The Incompatibilities between Software Component Based Development and Present UK MoD Procurement Approaches

Michael Looney
Department of Information Systems
University of Portsmouth
Presentation

Background
Paradigm Shift
Procurement & Management Issues
Summary
**Software Problems**

- **Intangible**
  - invisible,
  - flexible ‘easy to change,

- **Discontinuous Failure Modes**
  - single error can cause system failure
  - 100% correctness required

- **Complex**
  - many levels
  - many modules
  - millions of lines of code

- **Hardware first**
  - traditional systems started with hardware first
  - software was expected to take up the slack
Traditional Review Process

Initiation -> Development -> Build -> Field

- Concept Approval
- System Acceptance
- Progress Reviews
Lifecycle Timeline

R&D/Development

30% LCC

5 - 10 Years

Operation

70% LCC

25 - 50 Year Service Life

Disposal

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## System Complexity

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Description</th>
<th>Memory Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-60s</td>
<td>Dedicated Subsystems</td>
<td>64KB</td>
</tr>
<tr>
<td></td>
<td>Digital Fire Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pt-Pt Wiring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crew dominated operations</td>
<td></td>
</tr>
<tr>
<td>1970-80s</td>
<td>Federated systems</td>
<td>1MB</td>
</tr>
<tr>
<td></td>
<td>Flight Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fly by Wire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crew-assisted operations</td>
<td></td>
</tr>
<tr>
<td>1990-00s</td>
<td>Integrated Systems</td>
<td>100MB</td>
</tr>
<tr>
<td></td>
<td>Aircraft wide information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>integration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Massive data bases</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Digital sensor processing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integrated diagnostics</td>
<td></td>
</tr>
</tbody>
</table>

Source: US Air Force Research Laboratory
## System Comparisons

<table>
<thead>
<tr>
<th>System</th>
<th>Processors</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADA1(1961)</td>
<td>3</td>
<td>36K</td>
</tr>
<tr>
<td>ADA2</td>
<td>2 + 3</td>
<td>96K</td>
</tr>
<tr>
<td>ADAWS</td>
<td>2 + 2</td>
<td>600K</td>
</tr>
<tr>
<td>CAAIS</td>
<td>1</td>
<td>100K</td>
</tr>
<tr>
<td>CACS</td>
<td>2 + 7</td>
<td>1M</td>
</tr>
<tr>
<td>SMCS</td>
<td>~150</td>
<td>~100M</td>
</tr>
<tr>
<td>SSCS(1997)</td>
<td>~300</td>
<td>~400M</td>
</tr>
</tbody>
</table>
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Background

Paradigm Shift

Procurement & Management Issues

Summary
Changes

- Process
- Control over the outcome
- System costs
*Paradigm Shift*

System developers/procurers have moved from being producers to being consumers.
Producer v Consumer

Producer

• Identify requirements
• Build bespoke components
• Identify unique interfaces
• Integrate bespoke components
• Field and support bespoke system

Consumer

• Identify requirements
• Framework/Integration Strategy
• Adopt standard interfaces
• Procure components based on standards
• Integrate Components into Framework
• Field and support integrated system
A Necessary New Way of Doing Business

Traditional Development Approach

- System Context
- Architecture & Design
- Implementation

Required Approach for COTS Based Systems

- System Context
- Simultaneous Definition and Tradeoffs
- Marketplace
- Architecture & Design

Adapted from Oberndorf & Foreman, SEI, 1999
Systems Integration of Components

Real World Systems of Systems
Component Based Development

- Legacy Components
- Commercial Components
- New Development Items
Architecture/Interface/Glue Code

Fully Wrapped
New Development Item

Added/Modified Interface

Glue code
Legacy component
Legacy component
Newly developed component
Presenting Alternative Options for Decision Making Process at Business Level

- Analyse System
- Negotiate Trade Off at Technical System Level & Prototype Solution
- Produce Set of Feasible System Designs
- Presentations of Alternative Options for Decision Making Process at Business Level
- Specify Requirements/Constraints
- Project Management, Configuration Control
- Implementation/Acceptance

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Sub Process Model

Produce set of feasible System Designs

Selection of Arch./Framework Identification of Glue Code Standard Identification of Interface Standards

Derived Constraint, Human Factors Socio/economic Implications

Component Selection Component Tailoring

Impact Analysis, Combinatory issues
Presentation

Background

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Procurement & Management Issues

Summary
Management Process

- Initiating processes
- Planning processes
- Executing processes
- Controlling processes
- Closing processes
Management Changes

For

• More sources
• Better quality
• Newer technology
• Cheaper implementations
• Faster availability
• Easier Interconnections

Against

• Not finding precisely the right component
• Market driven changes
• Vendor support for the component stops
Software Project Managers’ Balancing Act

- Strategies for through life support
- Impact of high reliance on COTS components
- Trade offs between requirements, components and cost
- Components, architecture, integration
- Strategies to deal with component obsolescence
Procurement

Acquisition is a whole life process, covering requirements setting, initial procurement, in-service support and disposal
Smart Procurement

Through Teamworking
Whole life approach
Using best practice

Capability Acquisition will be
Faster
Cheaper
Better
Mythical or Real?

