LIFE CYCLE
FACILITY ASSET MANAGEMENT
Correlate the current business environment to the demands placed on facility managers

Assess how decisions made throughout the facility life cycle impact value

Identify gaps in their maintenance management processes

Determine the strategy for implementing a risk-based approach that will address those gaps
AGENDA

- Current business environment
- Life cycle facility asset management
- Changing world of maintenance management
- Risk-based reliability approach
BUSINESS ENVIRONMENT

- Aging facility assets
- Financial pressures
- Emergency preparation
- Information management
- Personnel management
- Evolving skill sets
Key Issues:

- Deferred maintenance
- Facility end-of-life decisions
- Customer satisfaction

Demands on Facility Managers:

- Utilization of facility condition assessment
- Manage maintenance backlog
- Life-cycle management
- Reduce Cost to Maintain
FINANCIAL PRESSURES

Key Issues:
- Outsourcing may not reduce costs
- Routine maintenance requires effort

Demands on Facility Managers:
- Reduce Cost to Maintain
- Satisfy operating expectations
- Manage maintenance without supporting data
- Creating value from physical assets
**Key Issues:**

- Data
  - complexity
  - quantity
  - usability
- Industry standards

**Demands on Facility Managers:**

- Proactive data management
- Decision-making support
- Documentation management
- Off-peak operations capabilities
**Key Issues:**

- Focus
  - personnel safety
  - business disruption
  - supply chain disruption
  - recovery
- Facility self-reliance

**Demands on Facility Managers:**

- Analyze vulnerabilities
- Develop risk mitigation strategies
  - maintenance of protective systems
  - business recovery and continuity
  - on-site presence
PERSONNEL MANAGEMENT

Key Issues:

- Marketing
  - Branding
  - Outreach
- Business case

Demands on Facility Managers:

- Competency-based models
- Difficulty in recruiting
- Career path
Key Issues:

- Technical knowledge
- Business acumen
- Human factors

Demands on Facility Managers:

- Assess current capabilities of core competencies
- Develop management and leadership skills
- Learn best practices
- Improve presentation skills
INDUSTRY CHALLENGES

Commercial Buildings

- **Business pressures**
  - Performing as stable, liquid assets
  - Adapting to changing, shorter business cycles

- **Design and construction**
  - Growing demand for green, high-performance properties
  - LEED requirements for new construction and substantial renovations
  - Energy: small improvements, large impact
  - ADA: significant changes
INDUSTRY CHALLENGES

Tourism, Hospitality & Leisure

- **Short term: less spending**
  - Fewer funds for consumers’ discretionary spending
  - Corporate cost-cutting measures

- **Longer view: capitalize on opportunities**
  - Human connection/interaction remains important
  - Innovative, cost-effective programs can increase customer loyalty and drive demand
INDUSTRY CHALLENGES

Life Sciences

- **Patient life drivers**
  - Manufacturing not a core business driver
  - R&D and Marketing
  - High pressure production start-up
  - High profitability during patient life

- **Sustainability**
  - Long validation times and high cost
  - Inflexibility for continuous improvement
  - Underutilization of automation and information
INDUSTRY CHALLENGES

Healthcare

- **Capital requirements for facility and technology needs**
  - Increased costs of borrowing
  - Decreased access to financing

- **Financial health is worsening**
  - Patients seek less care
  - Investment gains turn to losses

- **Hospitals and health care are critical to the economy**
  - 2007: Health sector accounts for 45% of new private sector jobs
  - Hospitals employ more than 5 million people

- **Safety and Security compliance**
  - ITM (Inspection, testing, maintenance)
    - Program compliance
    - Protective systems
    - Documentation
  - Housekeeping
  - Storage
FACILITY LIFE CYCLE

- Commissioning
- Utilization
- Failure Management Decisions?

