CISC/CMPE 327 Software Quality Assurance

Queen's University, 2019-fall

Lecture #4
Software Process Evaluation

Software Process Evaluation

- How can we measure software processes?
  - Today we look at methods for evaluating and improving software processes, regardless of which process is being used
  - There are several methods and standards for software process evaluation
  - Most are aimed at improving existing development processes as they are applied, calling maturing them
  - Idea is that as a company or team gains experience with a process, they continually improve it to make it better in their use

Today's Lecture

- Defect Prevention Process (DPP)
- Quality standards:
  Maturity models and certification standards
  - Capability Maturity Model (CMM)
  - Malcolm Baldrige processes
  - ISO 9000

The Defect Prevention Process

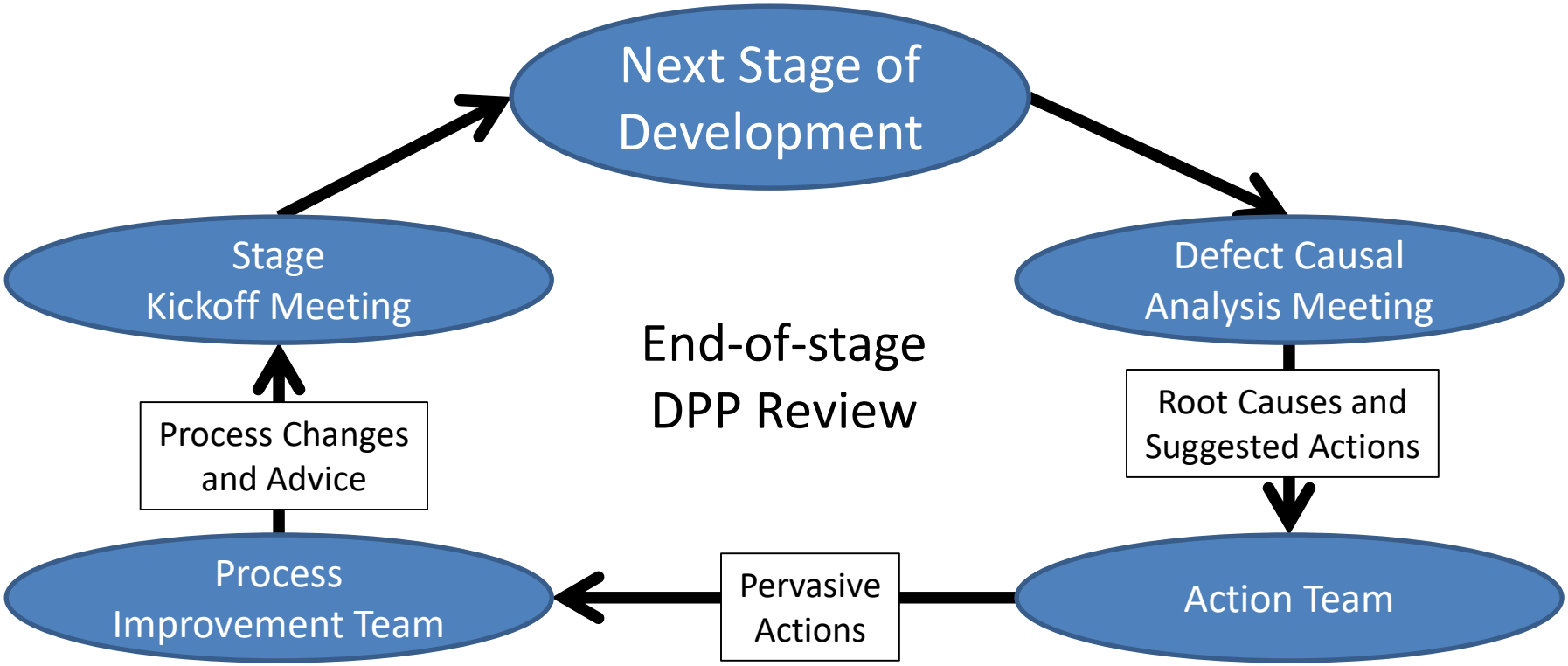
- DPP - Defect Prevention Process
  - DPP is not itself a software development process, but rather a process for continually improving the development process
  - Modelled on quality assurance techniques used in Japan for decades

