Assess and Prioritize
Keys to Asset Management

Presentation Outline
- Assessment
- Prioritization Ideas
- Approach for Multiple, Large Assets
  - Developing an Elemental Approach
  - Inspection Types
  - Scoring Methodology

Asset Management
- Establish Priorities
- Develop Input Parameters
- Scoring Methodology

Example: Waste Water Treatment Plant
Establish Priorities

Scoring Methodology

• Importance Weights
  • Weighting importance = \( \text{importance} \times \frac{100}{\max \text{rating}} \)
  • \( \sum \text{category score} \times \text{weighting} = \text{priority rating} \)

• Structural Deterioration (25%)
• Operational Impact (25%)
• Safety Hazards (25%)
• Environmental Impact (25%)
Prioritization Matrix

- Structural assessment to develop deterioration ratings

Port Facilities - Asset Management

Basis for Prioritization

Overall Priority

- Location Assessment
- Repair Recommendations
- Risk of Failure
- Cost & Revenue
Wharf Characteristics

- Dock Configuration
- Area
- Usage
- Load Rating
- Location on Site
- Channel

Condition Assessment

- Element-by-Element
- Current Condition
- Future Condition
- Years of Service Remaining

Cost & Revenue

- Cost of Repair Program
  - Maintain current loads?
  - Upgrade to greater loads?
- Revenue
  - Current
  - Projected (no repairs)
  - Projected (with repairs)
Final Scoring

- Desirability Approach
  - Individual Score: 0 to 1
  - Overall Score: Geometric Mean

Asset Management Plan

- Objectives and Measure
- Performance Gap Identification
- Lifecycle Cost & Risk Management Analysis
- Financial Planning – Capital Budget
Facility Inspection Program

- Database of Asset Inspection and Inventory
- Element-level Inspection
  - Feeds into Component-level Data
  - Rates Asset Performance
  - Monitors Deterioration
- Maximizes Owner Benefits
- Minimizes Owner Costs

Element-based Inspection Approach

- Inspections are conducted at the element level
  - Provides level of detail necessary for credible condition assessment
  - Damage/deterioration characterized by element and material type
- Element condition used to determine component ratings
  - Engineering interpretation of element condition states and corresponding impact on component condition
  - Guides Follow-up Actions
- Component ratings used to determine overall asset condition assessment

Hierarchy of Facility Terms – Elemental-based

- Property or Terminal
  - Contains several maritime assets
    - e.g., Container Terminal, Bulk Cargo Terminal, Transportation Area
- Maritime Asset
  - Wharf
    - Boat Dock
    - Breakwater
    - Shoreline
    - Comprise of One or More Components
- Component
  - Structural or Non-structural System of Elements
    - Structural (e.g., superstructure, bulkheads)
    - Berthing System
    - Shoreline
    - Ancillary (e.g., crane rails, access systems)
- Element
  - Individual Elements that Make Up a Component
    - Structural or Non-structural
      - e.g., RC slab, RC deck beam, steel pipe, timber pile, cleat, bollard, wearing surface
### Inspection Types

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<thead>
<tr>
<th>Type</th>
<th>Sub-type</th>
<th>Primary Objective</th>
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<tbody>
<tr>
<td>Baseline</td>
<td>Above Water</td>
<td>Inspection to establish the baseline (initial) asset inventory, component condition states, component ratings, and asset condition for a new asset or for an existing asset where no previous record exists.</td>
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<tr>
<td>Routine</td>
<td>Above Water</td>
<td>Regularly-scheduled inspection to define asset condition, component ratings, and element condition states at a point in time and to allow tracking of conditions over time.</td>
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<td>Special</td>
<td>Post-event</td>
<td>Rapid inspection to assess overall condition following an extreme event such as a hurricane, flood, or vessel impact.</td>
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<td></td>
<td>In-depth</td>
<td>In-depth inspection to determine specific damage or distress, to aid in determining a suitable repair approach, or to define quantities necessary for repair purposes.</td>
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<tr>
<td></td>
<td>Due Diligence</td>
<td>Inspection to establish the general condition, asset value, or needed for and approximate cost of repairs, at times of change of ownership, lease, or for insurance purposes.</td>
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### Relationship Between Inspection Types

