Value-Based Software Engineering: Theory, Process, and Case Study

CS 566 – Software Management and Economics
Lecture 3 (Boehm 2005; Chapter 9, Selby 2007)

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Outline

- VBSE Structure
- VBSE Process and Case Study
  - Elements and Contributions
  - Theory-driven process
  - Supply chain case study
- Summary
- References
Theory W: Enterprise Success
Theorem (with Informal Proof)

Theorem: Your enterprise will succeed if and only if it makes winners of your success-critical stakeholders.

- Proof of “if”:
  Everyone that counts is a winner. Nobody significant is left to complain.

- Proof of “only if”:
  Nobody wants to lose. Prospective losers will refuse to participate, or will counterattack. The usual result is lose-lose.
Theory W: WinWin
Achievement Theorem

Making winners of your SCSs requires:

i. Identifying all of the SCSs.

ii. Understanding how the SCSs want to win.

iii. Having the SCSs negotiate a win-win set of product and process plans.

iv. Controlling progress toward SCS win-win realization, including adaptation to change.
VBSE Theory: 4+1
Structure

Dependency Theory
How do dependencies affect value realization?

Utility Theory
What values are important? How is success assured?

How important are the values?

Decision Theory
How do values determine decision choices?

SCS Win-Win
How to adapt to change and control value realization?

Control Theory
How important are the values?
**VBSE Component Theories**

- Theory W (Stakeholder win-win)
  - Enterprise Success Theorem, Win-Win Achievement Theorem
- Dependency Theory (Product, process, people interdependencies)
  - Systems architecture/performance theory, costing and scheduling theory; organization theory
- Utility Theory
  - Utility functions, bounded rationality, Maslow need hierarchy, multi-attribute utility theory
- Decision Theory
  - Statistical decision theory, game theory, negotiation theory, theory of Justice
- Control Theory
  - Observability, predictability, controllability, stability theory
Dependency Theory - Example

Users
- Many features
- Changeable requirements
- Applications compatibility
- High levels of service
- Voice in acquisition
- Flexible contract
- Early availability

Maintainers
- Ease of transition
- Ease of maintenance
- Applications compatibility
- Voice in acquisition

Acquirers
- Mission cost/effectiveness
- Limited development budget, schedule
- Government standards compliance
- Political correctness
- Development visibility and control
- Rigorous contact

Developers
- Flexible contract
- Ease of meeting budget and schedule
- Stable requirements
- Freedom of choice: process
- Freedom of choice: team
- Freedom of choice: COTS/reuse

PC: Process
PD: Product
PP: Property
S: Success
Utility Theory - Example
Decision Theory - Example

A simple decision tree.
Decision Theory – Example (2)

- RE due to inadequate plans
- RE due to market share erosion
- Sum of risk exposures

**Sweet Spot**

- high P(L): inadequate plans
  - high S(L): major problems (oversights, delays, rework)

- low P(L): few plan delays
  - low S(L): early value capture

- high P(L): plan breakage, delay
  - high S(L): value capture delays

- low P(L): thorough plans
  - low S(L): minor problems

\[ RE = P(L) \times S(L) \]
Control Theory - Example

Value Realization Feedback Control

1. Develop/update business case; time-phased cost, benefit flows; plans
2. Perform to plans
3. Value being realized?
   - Yes: No further action
   - No
     - Assumptions still valid?
       - Yes: No further action
       - No: Determine corrective actions

Yes

No
Initial VBSE Theory: 4+1 Process – With a great deal of concurrency and backtracking

Dependency Theory
- 2a. Results Chains
- 3b, 5a, 7b. Cost/schedule/performance tradeoffs
- 3b, 7a. Solution Analysis

Utility Theory
- 3. SCS Value Propositions (Win conditions)
- 4. SCS expectations management
- 5a, 7b. Prototyping

Theory W: SCS Win-Win
- 1. Protagonist goals
- 3a. Solution exploration
- 7. Risk, opportunity, change management
- 5a, 7b. Option, solution development & analysis

Control Theory
- 6, 7c. Refine, Execute, Monitor & Control Plans
- 6a, 7c. State measurement, prediction, correction; Milestone synchronization

Decision Theory
- 5a. Investment analysis, Risk analysis
- SCS: Success-Critical Stakeholder

LUMS
6/18/2008
Case Study
Sierra Mountainbikes

- Based on what would have worked on a similar project
- Quality leader in specialty area
- Competitively priced
- Major problems with order processing
  - Delivery delays and mistakes
  - Poor synchronization of order entry, confirmation, fulfillment
  - Disorganized responses to problem situations
  - Excess costs; low distributor satisfaction
Project Strategy and Partnerships

- Partner with eServices, Inc. for order processing and fulfillment system
  - Profit sharing using jointly-developed business case
- Partner with key distributors to provide user feedback
  - Evaluate prototypes, beta-test early versions, provide satisfaction ratings
- Incremental development using MBASE/RUP anchor points
  - Life Cycle Objectives; Architecture (LCO; LCA)
  - Core Capability Drivethrough (CCD)
  - Initial; Full Operational Capability (IOC; FOC)
- Architect for later supply chain extensions
**Order-Processing Project**

**Goals:** Improve profits, market share, customer satisfaction via improved order processing

**Questions:** Current state? Root causes of problems? Keys to improvement?

**Metrics:** Balanced Scorecard of benefits realized, proxies
- Customer satisfaction ratings; key elements (ITV: in-transit visibility)
- Overhead cost reduction
- Actual vs. expected benefit and cost flows, ROI
# Frequent Protagonist Classes

