Predicting M&R Investments and Outcomes with the BUILDER™ Sustainment Management System

Lance Marrano
Program Manager
ERDC-CERL
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Agenda/Outline

- Background
- Inventory
- Assessment
- Prediction
- Work Planning
- Forecasting
- Visualization & Integration
- Summary & Discussion
Facility Managers’ Needs

**Engineered Asset Lifecycle Management Tools**

Provide objective facility investment guidance for:

- **Systematic** assessment to identify maintenance requirements for increased reliability
- **Analyze** gap between current state and requirements; plan investments to close this gap and optimize return on investment
- **Prioritize** scarce resources according to economic and mission priorities
- **Predict** the effects/consequences of decisions to ensure mission readiness
The Goal

- **Investment Planning** driven by meaningful metrics:
  - Asset Lifecycle
  - Return on Investment (ROI)
  - Mission Assuredness

- **Supports Installation, Regional, and HQ processes**
  - Tactical Facility Requirements (Short Term)
  - Strategic Facility Requirements (Long Term)
  - Objective, Repeatable, & Affordable

Practice **proactive rather than reactive** maintenance planning at all levels of the organization.
Approach – A New Way of Looking At Assets

Traditional vs. SMS

**Deficiency:** Re-point brick retaining wall

**Work Quantity:** 200 SF

**Scoping Estimate:** $4400

**Urgency/Priority:** 3

**Distress Type(s):** Deteriorated and Cracked

**Severity Level(s):** Low and Med

**Quantity/Density:** 200 SF and 12 LF

**Condition Index (calc.):** 72
Process

Inventory
- Real Property Inventory
- Component Inventory

Assessment
- Condition Assessment
- Functionality Assessment

Prediction
- CI Prediction

Work Planning
- Work Generation
- Work Prioritization

Forecasting
- Course of Action (COA) Analysis
Inventory

- Identify “building blocks” of facilities that will be independently maintained
  - Identify components (doors, walls, windows, roof, etc.), as well as equipment.
  - Like equipment may be grouped when managed as one lifecycle group (i.e. set of exhaust fans, overhead doors)
- Capture appropriate detail to accurately reflect replacement values and service lives
Inventory Results

- Inventory models aligned with RPI requirements
  - RP Site ID
  - RP UID
  - (Future) RP Equipment ID
- Detailed inventory can be derived from maintenance records*
  - Quantity
  - Equipment Type
  - Age
  - Etc.

* Need to also include facility assemblies, such as walls, roofs,

<table>
<thead>
<tr>
<th>System</th>
<th>Component</th>
<th>Section Description</th>
<th>Quantity (UM)</th>
<th>Yr. Installed</th>
<th>Yr. Painted</th>
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<tbody>
<tr>
<td>Conveying</td>
<td>Elevator</td>
<td>Electric Freight 2 Stops</td>
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<td></td>
<td>Generator Set</td>
<td>Gasoline &lt;35 KW</td>
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<td>Intruder Detection/Security</td>
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<tr>
<td></td>
<td>Lighting Fixtures</td>
<td>Fluorescent Interior</td>
<td>425 (EA)</td>
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<tr>
<td>Exterior Closure</td>
<td>Exterior Door</td>
<td>Glass Personnel</td>
<td>6 (EA)</td>
<td>2007</td>
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<td></td>
<td>Exterior Wall</td>
<td>Masonry Face Brick w/ CMU Backup</td>
<td>5,268 (SF)</td>
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<td></td>
<td>Exterior Window</td>
<td>Metal Casement</td>
<td>57 (EA)</td>
<td>2007</td>
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Process

1. **Inventory**
   - Real Property Inventory
   - Component Inventory

2. **Assessment**
   - Condition Assessment
   - Functionality Assessment

3. **Prediction**
   - CI Prediction

4. **Work Planning**
   - Work Generation
   - Work Prioritization

5. **Forecasting**
   - Course of Action (COA) Analysis
## Condition Assessment

- Standardized, objective process uses technician-level experience, rather than architects/engineers
  - Inspector is “human sensor”, doesn’t insert their opinion/interpretation
  - Models the rating that would be given by a group of experts.
  - Increases consistency and quality of information across organization (apples-to-apples)

### Distress Type(s):
- Deteriorated and Cracked

### Severity Level(s):
- Low and Med

### Quantity/Density:
- 200 SF and 12 LF

### Condition Index (comp.):
- 72

### Deficiency:
- Re-point brick retaining wall

### Work Quantity:
- 200 sf

### Scoping Estimate:
- $4400

### Urgency/Priority:
- 3

### Traditional

<table>
<thead>
<tr>
<th>Deficiency</th>
<th>Re-point brick retaining wall</th>
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<tbody>
<tr>
<td>Work Quantity</td>
<td>200 sf</td>
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<tr>
<td>Scoping Estimate</td>
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<tr>
<td>Urgency/Priority</td>
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### SMS

<table>
<thead>
<tr>
<th>Distress Type(s)</th>
<th>Deteriorated and Cracked</th>
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<tbody>
<tr>
<td>Severity Level(s)</td>
<td>Low and Med</td>
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<tr>
<td>Quantity/Density</td>
<td>200 SF and 12 LF</td>
</tr>
<tr>
<td>Condition Index (comp.)</td>
<td>72</td>
</tr>
</tbody>
</table>

BUILDING STRONG®
Utilize objective, rules-based inspection to capture consistent information set.