**Timeline**
- 10 years
- 20 years
- 30 years

**Functional Requirements**
- Owner
- User
- Architectural
- Engineering
- Regulatory

**Failure Causes**
- Bad design
- Faulty constructions
- Normal wear & tear
- Environment
- Misuse
- Random failures

**Facility Impact**
- Costs
- Value
- Safety
- Environmental
- Compliance
- Occupancy

**Maintenance**
- Predictive
- Preventive
- Detective

**Restore/Rebuild/Replace**
- Equipment
- Infrastructure
- Technology

COMPANY STRATEGY FOR ASSET MANAGEMENT
(POLICY, STRATEGY, OBJECTIVES, PLANS)
Maximizing value through the Facility Life Cycle

VALUE CREATION

Concept  Design  Engineering  Build  Commission  Operate  Maturity

VALUE LOSS

VALUE RECOVERY

Facility Operational Readiness

VALUE DETERIORATION

VALUE PRESERVATION

Facility Performance Assurance

FACILITY LIFE CYCLE ASSET MANAGEMENT
FACILITY LIFE CYCLE

DECISIONS AND OPPORTUNITIES

- **Strategy**: Misalignment between critical project stakeholders (owners, architects, engineers, contractors, operations & maintenance)
- **Design**: User requirements not validated
- **Maintenance**: Antiquated maintenance strategies based largely on OEM recommendations, typically time-based PM with heavy reliance on parts replacements
- **Information**: High volume of operations and maintenance information in disparate formats
- **Personnel**: Operators and maintainers unprepared with necessary knowledge and skills
- **Asset protection**: Protective systems plans not defined
The Changing Scope of User Expectations

1st Generation
- Fix it when it breaks

2nd Generation
- Increased availability
- Cost reduction
- Longer asset life

3rd Generation
- Greater reliability
- Cost-effectiveness
- Reduced risk
The Changing Environment

- Scope of user expectations
- Better understanding of why assets fail
- Changing paradigms
- Varied and complex equipment
- New technologies and techniques
- Information management
Better understanding of Equipment Failure

### Asset Failure Patterns

**A**
- Age: Bathtub

**B**
- Age: Constant, ending with wear out zone

**C**
- Age: Slowly increasing

**D**
- Age: Rapid increase

**E**
- Age: Random

**F**
- Age: Infant mortality to random

### Industry Data

- **A**: 4% => 11% **Age-related**
  - Equipment with dominant failure modes, normally subject to:
  - direct product contact
  - fatigue
  - corrosion
  - abrasion

- **D**: 7% => 89% **Random**
  - Complex equipment:
  - electronics
  - pneumatics
  - hydraulics

- **B**: 2%
- **C**: 5%
- **E**: 14%
- **F**: 68%
Better understanding of Equipment Failure

<table>
<thead>
<tr>
<th>Before assets enter service...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asset delivery process:</strong></td>
</tr>
<tr>
<td>Incorrect specifications</td>
</tr>
<tr>
<td>Improperly designed</td>
</tr>
<tr>
<td>Improperly built</td>
</tr>
<tr>
<td>Wrong equipment delivered</td>
</tr>
<tr>
<td><strong>Asset commissioning process:</strong></td>
</tr>
<tr>
<td>Improper installation</td>
</tr>
<tr>
<td>Inadequate spares policies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After assets enter service...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets lose capability:</strong></td>
</tr>
<tr>
<td>Equipment-related (mechanical, electrical, hydraulic)</td>
</tr>
<tr>
<td>Inadequate process conditions (temperature, pressure)</td>
</tr>
<tr>
<td>Inadequate process inputs (raw materials, energy, utilities)</td>
</tr>
<tr>
<td>Inadequate work methods (maintenance/cleaning/operations/quality)</td>
</tr>
<tr>
<td><strong>Asset capability exceeded:</strong></td>
</tr>
<tr>
<td>Demand and goals increased</td>
</tr>
<tr>
<td>Equipment overloaded</td>
</tr>
<tr>
<td>Incorrect capacity planning</td>
</tr>
</tbody>
</table>
Changing Paradigms

**Old paradigms**
- Maintain equipment
- Minimize failures
- Preventive maintenance
- Maintenance department focus

**New paradigms**
- Preserve functions
- Minimize risk
- Proactive Maintenance
- Multidisciplinary team focus
Key Issues:

- Right information
  - Technical
  - Operational
  - Historical
  - Financial

- Managed information
  - Availability
  - Completeness
  - Usability

- Documentation
  - Physical
  - Digital
  - Access
The Maintenance Process

Asset Information
- Hierarchal list
- Owners & responsibilities
- Documentation
- History
- Condition & Status