3 Steps of DPP

- Based on three simple steps:
  - Analyze existing defects or errors to trace their root causes in the process (how they were missed)
  - Suggest preventive actions to eliminate the defect root causes from the process
  - Implement the preventive actions to improve the process

The Defect Prevention Process

- Formal DPP Reviews
  - First used at IBM Communications Programming Lab (1985)



4 Components of DPP

- 1) Defect Causal Analysis Meeting
  - At end of each stage of development, review and analyze defects that occurred in that stage
  - Developers trace root causes of errors; suggest possible actions to prevent similar errors in future
- 2) Action Team
  - Action team has cross-organization members
  - Evaluates suggested actions, initiates actions across the organization, including development team actions
  - Size varies; could be just one person (Jones 1985)

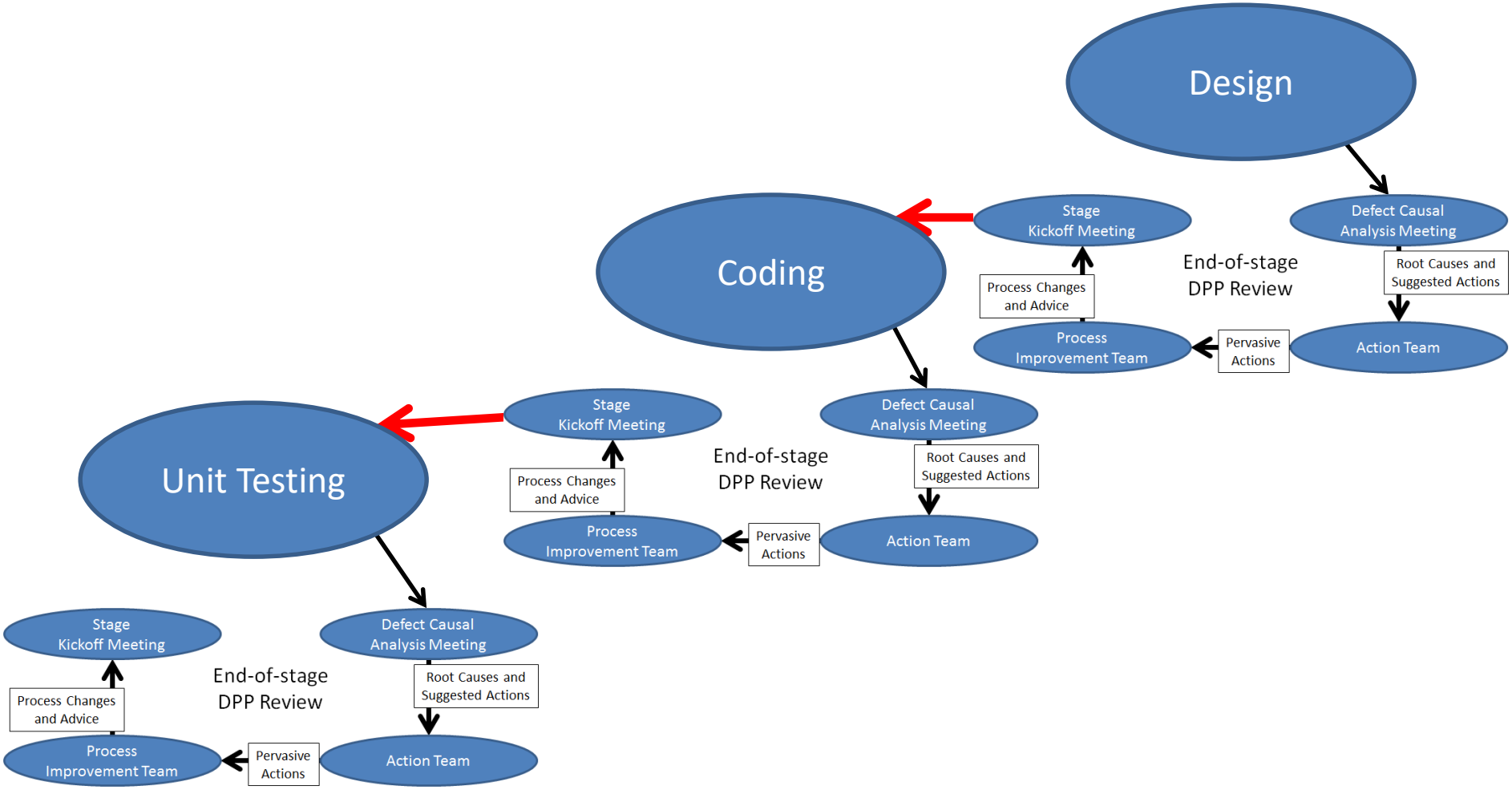
4 Components of DPP

- 3) Process Improvement Team
  - Members of the development team
  - Implements process changes and provides advice for next stage of development
- 4) Stage Kickoff Meeting
  - Development teams meet to review process changes and re-emphasize focus on quality

DPP vs. Postmortem

- A traditional “postmortem analysis”,
  at the end of the entire project,
  would also look at defects and their causes
- DPP happens throughout the stages, not just at the end…

DPP Applied to Waterfall Model



Process Quality Standards

- Software Process Assessments and Standards
  - Two kinds:
  - 1. Maturity models

    attempt to measure how mature
    the software process in a particular organization is,
    and thus how likely it is to produce quality results
  - 2. Certification standards

    measure an organization's software process against a defined standard, and certify the organization if its process meets the standard

Capability Maturity Model (CMM)

- The SEI Process Capability Maturity Model
  - CMM defines a five-level scale of process maturity; an organization's software process is assessed as "CMM-1", "CMM-3", "CMM-5" indicating its level on the scale
  - Used by government agencies and companies in the U.S.
  - Assessed using an 85-item questionnaire

Capability Maturity Model (CMM)

- CMM Level 1 - "Initial"