- Models the rating that would be given by a panel of experts.
- Expresses the ability of the component to continue to reliably provide the as-designed function.

Condition Index Metric

- Distress
- Severity (H/M/L)
- xCI (PCI, CSCI, etc.)

Standard Rating Scale
- Good
- Satisfactory
- Fair
- Poor
- Very Poor
- Serious
- Failed

Ex. Distresses
- Animal Dmg
- Blisters
- Cracking
- Displacement
- Inoperable
- Vibration
- Etc.
## Condition Assessment

### Component: Exterior Door
- **Section:** Metal Overhead

### Subcomponent: Door Frame

<table>
<thead>
<tr>
<th>Distress</th>
<th>Severity</th>
<th>(Optional) Subcomp</th>
<th>(Optional) Distress</th>
<th>Density</th>
<th>Critical</th>
<th>ESC</th>
<th>ESC Number</th>
<th>ESC Date</th>
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<tbody>
<tr>
<td>Animal/Insect Damage</td>
<td>Low</td>
<td></td>
<td></td>
<td>&gt;1% - 5%</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Knowledge Based Inspection

- An asset does not require the same level of scrutiny at all points in its lifecycle.
- All assets do not degrade at the same rate.
- Focus inspection attention and resources on what’s important, considering risk.
- Tailor the frequency and level of detail to the purpose and lifecycle condition.
Knowledge Based Inspection

Inspection costs are ~25% of traditional, deficiency-based inspections
Functionality Assessment

- Modernization inspection addresses issues of:
  - Capacity (too little or too much)
  - Configuration
  - Change in user requirements
  - Technical obsolescence
  - Regulatory/code compliance
  - Etc.

- Available at building, space, and component levels
- Can simulate mission change to determine investment requirements for future occupants

<table>
<thead>
<tr>
<th>Issue</th>
<th>Issue F1</th>
<th>Last Assessment</th>
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<tr>
<td>Location</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
<tr>
<td>Building Size and Configuration</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
<tr>
<td>Structural Adequacy</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
<tr>
<td>Access</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
<tr>
<td>ADA</td>
<td>100</td>
<td>02/21/2007</td>
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<tr>
<td>ATFP</td>
<td>100</td>
<td>02/21/2007</td>
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<tr>
<td>Building Services</td>
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<td>02/21/2007</td>
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<tr>
<td>Comfort</td>
<td>100</td>
<td>02/21/2007</td>
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<tr>
<td>Efficiency and Obsolescence</td>
<td>100</td>
<td>02/21/2007</td>
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<tr>
<td>Environmental/Health</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
<tr>
<td>Missing or Improper Components</td>
<td>100</td>
<td>02/21/2007</td>
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<tr>
<td>Aesthetics</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
<tr>
<td>Maintainability</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
<tr>
<td>Cultural Resources</td>
<td>100</td>
<td>02/21/2007</td>
</tr>
</tbody>
</table>
Functionality Assessment

- Building: 11 - EXCHANGE
- Functionality Assessment:
  - Assessment Date: 03/21/2011
  - Building Use Type: 7401 - EXCHANGE RETAIL STORE
  - Status: Active

- Issue Table:
  - Location: N/A
  - Building Size and Configuration: N/A
  - Structural Adequacy: N/A
  - Access: N/A
  - ADA: N/A
  - ATFP: N/A

- Sub-Issue Table:
  - If the internal power supply is adequate?
  - If the pre-wire power supply (if any) is adequate?
  - If the water supply is adequate?
  - If the hot water supply is adequate?
  - If the specialty water supply is adequate?
  - Are the plumbing fixtures adequate?
  - Is the stand-alone wastewater removal system adequate?
  - Is the industrial wastewater removal system adequate?
  - Is the information technology (IT) system adequacy?
  - Is the fuel distribution system adequate?
  - Is the oxygen (or other gas) system adequate?
  - Is the compressed air system adequate?
  - Is the security system adequate?
  - Is the telephone system adequate?
  - Is the electrical distribution adequate?