#### Baseline Inspection
- **Immediate Action:**
  - Respond to conditions that may compromise facility operations or lead to loss of life, property damage, or environmental damage

#### Routine Inspection
- **Outcomes:**
  - No Action
  - More information or repairs needed

#### In-depth Inspection
- **Outcomes:**
  - No Action
  - More information or repairs needed
  - Immediate Action

### Baseline Inspection
- **Applies to:**
  - New assets
  - Existing assets without previous inspection documentation
  - Above water (visual) and underwater
- **Objectives:**
  - Develop asset inventory record (reference for future inspections)
  - Inspect elements to set baseline condition states
  - Determine component condition ratings & asset condition assessment
Baseline Inspection

- **Deliverables:**
  - Asset Inventory Record (standard form created during baseline inspection)
    - Asset Description and History
    - List of Components and Elements
    - Photographs (typical)
  - Standard Inspection Drawings
    - Cumulative As-built
    - Using standard reference grid system and component/element names

Baseline Inspection (continued):

- **Deliverables:**
  - Baseline Condition
    - Element condition states and quantities (Elemental Inspection Form)
    - Component condition rating and overall asset condition (Inspection Summary Form)
  - List of recommended follow-up actions (Follow-up Actions Form)
Routine Inspection

- Applies to:
  - Existing assets with previous Baseline Inspection
  - Above water (visual) and underwater
- Objectives:
  - Document asset condition at pre-defined time intervals
    - Visual inspection of elements to set current condition states
    - Determine component ratings & overall asset condition assessment
    - Allows tracking of conditions over time

Routine Inspection Frequency

- Max. once every 3 years for above water
- Max. once every 6 years for underwater
- May be more frequent* for assets with severe deterioration or heavy use
- May be less frequent* for new assets
- Works from Existing Documentation (from Baseline Inspection):
  - Asset Inventory Record
  - Standard Inspection Drawings
  - Previous Inspection Records (forms, quantities, previous condition, etc.)

Discussion – Inspection Frequency

<table>
<thead>
<tr>
<th>Source</th>
<th>Max. Above Water</th>
<th>Max. Underwater</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>WJE</td>
<td>3 yrs</td>
<td>6 yrs</td>
<td>Interval may be reduced or increased depending on condition or use</td>
</tr>
<tr>
<td>Bridges (FHWA BIRM)</td>
<td>2 yrs</td>
<td>5 yrs</td>
<td>Interval may be reduced or increased depending on condition or use</td>
</tr>
<tr>
<td>Waterfront Structures</td>
<td>0.5 to 6 yrs (ASCE 130)</td>
<td>0.5 to 6 yrs (ASCE 101)</td>
<td>Interval depends on previous condition rating, material, and environment (see ASCE 130 Table 2-2)</td>
</tr>
</tbody>
</table>
Routine Inspection

- Deliverables:
  - Current Condition
  - Element condition states and quantities (Elemental Inspection Form)
  - Component ratings and overall asset condition (Inspection Summary Form)
  - List of Recommended Follow-up Actions (Follow-up Actions Form)

Baseline and Routine Inspection Outcomes

- No further action required, schedule next Routine Inspection
- More information or repairs are required
  - In-depth inspection is needed to assess cause/severity of condition, determine repair quantities, etc.
  - Engineering Analysis may be recommended
  - Followed by implementation of repairs/strengthening
- Immediate action required
  - Address conditions that may compromise facility operations or lead to loss of life, property damage or environmental damage