Strategy
- Organizational alignment
- Criticality & prioritization
- Risk Management
- Reliability Program
- Management of Change

Optimization
- Reporting
- Performance gap analysis
- Resource Management
- Improvement program
- Protective systems

Work Management
- Work identification
- Reactive work
- Planning & Scheduling
- Execution & Follow-up
## Gap Assessment: Asset Information

<table>
<thead>
<tr>
<th>ACTIVITY/SCOPE</th>
<th>STATUS</th>
<th>BUSINESS RISK</th>
<th>BEST PRACTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listing and Hierarchy</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Owners and Responsibilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition &amp; Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History</td>
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</tbody>
</table>
## Gap Assessment:

### Strategy

<table>
<thead>
<tr>
<th>ACTIVITY/SCOPE</th>
<th>STATUS</th>
<th>BUSINESS RISK</th>
<th>BEST PRACTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Strategy Alignment</td>
<td></td>
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</tr>
<tr>
<td>Criticality/ Prioritization</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Risk Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability Program</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Management of Change</td>
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</tbody>
</table>
# MAINTENANCE PROCESS

## Gap Assessment: Work Management

<table>
<thead>
<tr>
<th>ACTIVITY/SCOPE</th>
<th>STATUS</th>
<th>BUSINESS RISK</th>
<th>BEST PRACTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proactive Work identification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive work identification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning &amp; Scheduling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Execution &amp; follow-up</td>
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</tbody>
</table>
# MAINTENANCE PROCESS

## Gap Assessment:

**Optimization**

<table>
<thead>
<tr>
<th>ACTIVITY/SCOPE</th>
<th>STATUS</th>
<th>BUSINESS RISK</th>
<th>BEST PRACTICE</th>
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</thead>
<tbody>
<tr>
<td>Work Reporting</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Performance analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement Program</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management of Protective Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Systemic processes to co-ordinate, facilitate and improve decision-making with respect to risk

Provides stakeholders with greater assurance of a company’s ability to deal with potential risk

Applicable to all types of business processes
- Facility planning & forecasting
- Architectural/Engineering design
- Construction management
- Commissioning
- Operations
- Maintenance
- Emergency preparation
What is the acceptable risk?

Who should decide?
Perception, acceptance and tolerance of risk is from the perspective of the stakeholder.

- Medical practitioners
- Patients
- Employees
- Companies

Risk has two components:
- Probability of occurrence of a harm
- Severity (consequences) of a harm

Risk Management is subjective because each stakeholder has a different viewpoint of probability and severity.
### Risk Policy

#### Severity Level

<table>
<thead>
<tr>
<th>Severity Level</th>
<th>Severity of Harm(^1) : Business</th>
<th>Severity of Harm(^1) : Governance</th>
<th>Severity of Harm(^1) to Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definition</td>
<td>Definition</td>
<td>Definition</td>
</tr>
<tr>
<td>Critical</td>
<td>&gt; $$$$$</td>
<td>Extended international media coverage</td>
<td>Output: Not recoverable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unrecoverable market share loss</td>
<td>Operating Costs: &gt; $$$$$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extended business disruption</td>
<td>Customer Service: Loss</td>
</tr>
<tr>
<td>High</td>
<td>&gt; $$$</td>
<td>One-time international media coverage</td>
<td>Output: Recoverable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recoverable market share loss</td>
<td>Operating Costs: &gt; $$$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Short-term business disruption</td>
<td>Customer Service: Complaint</td>
</tr>
<tr>
<td>Moderate</td>
<td>&gt; $$</td>
<td>Extended local media coverage</td>
<td>Output: Excess capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market share erosion</td>
<td>Operating Costs: &gt; $$$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local business disruption</td>
<td>Customer Service: Repeated late delivery</td>
</tr>
<tr>
<td>Low</td>
<td>&gt; $</td>
<td>One-time local media coverage</td>
<td>Output: Buffer inventory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited market share erosion</td>
<td>Operating Costs: &gt; $</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local business disruption</td>
<td>Customer Service: Late delivery</td>
</tr>
<tr>
<td>Negligible</td>
<td>&gt; $</td>
<td>No media coverage</td>
<td>Output: Downtime only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No market share loss</td>
<td>Operating Costs: &gt; $</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No business disruption</td>
<td>Customer Service: Not affected</td>
</tr>
</tbody>
</table>
### Risk Policy