  - Characteristics: chaotic; unpredictable cost, schedule, and quality
- CMM Level 2 - "Repeatable"
  - Characteristics: intuitive; cost and quality highly variable, reasonable control of schedules, ad hoc methods and procedures
  - Key elements: requirements management, project planning, software configuration management, quality assurance procedures

Capability Maturity Model (CMM)

- CMM Level 3 - "Defined"
  - Characteristics: qualitative; reliable costs and schedules, improving but unpredictable quality
  - Key elements: process definition and improvement, training program, integrated software management, product engineering, intergroup coordination, peer reviews

Capability Maturity Model (CMM)

- CMM Level 4 - "Managed"
  - Characteristics: quantitative; reasonable statistical control over product quality
  - Key elements: process measurement and analysis, quality management
- CMM Level 5 - "Optimizing"
  - Characteristics: quantitative basis for continual process automation and improvement
  - Key elements: defect prevention, technology innovation, process change management

The CMM Integration (CMMI)

- Integrate practices from four CMMs to generalize (not just for software maturity)
  - Maturity Level 1: Initial
    - Processes are ad-hoc and chaotic
  - Maturity Level 2: Managed
    - Focuses on basic project management
  - Maturity Level 3: Defined
    - Focuses on process standardization
  - Maturity Level 4: Quantitatively Managed
    - Focuses on quantitative management
  - Maturity Level 5: Optimizing
    - Focuses on continuous process improvement

SPR Maturity Assessment

- Software Productivity Research (SPR) Assessment
  - Much like CMM, but focuses more broadly on corporate strategy and tactical issues, as well as CMM's issues of software organization and process
  - Also uses a questionnaire, but has 400 questions as opposed to CMM's 85, and uses a 5-point scale instead of yes/no answers
    - Excellent, Good, Average, Below Average, Poor

SPR Maturity Assessment

- SPR Assessment
  - Assessment uses measures such as:
    - Quality and productivity measurements
    - Experience of programmers in defect removal and testing
    - Project quality and reliability targets
    - Defect removal history in each phase (design, coding, testing, release)