Element-type Descriptions

- Components of an asset are made up of individual elements
- Element types are defined by structural or functional purpose and material type
  - Structural: load-carrying elements, such as a beam, slab, or pile
  - Non-structural: wearing surface, railing, or coating
- Element types need to be provided
- Elements for a particular asset must be listed on Asset Inventory Record form
Element-type Descriptions
- Defined in Terms of:
  - Associated Component
  - Element Code
  - Element Descriptor
  - Element Identification
  - Measured Units

Element Condition States
- Fundamental aspect of element-based inspection (applies to Baseline, Routine and Due Diligence Inspections)
- Used to document condition of individual elements
  - Type of damage or deterioration (e.g., structural steel or reinforcement corrosion, concrete spalling, wood decay, impact damage, or void)
  - Severity of damage or deterioration (e.g., type and size of defects, section loss, etc.)
  - Scope or extent of damage or deterioration (quantified by the length, area, or number of units having the condition state in question)

FICAP Manual – Chapter 3 Elements & Element Condition States
Four Element Condition States

<table>
<thead>
<tr>
<th>Condition State</th>
<th>Damage or Deterioration</th>
<th>Impact on Structural or Functional Performance</th>
<th>Need for Further Inspection or Structural Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS1 Good</td>
<td>None or Acceptable</td>
<td>None</td>
<td>Not Required</td>
</tr>
<tr>
<td>CS2 Fair</td>
<td>Minor</td>
<td>None or Negligible</td>
<td>Not Required</td>
</tr>
<tr>
<td>CS3 Poor</td>
<td>Moderate</td>
<td>May be Affected</td>
<td>May be Required</td>
</tr>
<tr>
<td>CS4 Severe</td>
<td>Significant</td>
<td>Use of Asset is Affected</td>
<td>Required</td>
</tr>
</tbody>
</table>
Documenting Element Condition States

**Components**

- Group of elements forming a structural or non-structural system
- Boundaries dictated by structural or functional purpose, changes in structural system, framing, or construction material
- Component types are defined during the baseline inspection
  - Should be referred to for all subsequent routine or other inspections
Component Types and Definitions

**Structural Components:** group of elements that comprises a structural system (e.g., deck, superstructure, bulkhead)

**Berthing Components:** group of elements that serves a functional purpose related to the berthing of vessels (e.g., mooring system or fender system)

**Shoreline Components:** group of elements (or single element) that defines channel shoreline (e.g., unprotected shoreline, rip-rap)

**Ancillary Components:** group of elements that serves a purpose other than categorized as above (e.g., utility systems, paint and markings, personnel access systems)

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Four Primary Asset Types

- Wharves
  - Open platform with open structure
  - Open platform with solid structure
  - Solid bulkhead
  - Solid bulkhead with relieving platform
- Boat Docks
- Bulkheads (not associated with a wharf or boat dock)
- Shoreline (protected or unprotected)

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Condition Rating – Components and Assets

- **Primary Objectives of Condition Rating:**
  - Provide the condition information to support asset management and maintenance programs
  - Identify conditions requiring actions
- **Condition information is provided in terms of:**
  - **Component Ratings:** based on engineering assessment of element condition states
  - **Overall Asset Condition Assessment:** based on Component Ratings
Component Rating

- Applicable to Baseline, Routine, and Due Diligence Inspections
- Assigned relative to assumed as-built condition
  - Intended to reflect effects of defects, deterioration, or damage
  - Not intended to reflect current or future use/loading, which may be different from that at the time of original construction
- Consider implication of observed element condition(s) on structural integrity, serviceability, and functionality of component

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<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Good</td>
<td>Minor or no problems noted. Also applies to newly constructed or rehabilitated components.</td>
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<tr>
<td>2. Satisfactory</td>
<td>Minor defects, damage, or deterioration - not extensive.</td>
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<tr>
<td>3. Fair</td>
<td>Extensive minor or limited moderate defects, damage, or deterioration. Structural capacity of primary structural components and functional use of facility or existing systems are not affected.</td>
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<tr>
<td>4. Poor</td>
<td>Moderate or extensive defects, damage, or deterioration that affects structural capacity of primary structural components or functional use of facility or existing systems.</td>
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<tr>
<td>5. Severe</td>
<td>Defects, damage or deterioration significantly reduce structural capacity of primary structural components or reduce functional use of facility or existing systems.</td>
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<tr>
<td>6. Critical</td>
<td>Advanced defects, damage, or deterioration with potential (immediate) of components imminent or observed. Immediate load or use restrictions, including closing of the asset should be considered.</td>
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Applicable Component Types: Deck, superstructure, substructure, bearings, midfield, moving and fixed barriers.