<table>
<thead>
<tr>
<th>Probability Level</th>
<th>Occurrence Per Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>&gt;= 4 in 20 Business Operations</td>
</tr>
<tr>
<td></td>
<td>&gt;15%</td>
</tr>
<tr>
<td>Probable</td>
<td>3 in 20 Business Operations</td>
</tr>
<tr>
<td></td>
<td>&gt;10 to 15%</td>
</tr>
<tr>
<td>Occasional</td>
<td>2 in 20 Business Operations</td>
</tr>
<tr>
<td></td>
<td>&gt;5 to 10%</td>
</tr>
<tr>
<td>Remote</td>
<td>1 in 20 Business Operations</td>
</tr>
<tr>
<td></td>
<td>&gt;1 to 5%</td>
</tr>
<tr>
<td>Improbable</td>
<td>&lt;= 1 in 100 Business Operations</td>
</tr>
<tr>
<td></td>
<td>&lt;=1%</td>
</tr>
</tbody>
</table>
## Risk Policy:
### Standard Matrix 5x5

### RISK EVALUATION MATRIX

<table>
<thead>
<tr>
<th>RATING</th>
<th>DESCRIPTION</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Negligible</td>
<td>Minor</td>
<td>Serious</td>
<td>Critical</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>5</td>
<td>Frequent</td>
<td>P₁ S₁</td>
<td>P₂ S₂</td>
<td>P₃ S₃</td>
<td>P₄ S₄</td>
<td>P₅ S₅</td>
</tr>
<tr>
<td>4</td>
<td>Probable</td>
<td>P₂ S₁</td>
<td>P₂ S₂</td>
<td>P₃ S₃</td>
<td>P₄ S₄</td>
<td>P₅ S₅</td>
</tr>
<tr>
<td>3</td>
<td>Occasional</td>
<td>P₃ S₁</td>
<td>P₃ S₂</td>
<td>P₃ S₃</td>
<td>P₄ S₄</td>
<td>P₅ S₅</td>
</tr>
<tr>
<td>2</td>
<td>Remote</td>
<td>P₄ S₁</td>
<td>P₄ S₂</td>
<td>P₄ S₃</td>
<td>P₄ S₄</td>
<td>P₅ S₅</td>
</tr>
<tr>
<td>1</td>
<td>Improbable</td>
<td>P₅ S₁</td>
<td>P₅ S₂</td>
<td>P₅ S₃</td>
<td>P₅ S₄</td>
<td>P₅ S₅</td>
</tr>
</tbody>
</table>

### RISK MANAGEMENT

<table>
<thead>
<tr>
<th>RISK</th>
<th>REQUIRED ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unacceptable Risk</td>
<td>Risk Reduction Required</td>
</tr>
<tr>
<td>Risk May be Acceptable / Tolerable</td>
<td>Investigate Risk Reduction</td>
</tr>
<tr>
<td>Acceptable</td>
<td>No Risk Reduction Required</td>
</tr>
</tbody>
</table>
Risk Management Approaches

- **Quantitative**
  - Requires high-quality data
  - Assigns numerical value to indices
  - Reduces uncertainty
  - Time-consuming
  - May require specialized tools and software

- **Qualitative**
  - Requires experience
  - Assigns interval scales to indices
  - More subjective
  - Quick and easier
  - No specialized tools
Risk Management Approaches

- Qualitative Processes
  - Event trees
  - Failure Cause Mapping
  - FMEA
  - Process mapping
  - Hazard and Operability Study (HAZOPS)
  - Preliminary Hazards Analysis (PHA)
  - Human Factors Analysis
  - TRIZ (Theory of Inventive Problem Solving)

- Qualitative Processes
  - Probabilistic Risk Assessment (PRA)
  - Monte Carlo simulation
  - Reliability Availability Model
  - What-if analysis
Core Elements
- Risk Management Policy
- Risk Management Plan
- Risk Assessment
- Solution implementation
- Continuous improvement

