# Software Reviews Since Acquisition Reform – The Artifact Perspective


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# Background of Problem

- **Pre-1994:**
  - MIL-STD-1521B (Technical Reviews)
    - Formal milestone reviews
    - Date of last version is June 4, 1985 (!)
  - DoD-STD-2167A (Defense System Software Development)
    - Single pass Waterfall Life Cycle Model bias
- **1994:**
  - MIL-STD-498 (Software Development & Documentation)
    - Although all other MIL standards are cancelled by the DoD, **MIL-STD-498** was approved as an interim standard for 2 years
    - Eliminated any Waterfall bias
    - Joint reviews: Schedule and content proposed by contractor

# The Problems with Reviews

- **Now:**
  - No official development or review standards of record
  - Neither the government nor the contractor has clear concept of what reviews should contain and when they should occur
  - Interpretation of major contractual technical reviews (e.g., System PDR, System CDR) is left to individuals to decide
  - Quality and content of reviews is widely different both within and across programs
  - Quick, last-minute, before-review efforts to revive and customize MIL-STD-1521B proved to be ineffective

# Perspectives on Review Issues

- **The Life Cycle Perspective ("When?")***
  - Pre-acquisition reform assumptions:
    - Acquisition and development are exclusively Waterfall
    - Reviews (SSR, PDR, CDR, etc.) are clearly positioned
  - Now:
    - Evolutionary Acquisition
    - Iterative/Incremental and Spiral Development
    - Emerging agile methods
    - Asynchronous, in-process, interim reviews
- **The Artifact Perspective ("What?")**
  - This is the subject of the presentation

**** For more details see my upcoming presentation at the 2004 Software Technology Conference in Salt Lake City, Utah: Hantos, P.,"Software Reviews Since Acquisition Reform – The Life Cycle Perspective"***

# Presentation Objectives

- **Identify** modern software development trends within key areas of interest
- **Compare** pre-acquisition reform software development practices with the state-of-the-practice (With minor references to the state-of-the-art…)
- **Highlight** new work products and related, new review artifacts

# Key Areas of Interest

| | |
|---|---|
| **Architecture** | Unit Designation and Nomenclature |
| | Architecture Focus |
| | Software Reuse and COTS |
| | Frameworks |
| | Open Systems |
| | Distributed Systems |
| **Product-Oriented Software Engineering Activities** | Analysis/Design |
| | Programming Languages |
| | Programming |
| | Integration |
| | Test |
| **Engineering Management Process** | The Software Concept |
| | Quantitative Management, use of Software Metrics |
| | Organizational and Management Models |
| | Systems Engineering |
| **Integral Software Engineering Activities** | Process Maturity and Quality Frameworks |
| | Quality |
| | Risk Management |
| **Hardware-Software Technology** | Design Paradigms |
| | Host Processor |
| | Communications |
| | Database Management |
| | Tools |
| | Documentation |
| **Security** | Security |



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# Architecture

| | OLD | NEW |
|---|---|---|
| Unit Designation and Nomenclature | **CSCI – HWCIs with high granularity:**<br>• Homogeneous, static view of CSCIs assuming unchanging configuration entities:<br>*Design -> Source Code ->*<br>*-> Developmental executables ->*<br>*-> Delivered executables* | **O-O concepts and nomenclature:**<br>Objects – with flexible granularity<br>Packages – for higher order, logical object structure<br>Component diagrams – for components and interfaces<br>Deployment – distribution of components on nodes<br>Source code vs. executable releases |
| Architecture Focus | **Weak:**<br>• High-level Design = Architecture<br>**Monolithic architectural patterns:**<br>• Mainframe<br>• Process control-type instruments | **Strong:**<br>Multiple,stakeholder views<br>**Variety of architectural patterns:**<br>Client-Server<br>Distributed/networked<br>Application-services |
| Software Reuse and COTS | **Sporadic, opportunistic reuse**<br>**Limited, low-level libraries only**<br>**No sensitivity to COTS software:**<br>• No impact on life cycle models<br>• No acknowledgement of risks due to COTS volatility | **Systematic, application-domain reuse**<br>**Increased use of system libraries**<br>**High emphasis on using COTS:**<br>Acknowledging life cycle impact<br>High sensitivity to COTS volatility<br>Coexistence with legacy code, "wrappers" |


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# Architecture (Cont.)

| | OLD | NEW |
|---|---|---|
| Frameworks | **Middleware concept didn't exist** | **Wide use of frameworks:**<br>COM, .NET, CORBA, etc.<br>Distributed objects<br>Domain-specific, reusable assets |
| Open Systems | **Concept didn't exist**<br>• Most solutions were proprietary<br>• Limited acceptance of best practices | **Rapidly emerging concept**<br>Push for commercial solutions<br>Open to wide array of best practices<br>Emerging, Open UML-based standards |
| Distributed Systems | **Primitive networks only**<br>• No WWW (World-Wide Web) | **Large, high bandwidth networks**<br>100 Gbit/sec<br>Rapidly growing WWW<br>Intranets/Extranets<br>Remote network management<br>Remote diagnostics |



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# Product-Oriented SW Engineering Activities

| | OLD | NEW |
|---|---|---|
| Analysis/Design | **Structured/Hierarchical:**<br>• Functional decomposition of requirements<br>• No or little coding until design completed | **Object-Oriented/UML-based:**<br>Iterative/Incremental<br>Use Case driven<br>Exploratory coding, prototyping<br>Might follow test-driven design process |
| Programming Languages | **Primarily procedural**<br>**Textual only** | **Dominant Object-Oriented**<br>**Visual languages** |
| Programming | **Manual only**<br>**Code metrics:**<br>• McCabe complexity | **Visual programming**<br>**Automated code generators:**<br>Executable models<br>Round-trip engineering<br>**Code metrics for O-O programs:**<br>New metrics replace McCabe |
| Integration | **"Big-bang":**<br>• Single, major event at the end | **Incremental integration:**<br>Multiple, frequent releases |
| Test | **Manual only** | **Increased automated testing**<br>**Load testing of networks** |