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<tr>
<th>Table 6.1</th>
<th>Ratings for Structural and Bearing Components</th>
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<td>Rating</td>
<td>Description</td>
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<td>1</td>
<td>None or limited to structural or localized damage.</td>
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<td>2</td>
<td>Some minor damage but does not affect serviceability.</td>
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<tr>
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</tbody>
</table>
Overall Asset Condition Assessment

- Overall Asset Rating (AR) for Baseline, Routine, and Due Diligence Inspections
  - Reflects overall adequacy and safety of the asset
  - Based on ratings for structural and non-structural components

\[
AR = \begin{cases} 
SR + FR & \text{for all assets except shorelines} \\
4 \times FR & \text{for shoreline assets}
\end{cases}
\]

\[0 \leq AR \leq 100\]

- Entirely adequate and safe
- Entirely deficient

Structural Component Combined Rating (SR)

- Combined rating based on adequacy and safety of structural components (deck, superstructure, substructure, and bulkhead)

\[
SR = 75 \times (SP + SB + DK + BH) \geq 0 \quad \text{(max. 75)}
\]

- Significance of component to safety (structural, personnel, environmental) of asset
- Significance of component to functional adequacy of asset
- Ease of maintenance, repair, and/or replacement of component

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 Good</td>
<td>Minor or no problems noted. Also applies to newly constructed or rehabilitated components.</td>
</tr>
<tr>
<td>8 Satisfactory</td>
<td>Minor defects, damage or deterioration - not severe.</td>
</tr>
<tr>
<td>7 Fair</td>
<td>Extensive minor or localized moderate defects, damage or deterioration. All primary elements and their attachment to the asset are sound. Moderate non-structural components are not affected. Minor repairs or maintenance may be required.</td>
</tr>
<tr>
<td>6 Poor</td>
<td>Moderate or extensive defects, damage or deterioration that affects fundamental properties of the component and/or its attachment to the asset.</td>
</tr>
<tr>
<td>5 Critical</td>
<td>Advanced damage or deterioration that results in immediate or observable failure(s) of the attachment of the component to the asset. The component may be repaired in functional performance and/or conditions are present that may lead to property damage or environmental damage. Immediate repairs or other preventive measures should be considered, and/or component is removed.</td>
</tr>
</tbody>
</table>

Table A.1: Functional Ratings for Ancillary Components

<table>
<thead>
<tr>
<th>Applicable Component Types</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanchion, Rail, Guardrail, or Parapet</td>
<td>-</td>
</tr>
<tr>
<td>Waterway shorelines</td>
<td>-</td>
</tr>
<tr>
<td>Railings, Fences, or Signposts</td>
<td>-</td>
</tr>
<tr>
<td>Utility System Support</td>
<td>-</td>
</tr>
<tr>
<td>Berms, Sills, or Embankments</td>
<td>-</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>-</td>
</tr>
</tbody>
</table>

Deductions based on Component Ratings

- Depends on

2013 Fall Convention | November 16-17 | New Orleans, LA
Functional Component Combined Rating (FR)

- Combined rating based on adequacy and safety of functional components (bearings, joints, fender and mooring systems, shoreline, and ancillary)

\[
FR = 25 \cdot (BR + JN + FS + MS + SH + AC) \geq 0 \quad (\text{max. } 25)
\]

Deductions based on Component Ratings

- Significance of component to safety (structural, personnel, environmental) of asset
- Significance of component to functional adequacy of asset
- Ease of maintenance, repair, and/or replacement of component