Outputs
- Process improvements
- SOPs
- Employee training

Standards
- ISO
- OSHA
- ANSI
- NFPA
## RISK MANAGEMENT

### Risk Assessment

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>FUNCTIONAL FAILURE</th>
<th>FAILURE MODE</th>
<th>FAILURE CAUSE</th>
<th>FAILURE EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do we want this facility to do? • Building envelope • HVAC • Electrical • Plumbing • Illumination • Infrastructure • Transport</td>
<td>How can this function fail? • Owners • Managers • Users</td>
<td>1st level failure: • Environment • Material • Method • Human Resources • Equipment</td>
<td>1st level failure is due to: • Actions • Conditions</td>
<td>Evidence • Impact • Safety • Environment • Operations • Repair • Resolution</td>
</tr>
</tbody>
</table>
# Risk Assessment

## Risk Mitigation Worksheet

<table>
<thead>
<tr>
<th>Risk Analysis</th>
<th>Current Controls</th>
<th>Unmitigated Risk Evaluation</th>
<th>Mitigation Decisions</th>
<th>Unmitigated Risk Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td></td>
<td>Risk Guidance</td>
<td>Inspections</td>
<td>Risk Guidance</td>
</tr>
<tr>
<td>• Governance</td>
<td></td>
<td>• Acceptable</td>
<td>• Predictive</td>
<td>• Acceptable</td>
</tr>
<tr>
<td>• Financial</td>
<td></td>
<td>• Tolerable</td>
<td>• Maintenance</td>
<td>• Tolerable</td>
</tr>
<tr>
<td>• Safety</td>
<td></td>
<td>• Unacceptable</td>
<td>• Preventive</td>
<td>• Unacceptable</td>
</tr>
<tr>
<td>• Environment</td>
<td></td>
<td></td>
<td>• Corrective action</td>
<td></td>
</tr>
<tr>
<td>• Compliance</td>
<td></td>
<td></td>
<td>• Redesign:</td>
<td></td>
</tr>
<tr>
<td>• Operations</td>
<td></td>
<td></td>
<td>• Procedures and</td>
<td></td>
</tr>
<tr>
<td>• Repair costs</td>
<td></td>
<td></td>
<td>Training</td>
<td></td>
</tr>
<tr>
<td>Probability</td>
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<tr>
<td>• High</td>
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<tr>
<td>• Medium</td>
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<tr>
<td>• Low</td>
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</tr>
</tbody>
</table>
In the *ideal* world, all facility assets—manufacturing, utilities, and facilities—would operate in a stable environment with normal conditions.

In the *real* world, the equipment is subject to abnormal conditions that could produce a scenario which threatens the facilities, affects the product, compromises security or threatens human lives and the environment.
Protective systems are necessary to avoid or mitigate the consequences of abnormal conditions placed on equipment.

Designers have incorporated features on equipment to improve confidence that we are well protected in the unlikely event that the abnormal condition actually occurs.

But, what if the protection fails?

We still need to manage protective systems to minimize the personal and business risk associated with their failures.
Protective Systems

Categories of protective systems:

- Warn of abnormal conditions
- Shutdown equipment and processes in the event of an abnormal condition
- Eliminate or relieve abnormal conditions
- Take-over when other equipment has failed
- Prevent dangerous situations from occurring in the event of an abnormal condition
Protective Systems can fail in two ways:

- **By not providing protection when needed**
  
  In the worst case, this could produce a scenario which destroys the equipment or facilities, contaminates the product or threatens human lives and the environment.

- **By acting when they are not needed**
  
  In the best case, this results in a nuisance interruption in the operation of the equipment.
For many facility operations, up to 50% of the failures are protective systems. Their functions and failures are not clearly understood.

The vast majority of these systems require proactive intervention to reduce the risk.

Existing maintenance programs do not manage these systems adequately:
- Less than 1/3 of these systems are maintained at all (usually at the wrong interval)
- Another 1/3 receive no attention, although their existence is known by operations and maintenance
- The existence of the final 1/3 is not known
A successful Facility Lifecycle Management Program depends on a vision that merges people, place, purpose and technology. Organizations that are willing to address these issues can transform their business to meet the current challenges successfully and reduce business risk.

Design value adding processes to meet services levels & organization requirements.

Determine requirements to support processes:
- Information technologies
- Personnel selection & development
- Asset data collection
- Documentation organization
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