Baldrige Assessment Standard

- Malcolm Baldrige National Quality Award (MBNQA)
  - Originally U.S. Department of Commerce award, given to recognize outstanding achievement in quality management and achievement in any industry
  - Also basis of IBM's Market Driven Quality strategy and the European Quality Award
  - An "examination" for award criteria, companies get a "mark" out of 1,000

Baldrige Assessment Standard

- MBNQA
  - 28 examination items, in seven categories: leadership, information and analysis, quality planning, human resources, quality assurance, quality results, customer satisfaction
  - Three evaluation dimensions of each item
    - Approach: methods used to achieve the examination item
    - Deployment: how well approach is actually applied
    - Results: quality of outcome in examination item

Malcolm Baldrige, Jr.

- 26th U.S. Secretary of Commerce
  - January 20, 1981 to July 25, 1987
  - In his prior career in business, he led the conversion of a troubled brass mill to a highly diversified manufacturer of industrial goods
  - His experience with process improvement led to the guidelines in the National Quality Improvement Act of 1987

Impact of the MBNQA

- Evaluated in 2001 for economic benefit
  - Social costs of the program were US$119 million
  - Net private benefits to the economy were estimated at US$24.65 billion
  - The social benefit-to-cost ratio was 207:1
  - Prior to the quality improvement act, many U.S. businesses either did not believe that quality mattered for them or they did not know where to begin
  - https://www.nist.gov/document-17640

ISO 9000 Standard

- ISO 9000
  - A set of standards and guidelines for quality assurance management
  - Many customers, especially in Europe, require ISO 9000 registration of their suppliers
  - Companies become ISO 9000 "registered" as a result of a formal audit by ISO
  - ISO 9000 standards are documentation-based
    - Every aspect of every step of every process must be backed up by formal documents in a precisely defined format keeping records of how processes are applied

ISO 9000 Standard

- ISO 90003
  - ISO 90003 gives the standards for software development, supply, and maintenance
  - ISO 90003 specifies 20 elements to be assessed, with detailed requirements for each element

ISO 90003

Management responsibility	Inspection, measuring, and test equipment
Quality system	Inspection and test status
Contract review	Control of nonconforming products
Design control	Corrective action
Document control	Handling, packaging, delivery
Purchasing	Quality records
Purchaser-supplied product	Internal quality audits
Product identification and traceability	Training
Process control	Servicing
Inspection and testing	Statistics

ISO 9000 Standard

- ISO 9000
  - Standards are complex, detailed, and stringent
  - "Say what you do, do what you say, and prove it."
- Example:
  - The documentation standard goes so far as to specify:
    - owner of document must be specified on title page
    - distribution of document must be controlled with an archived master copy, distribution record book, etc.
    - version level must be clearly identified
    - all pages must be consecutively numbered
    - total number of pages must be indicated on title page
    - procedure for destruction of obsolete documents must be documented

ISO 9000 Standard

- ISO 9000
  - Most companies (60–70%) fail the ISO audit the first time
  - Most software companies are deficient in corrective actions and document control
  - Companies take steps to meet the standards in these areas and usually can be registered on the second try
  - Over a million organizations worldwide are independently certified

Criticisms of ISO 9000

- Companies may misunderstand the goal
  - ISO 9000 certification is desirable for getting customers
  - A company must want to apply the knowledge gained from obtaining ISO 9000 certification to improve quality processes
    - It is not enough to simply get the certificate and be done with it!
    - "A company can produce a poor quality product consistently, and with the proper documentation can put an ISO 9000 stamp on it."

Summary

- Software Process Evaluation
  - Software processes can be continually improved using meta-processes such as the Defect Prevention Process
  - Software processes can be evaluated with respect to their maturity or by comparison with a process standard
  - Maturity models include CMM and SPR
  - Process quality standards include Baldrige and ISO 9000

Summary

- Today's References
  - Kan, Metrics and Models in Software Quality Engineering, ch. 2 (§§2.7–2.8)
- Next Time
  - the eXtreme Programming software process