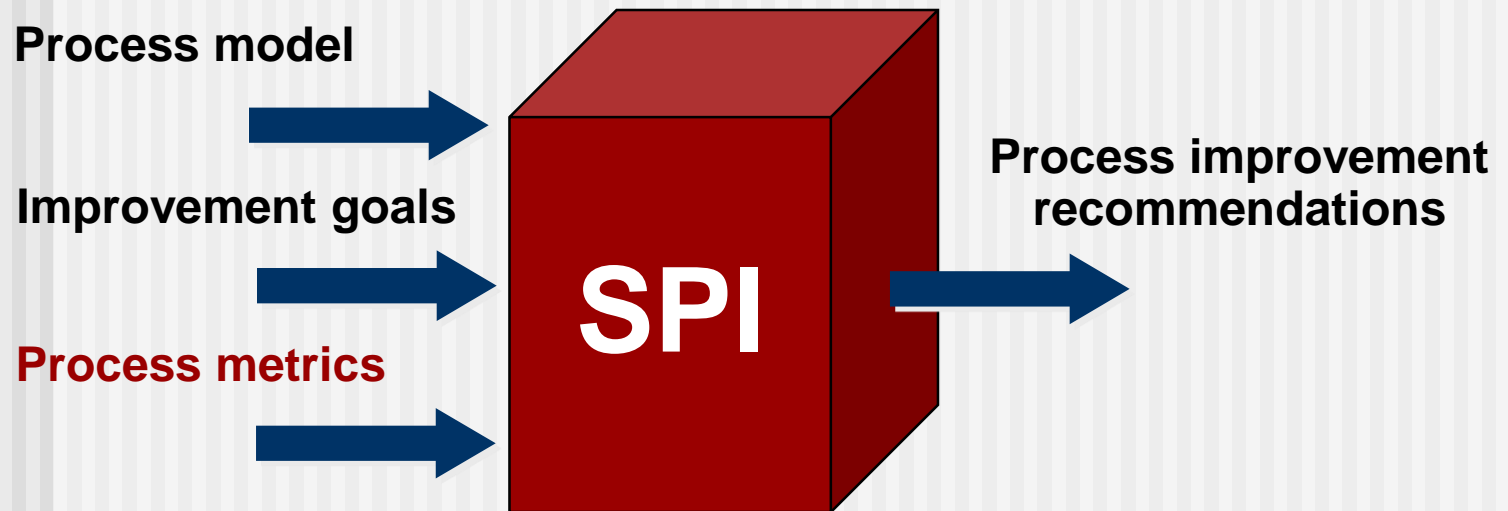
# Process Metrics Guidelines

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- Use common sense and organizational sensitivity when interpreting metrics data.
- Provide regular feedback to the individuals and teams who 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.

# Software Process Improvement

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# Process Metrics

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- **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

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- 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

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- 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

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- 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.

# Typical Size-Oriented Metrics

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- 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

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- 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  |
| Powerbuilder         | 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?

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- 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

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- Number of **scenario scripts** (use-cases)
- 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

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- 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

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- **Correctness** — the degree to which a program operates according to specification
- **Maintainability**—the degree to which a program is amenable to change
- **Integrity**—the degree to which a program is impervious to outside attack
- **Usability**—the degree to which a program is easy to use

# Defect Removal Efficiency

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

*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

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- 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

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- 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.