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# Engineering Management Processes

| | OLD | NEW |
|---|---|---|
| The Software Concept | **"Software is software"**<br>**"One size fits all":**<br>• Scaling assumed to be simple and transparent | **Acknowledges the differences between:**<br>Information Management (IM)<br>Decision-making systems<br>Real-time applications<br>Web-services<br>Etc.<br>**High sensitivity to scaling** |
| Quantitative Management, use of SW Metrics | **Weak management exploitation of metrics**<br>**Sporadic choice and use of metrics** | **Systematic use of software metrics**<br>**Strong emphasis on moving to statistical software process control:**<br>CMMI® Level 4-5<br>Six Sigma |
| Organizational and Management Models | **Functional organization structure**<br>• Matches the hierarchically decomposed product architecture<br>**No sensitivity to multi-contractor environments** | **Organization structured around IPTs (Integrated Product Teams)**<br><br>**Acknowledges highly diverse and complex contractor structure** |
| Systems Engineering | **Weak, nominal software representation and awareness:**<br>• Software always the bottleneck<br>• Disjointed hardware-software processes | **Stronger awareness of software processes and dependencies:**<br>Integrated hardware-software planning<br>Concurrent Engineering |

# Integral Software Engineering Activities

| | OLD | NEW |
|---|---|---|
| Process Maturity and Quality Frameworks | **Did not exist** | **CMM/CMMI®:**<br>Organizational process capability and maturity concepts<br>Clearly defined process areas with detailed practices<br>**ISO 9000 series of quality standards** |
| Quality | **Software Quality = QA + QC = Test**<br>**Emphasis on system test**<br>• Equivalent of QC<br>**Focus on product quality only** | **"New" Software Quality Assurance:**<br>Spread over the life cycle<br>Peer Review of all requirements, design, coding, and test artifacts<br>Emphasis is on defect prevention<br>Scope now includes process audit and process improvement coaching |
| Risk Management | **Hardware-focused:**<br>• Little sensitivity to and awareness of software risks<br>• Assumes hardware-like reliability models for software<br>• Hardware-software risks handled separately | **Integral activity of Spiral Development:**<br>Hardware-software risk mitigation related trade-offs must be done together |



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# Hardware-Software Technology

| | OLD | NEW |
|---|---|---|
| Design Paradigms | **Single, basic software paradigm** | **New, emerging paradigms:**<br>Object-Oriented<br>Agents<br>Genetic Programming<br>Neural Networks |
| Host Processor | **Single processor** | **Multi-processor:**<br>Multi-threaded applications<br>Networks of processors (Grid computing) |
| Communications | **Low bandwidth:**<br>• No significant compression<br>• Limited wireless communication | **High bandwidth:**<br>Sophisticated compression technologies<br>High-speed wireless communication |
| Database Management | **Mainframe oriented:**<br>• Large<br>• Text only<br>• At most relational schema | **On any Host:**<br>Fully scalable<br>Distributed<br>O-O for any objects (image, voice, video) |
| Tools | **Basic, independent tools**<br>**No COTS software perspective** | **Rich toolset, integrated with life cycle process**<br>**High tools vendor/product volatility sensitivity** |
| Documentation | **All documentation static**<br>**Delivered on paper**<br>**Text format primarily ASCII**<br>**No electronic page formatting** | **Dynamic, interactive, searchable**<br>**Executable models for design**<br>**New media (CD, DVD, or on-line server-based)**<br>**New formats (PDLs, XML)** |

# Security

| | OLD | NEW |
|---|---|---|
| Security | **No sensitivity to software specifics:**<br>• Satisfied with password level<br>• System security view only | **High Security Consciousness:**<br>Kernel level security<br>Malicious penetration and virus issues<br>Firewalls, honeypots<br>Denial of Service attacks<br>Trusted computer platforms<br>Sophisticated encryption algorithms<br>Digital Rights management |



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# Conclusions

- In-process software technical reviews are replacing rigid milestone reviews
- The understanding of software development trends is essential for determining review artifacts and their expected performance and maturity according to their position in the system life cycle
- Key Areas of Interest:
  - Architecture
  - Product-Oriented Software Engineering Activities
  - Engineering Management Processes
  - Integral Software Engineering Activities
  - New Hardware-Software Technologies
  - Security



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# Acronyms and Abbreviations

| | |
|---|---|
| ASCII | American Standard Code for Information Interchange |
| CD | Compact Disc |
| CDR | Critical Design Review |
| CMMI | Capability Maturity Model Integration |
| COM | Component Object Model |
| CORBA | Common Object Request Broker Architecture |
| COTS | Commercial Off-the-Shelf |
| CSCI | Computer Software Configuration Item |
| DVD | Digital Video Disc |
| HWCI | Hardware Configuration Item |
| IPT | Integrated Product Team |
| ISO | International Organization for Standards |
| .NET | Microsoft's Web-services Framework |
| O-O | Object-Oriented |
| PDL | Page Definition Language |
| PDR | Preliminary Design Review |
| QA | Quality Assurance |
| QC | Quality Control |
| SSR | System Specification Review |
| UML | Unified Modeling Language |
| USAF | US Air Force |
| WWW | World Wide Web |
| XML | Extensible Markup Language |



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