<table>
<thead>
<tr>
<th>Protagonist Class</th>
<th>Goals</th>
<th>Authority</th>
<th>Ideas</th>
<th>Resources</th>
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<tr>
<td>Inventor with Goals, Ideas</td>
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<td>Consortium with Shared Goals</td>
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</table>

- **Sierra Mountainbikes: Susan Swanson, new CEO**
  - Bicycle champion, MBA, 15 years’ experience
  - Leads with goals, open agenda
DMR/BRA* Results Chain

**INITIATIVE**: Implement a new order entry system

**CONTRIBUTION**: Reduce time to process order

**OUTCOME**: Reduced order processing cycle (intermediate outcome)

**CONTRIBUTION**: Reduce time to deliver product

**OUTCOME**: Increased sales

**ASSUMPTION**: Order to delivery time is an important buying criterion

*DMR Consulting Group’s Benefits Realization Approach*
Expanded Order-Processing System Benefits Chain

Assumptions
- Increasing market size
- Continuing consumer satisfaction with product
- Relatively stable e-commerce infrastructure
- Continued high staff performance

Developers

New order-entry system

Less time, fewer errors in order processing

Faster, better order entry system

Safety, fairness inputs

Interoperability inputs

New order fulfillment system

Increased customer satisfaction, decreased operations costs

Increased sales, profitability, customer satisfaction

On-time assembly

Improved supplier coordination

Suppliers

Distributors, retailers, customers

Faster order-entry steps, errors

New order-entry processes, outreach, training

Sales personnel, distributors

Increased profits, growth
Business Case Analysis

- Estimate costs and schedules
  - COCOMO II and/or alternative for software
  - PRICE H or alternative for hardware
  - COSYSMO for systems engineering

- Estimate financial benefits
  - Increased profits
  - Reduced operating costs

- Compute Return on Investment
  - \[ \text{ROI} = \frac{\text{Benefits} - \text{Costs}}{\text{Costs}} \]
  - Normalized to present value

- Identify quantitative metrics for other goals
  - Customer satisfaction ratings
    - Ease of use; In-transit visibility; overall
  - Late delivery percentage
## Order-Processing System Schedules and Budgets

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<th>Milestone</th>
<th>Due Date</th>
<th>Budget ($K)</th>
<th>Cumulative Budget ($K)</th>
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<td>FOC Beta</td>
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<td>6000</td>
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<td>Annual Oper. &amp; Maintenance</td>
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<td>Annual O&amp;M; Old System</td>
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## Order-Processing System: Expected Benefits and Business Case

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<th>Date</th>
<th>Current System</th>
<th>New System Financial</th>
<th>New System Customers</th>
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<td>Market Size ($M)</td>
<td>Market Share %</td>
<td>Sales</td>
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<td>12/31/03</td>
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<tr>
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<td>80</td>
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<tr>
<td>12/31/05</td>
<td>440</td>
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<td>88</td>
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<td>12/31/06</td>
<td>480</td>
<td>20</td>
<td>96</td>
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<td>12/31/07</td>
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<td>12/31/08</td>
<td>560</td>
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</table>
An Earned Value System (EVS)

- Current “earned value” systems monitor cost and schedule, not business value
  - Budgeted cost of work performed (“earned”)
  - Budgeted cost of work scheduled (“yearned”)
  - Actual costs vs. schedule (“burned”)


EVS Example

Budgeted Cost of Work Scheduled

Cost

Specs
Plans
Analyses
Prototypes

Time
EVS Example (2)

Cost

Time

Budgeted Cost of Work Scheduled

Specs

Plans

Analyses

Prototypes

Budgeted Cost of Work Performed

Project Expenditures
Earned Value Feedback Process

- Develop/update plans, BCWS
- Perform to plans
- BCWP ≥ BCWS?
  - Yes
  - BCWP ≥ cost?
    - Yes
    - No
    - No
- Determine corrective actions

• BCWS: Budgeted Cost of Work Scheduled
• BCWP: Budgeted Cost of Work Performed
A Real Earned Value System (REVS)

- A real earned value system monitors benefits realized
  - Financial benefits realized vs. cost (ROI)
  - Benefits realized vs. schedule
    - Including non-financial metrics
  - Actual costs vs. schedule
Real Earned Value Feedback Process

Develop/update business case; time-phased cost, benefit flows; plans

Perform to plans

Value being realized?

Assumptions still valid?

Determine corrective actions

Yes

No

No
## Value-Based Expected/Actual Outcome Tracking Capability

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Schedule</th>
<th>Cost ($K)</th>
<th>Op’l Cost Savings</th>
<th>Market Share %</th>
<th>Annual Sales ($M)</th>
<th>Annual Profits ($M)</th>
<th>Cum. Profits</th>
<th>ROI</th>
<th>Late Delivery %</th>
<th>Customer Satisfaction</th>
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<th>Ease of Use</th>
<th>Risks/Opportunities</th>
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<td>72</td>
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<td>12.4</td>
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<td>2.4*</td>
<td>1.0*</td>
<td>2.7*</td>
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<td>Using COTS ITV fallback; new HW competitor; renegotiating HW.</td>
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<td>$200K savings from renegotiated HW.</td>
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Summary

- 4 + 1 structure
- EVS vs. REVS
- Supply chain case study
References