CISC 327 - Software Quality Assurance

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)

![Diagram of the Defect Prevention Process]

- **Stage Kickoff Meeting**
  - Process Changes and Advice
- **Process Improvement Team**
- **Defect Causal Analysis Meeting**
  - Root Causes and Suggested Actions
- **Action Team**
- **Next Stage of Development**
- **End-of-stage DPP Review**
  - Pervasive Actions
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
  – 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
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

<table>
<thead>
<tr>
<th>Management responsibility</th>
<th>Inspection, measuring, and test equipment</th>
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<tbody>
<tr>
<td>Quality system</td>
<td>Inspection and test status</td>
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<td>Contract review</td>
<td>Control of nonconforming products</td>
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<td>Design control</td>
<td>Corrective action</td>
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<tr>
<td>Document control</td>
<td>Handling, packaging, delivery</td>
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<td>Purchasing</td>
<td>Quality records</td>
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<td>Purchaser-supplied product</td>
<td>Internal quality audits</td>
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<td>Product identification and traceability</td>
<td>Training</td>
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<td>Process control</td>
<td>Servicing</td>
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<tr>
<td>Inspection and testing</td>
<td>Statistics</td>
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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
  – The 2016 CISC 327 software project