Better, Cheaper, Faster?

System Requirements
Area of Flexibility

Quality

Schedule

Cost

Performance

Adapted from an NUWC presentation
**Smart Procurement Stages**

- **Concept Stage**: First stage which forms the integrated team and produces the user requirements. The business case is assembled for Initial Gate approval.

- **Assessment Stage**: Begins after Initial Gate, risk is reduced to a level consistent with delivering an acceptable level of performance to a controlled time and cost. The business case is assembled for Main Gate approval.

- **Demonstration Stage**: During this stage the ability to produce an integrated capability is demonstrated. The prime is selected and a contract based on the system requirements placed.

- **Manufacture Stage**: The integrated team deliver the solution to the military requirement, completing system development and production. System acceptance is conducted.

- **In-Service Stage**: The line management provide effective front line support and carries out approved upgrades or improvements, refits and acquisition increments.

- **Disposal Stage**: Efficient, effective and safe disposal of the system.
**Smart Procurement**

Progressive Acceptance

- User and System requirements
- Design Certification
- System Acceptance
- In-Service Date
**Smart Procurement Definitions**

- **Initial Gate**
  - A relatively low approval hurdle, between Concept and Assessment, intended to encourage early and full exploration of a wide range of options for meeting a particular capability.

- **Main Gate**
  - An exacting approval hurdle, between Assessment and Demonstration. A business case at Main Gate should recommend a single technology and procurement option.
Maintenance/Upgrade Issues

Environment

Operational requirement

Platform availability

Programme

Cost

Modification task

Risk

Capability upgrade

Technology availability

Obsolescence change

- Drives
- Enables/causes
- Dictates
- Implies
- Constrains
### Change Drives/Rates

<table>
<thead>
<tr>
<th>GSAW Survey</th>
<th>Release Frequency (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>6.3</td>
</tr>
<tr>
<td>2000</td>
<td>8.5</td>
</tr>
<tr>
<td>2001</td>
<td>8.75</td>
</tr>
</tbody>
</table>

1. Adaptive maintenance often biggest CBS life cycle cost
2. Average of 3 releases before becoming unsupported

Ron Kohl survey

Development Cost Model

- Requirements specification
- Design review
- In service date

<table>
<thead>
<tr>
<th>Time</th>
<th>Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cots Assessment</td>
</tr>
<tr>
<td>2</td>
<td>Cots Tailoring</td>
</tr>
<tr>
<td>3</td>
<td>Glue code dev.</td>
</tr>
<tr>
<td>4</td>
<td>COTS volatility effort</td>
</tr>
<tr>
<td>5</td>
<td>New Developments</td>
</tr>
</tbody>
</table>

USC Report for ONR Sept 2000

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Through Life Cost Model

Adapted from USC Report
Traditional Life Cycle Cost View

Cost Factor - £

Traditional Development & Support

Mid-Life Upgrade

Life Cycle Years - Development & Fielding

NUWC presentation on Open System and COTS software June 99
COTS/NDI Life Cycle Cost View

COTS/NDI Development & Support

Periodic Upgrade/ Component Replacement

Life Cycle Years - Development & Fielding

Cost Factor - £
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Changes

For

• More sources
• Better quality?
• Newer technology
• Cheaper implementations
• Faster availability
• Easier Interconnections?

Against

• Not finding precisely the right component
• Market driven changes
• Vendor support for the component stops
• Component Volatility
• Less effective estimation and tracking
• More complexity and less adherence to any set process
Comments

In a dynamic environment following a fixed plan can produce the system intended but not necessarily the system needed.
Comments

‘Do it right first time’

- No uncertainty
- No experimentation
- No deviation from the plan
Critical Issues

- Architecture, standards, & interfaces.
- Component selection.
- Support paradigm.
Conclusions

- Development and support paradigm has changed
- Project management is different
- Risks are different
- Frequency of change is significant
- Fielding and acceptance could be main cost driver
- Understanding the market is essential
- Present procurement approaches are incompatible
For Additional Information

Michael Looney  
Senior Research Fellow  
Department of Information Systems  
Burnaby Terrace  
1-8 Burnaby Road  
Portsmouth  PO1 3AE

Tel. 023 9284 6407  
E-mail: looney@which.net