- Functionality Sub-Issue Definitions:
  - Issue: Building (or Functional Area) Services
  - Sub-Issue: Internal Power Supply
  - Definition: The internal power supply, such as a generator, within the building (or functional area) is inadequate.
  - Severity Levels:
    - Red - The components assigned to the generator do not receive the appropriate power, posing a life safety issue or adversely affecting the mission to a significant degree.
    - Amber - The components assigned to the generator do not receive the appropriate power, but life safety is not an issue and the mission is not affected to the level of red.
    - Green(+) - The internal power supply is adequate.
Assessment Results

- Readiness Reporting (Condition, or Quality)
- Condition for **complete** inventory, not just problems
- Up-to-date scorecard that doesn’t require constant data maintenance
Process

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- Component Inventory

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- COA Analysis
Weibull distribution used to model risk of component failure
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Work Generation

- Work is automatically created based upon rules
  - Standards define acceptable levels of risk as thresholds to trigger work
  - Policies apply these differing risk levels to different assets
  - Mission critical assets require higher condition levels
- Cost estimates are automatically calculated based on replacement costs
  - Repair vs. Replace calculations automatically performed to maximize ROI
- Work is tied to specific assets; establishes traceability and accountability.

Defensible rules enforce consistent investment policies across the enterprise.
Investment Triggers

Work requirements are automatically generated when condition falls below enterprise policy levels.
Work Prioritization

- Funding resources are always constrained
  - Need prioritization to rank work requirements
- Use various parameters including economic, criticality, and geographic factors
- Focus work efforts on items most critical to mission accomplishment while reducing lifecycle costs.

Enterprise-defined prioritization allows organization to **optimize** multiple competing requirements for scarce funding.
FCI Calculation

BUILDER-derived value is more consistent and repeatable than deficiency-based methods

► Work is now generated using objective ratings AND an defensible set of enterprise policies, rather than subjective judgment
Work Planning Results

- Annual work planning attached to specific assets (accountability and traceability)
- Work planning prioritized by mission requirements to direct scarce dollars against mission-critical needs (Mission-Focused Facility Investments)
Process

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Forecasting

Same process as annual work planning, but repeated for multiple years over known inventory, behavior, policies, and funding.

- Simulate the long-term impact on condition, performance, and estimated backlog
- Evaluate different scenarios (budgets, policies, prioritization schemes, etc.)

Gain consequence awareness by magnifying the effects of policy decisions over multiple years.
Forecasting Results

- Budget Creation
- COA Analysis
- Budget Defense
- Out-year strategic condition trends
  - Will levels meet current or future mission requirements?
INTEGRATION & VISUALIZATION
GIS

- Contains integrated or connected GIS solutions to query and display a variety of facility inventory, condition, and work planning information
  - CI,
  - RSL,
  - Work Costs,
  - and many more
CMMS Integration

- Work Planning and Work Execution have complementary roles

**SMS**
- Consolidated inventory
- Plan inspections (KBI)
- Inspection results
- Determine condition
- Analyze condition
- Update RSL
- SRM and budget planning, including project development
- Consequence analysis

**CMMS**
- Specialized inventory
- Plan, schedule, and execute PM
- Inspection needs analysis
- Schedule inspections
- Service call history
- RCM analysis
- Plan, schedule, and execute specific projects
IMPLEMENTATION
## SMS Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BUILDER</strong></td>
<td>for all Building Components</td>
</tr>
<tr>
<td><strong>PAVER</strong></td>
<td>for Airfields and Roads</td>
</tr>
<tr>
<td><strong>RAILER</strong></td>
<td>for Track</td>
</tr>
<tr>
<td><strong>ROOFER</strong></td>
<td>for Roofing</td>
</tr>
</tbody>
</table>

Programs are also available to private sector users through multiple licensing partners:
- Increases availability of services to Federal Users
- Lowers support costs through increased availability and broader user base
DoD Users

**BUILDER**
- Army*, Air Force*, Navy, USMC, DLA

**PAVER**
- Army, Air Force, Navy, USMC
- OSD – 2012 Implementation Deadline

**RAILER**
- Army, Navy, USMC
- OSD – 2012 Implementation Deadline

**ROOFER**
- Army, Air Force (Limited Deployment), Navy (Regional Deployment), USMC (Limited Deployment)

* Denotes trial or pilot use, but not yet an enterprise standard
THE RESULTS

Defensible, engineering-based investment plan

- Traceable and executable to the facility component level
  - Component-based performance models work with any size portfolio
- Aligned with mission requirements
- Balances mission and economic priorities
- Provides course of action analysis
  - Avoidance of long-term penalties
  - Awareness of the consequences of today’s decisions

Manage by **leading** instead of **lagging** indicators
Summary Discussion

QUESTIONS?
More Information

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http://sms.cecer.army.mil
- SMS Resources

http://www.erdc.usace.army.mil
- Installation Operations (more products and expertise from the Engineer Research & Development Center)
BACKUP SLIDES
Condition Assessment Input

Ex. Distresses
- Animal Dam.
- Cracking
- Efflorescence
- Vibration
- Inoperable
- Etc.

Severity (H/M/L)

xCl (PCI, BCI, etc.)

Quantity

0 10 25 40 55 70 85 100

Standard Rating Scale

Good
Satisfactory
Fair
Poor
Very Poor
Serious
Failed