Deduction Tables

Sample Calculations for 4 Hypothetical Assets
Example Dock 1

<table>
<thead>
<tr>
<th>Component</th>
<th>Problem Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sill</td>
<td>Component rating of 2.0, FR = 1.5</td>
</tr>
</tbody>
</table>

Subtle:
- Two components using of 1.3, FR = 1.4
- Two components using of 1.5, FR = 1.3

Observed:
- Two components using of 1.5, FR = 1.4

Calculation:

\[ \text{ACR} = \sum_{i=1}^{n} (\text{Component Rating} - 1) \]

Calculation FR:

\[ \text{FR} = \frac{\text{ACR}}{n} \]

Geometric Series

Recommended Follow-up Action Guidelines

- Each inspection must include recommended Follow-up Actions
  - Five categories: Immediate Action, Investigation Recommendations, in-depth Investigation, Engineering Analysis, No Action Required
  - Depends on the severity and implications of the conditions observed
  - More than one action may arise from an inspection (must be prioritized)
  - Brief justification must be provided for any recommended actions
- Recommended actions documented on Follow-up Actions Form
Follow-up Action Types

1. Immediate Actions

Follow-up Action Types

2. Investigation
Recommendations
- Actions required to address non-urgent (not safety related) conditions

Follow-up Action Types

3. In-depth Investigation
- May be recommended to provide more information to assess atypical conditions observed during Routine, Baseline, or Due Diligence Inspections
  - Determine the cause or significance of deterioration
  - Collect detailed condition and quantity information necessary to develop repair design
  - Verify or determine as-built conditions (where information is unavailable)
- Normally required for the preparation of repair design and construction documents for all but the most routine of repairs
Follow-up Action Types

4. Engineering Analysis
   • May be recommended to provide more thorough assessment of asset condition

Follow-up Action Types

5. No Action Required
   • Observed conditions are such that none of the preceding Follow-up Actions are required
   • No further action is required until next Routine Inspection
   • Inspection Team/Engineer should provide recommendation for timing of next Routine Inspection

Standardized Reporting

• Documentation and reporting is standardized
  • Efficiency in inspection and reporting
  • Enable comparison among assets
  • Facilitate data storage and analysis
• Form-based approach is used for Baseline, Routine, Due Diligence, and Post-event Inspections (In-depth requires “custom” reporting)
• Two categories of documentation
  • Asset Description (1 form plus standard drawings)
  • Inspection Documentation (4 forms)
Asset Description Reporting

- Inventory Record Form
  - Describes as-built condition of the asset and history
  - Revised after modifications or significant repairs
  - Created as part of a Baseline Inspection

- Standard Inspection Drawings
  - Documents cumulative as-built configuration
  - May be adapted for use as inspection drawings (field notes, documentation of conditions)
  - Created as part of a Baseline Inspection

- Inspection Summary Form
  - Asset Condition Rating (AR) and Narrative
  - Component Condition Ratings & Element Summaries
  - Representative Photos
  - Baseline, Routine, Due Diligence, and Post-event Inspections

- Element Inspection Form
  - Documents Element Condition States
  - Baseline, Routine, and Due Diligence Inspections

- Inspection History Form
  - Record of all inspections
  - Summary of component and asset ratings

- Follow-up Action Form
  - Documents recommended follow-up actions
  - Created for Baseline, Routine, Due Diligence, and Post-event Inspections
Documentation for In-Depth Inspections

- Objective and Scope can vary
- Documentation does not use standard forms
- Report requirements:
  - Objective and Scope
  - Methodology and reference to standards
  - Record and interpretation of observations and data, including field or laboratory data
  - Recommendations
  - Summary

Summary: Assess and Prioritize

1. Establish Priorities for Asset Management
2. Condition Assessment
   - Concrete Inspection & Evaluation
   - Predicting Service Life
3. Prioritize Based on Assessment Results
4. Use AR to develop long-term capital expenditures

Questions...?

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