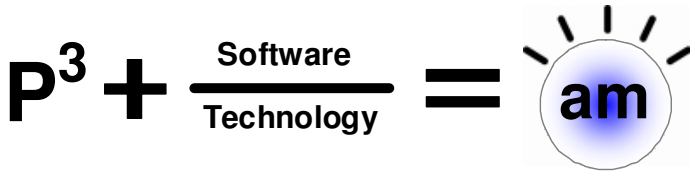
Business Consulting Services



People/Processes/Procedures PLUS Software over Technology EQUALS Smarter Asset Management[1]

A Leading Reliability Program

Don Barry
October 2009

amcoe
Asset Management Center of Excellence

Agenda

Our View of the World and Asset Management

Maintenance Excellence Leading Practices and Trends

What is a Reliability Program?

Why is Reliability important in Asset Management

Key points to consider in RCM

How could this apply to you?

Example of a successful Reliability program

How to achieve RCM goals? A route-map

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$P^3 + \frac{\text{Software}}{\text{Technology}} = am$

People/Processes/Procedures PLUS Software over Technology EQUALS Smarter Asset Management[1]

Our View of the World

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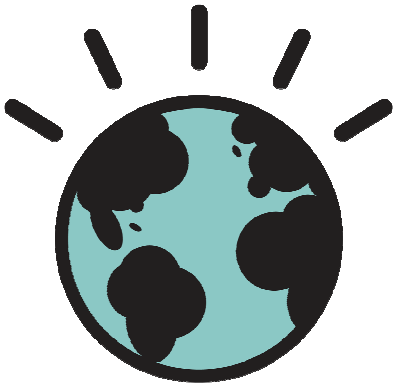
Something Meaningful is Happening

Building a smarter planet…



"Every human being, company, organization, city, nation, natural system and man-made system is becoming **interconnected, instrumented and intelligent.** This is leading to new savings and efficiency—but perhaps as important, new possibilities for progress."

Remarks Delivered by Sam Palmisano, Chairman, CEO and President, IBM, To The Council on Foreign Relations, Nov. 6, 2008

What Do These Changes Mean to Our Customers?

In a flatter, faster & "smarter" planet we face…

More ***complexity***
More ***competition***
More ***risk***
More ***resource consumption***
More ***interdependence***

but also have the opportunity to achieve...

More ***insight***
More ***collaboration***
More ***efficiency***
More ***innovation***
More ***growth & profit***

What Our Customers Want

Our customers want to *be smarter* :

Customers don't want software or services, they want solutions – that provide more insight, collaboration, efficiency, innovation, growth & profit.

Our customers want to *reduce costs*, preserve capital, improve return on assets:

Customers are focused on bottom line results – we can help.

Our customers want to *accelerate value*:

Now more than ever, customers need accelerated return on their investment.

"Our Angolan operation is going to be a key part of our global production in the next 20 to 30 years. By helping to develop our processes around work management, stock logistics and procurement, IBM has helped position BP for maximum efficiency and safety going forward."

"Our goal was to establish a platform for DTE Energy to thrive in a dynamic and challenging environment. We achieved our key objectives of integration and modernized our technology. We think IBM products and their integration were keys to our project's success"

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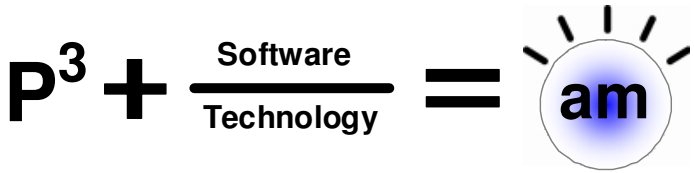

People/Processes/Procedures PLUS Software over Technology EQUALS Smarter Asset Management[1]

Our View of Asset Management

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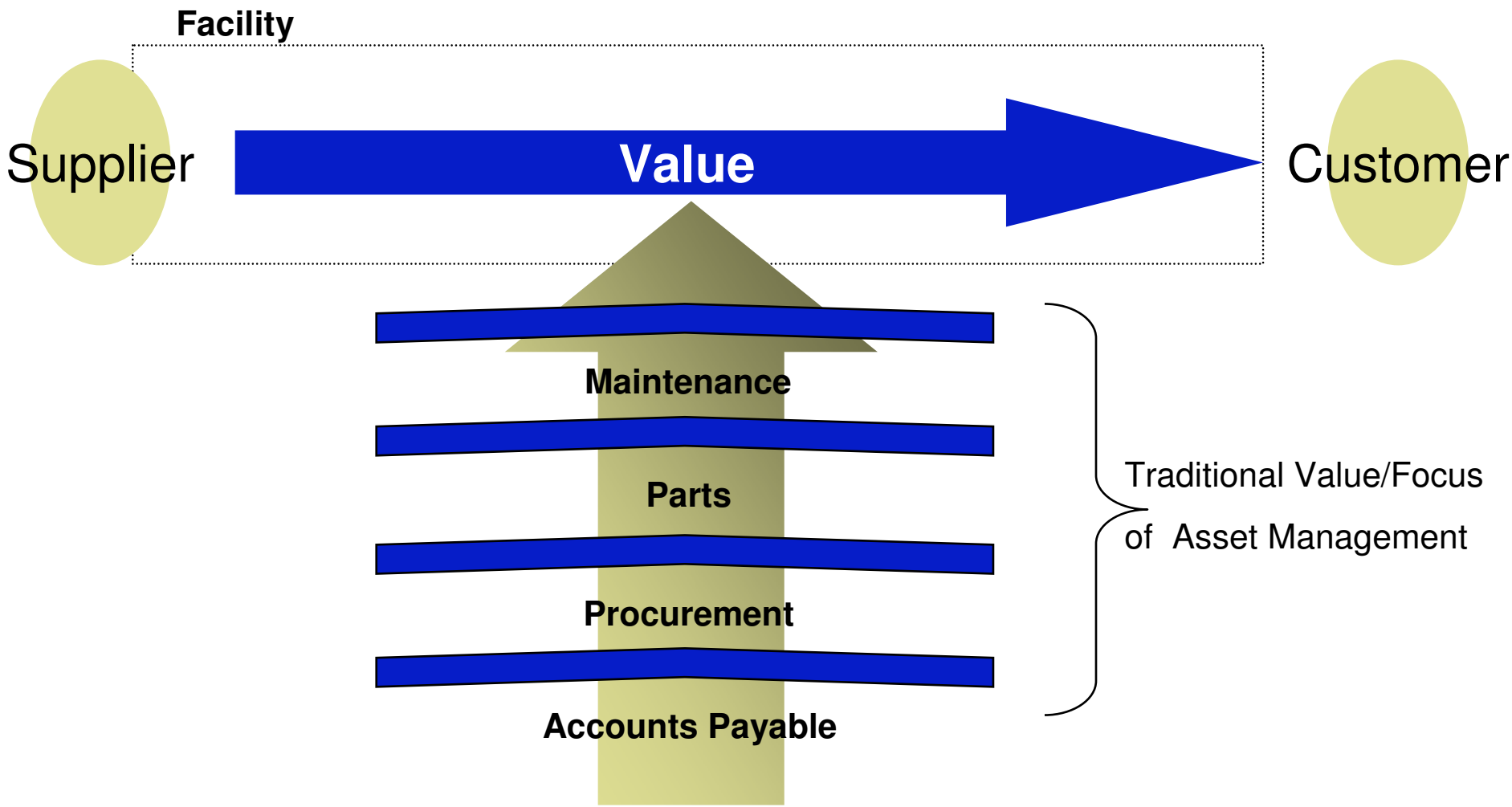
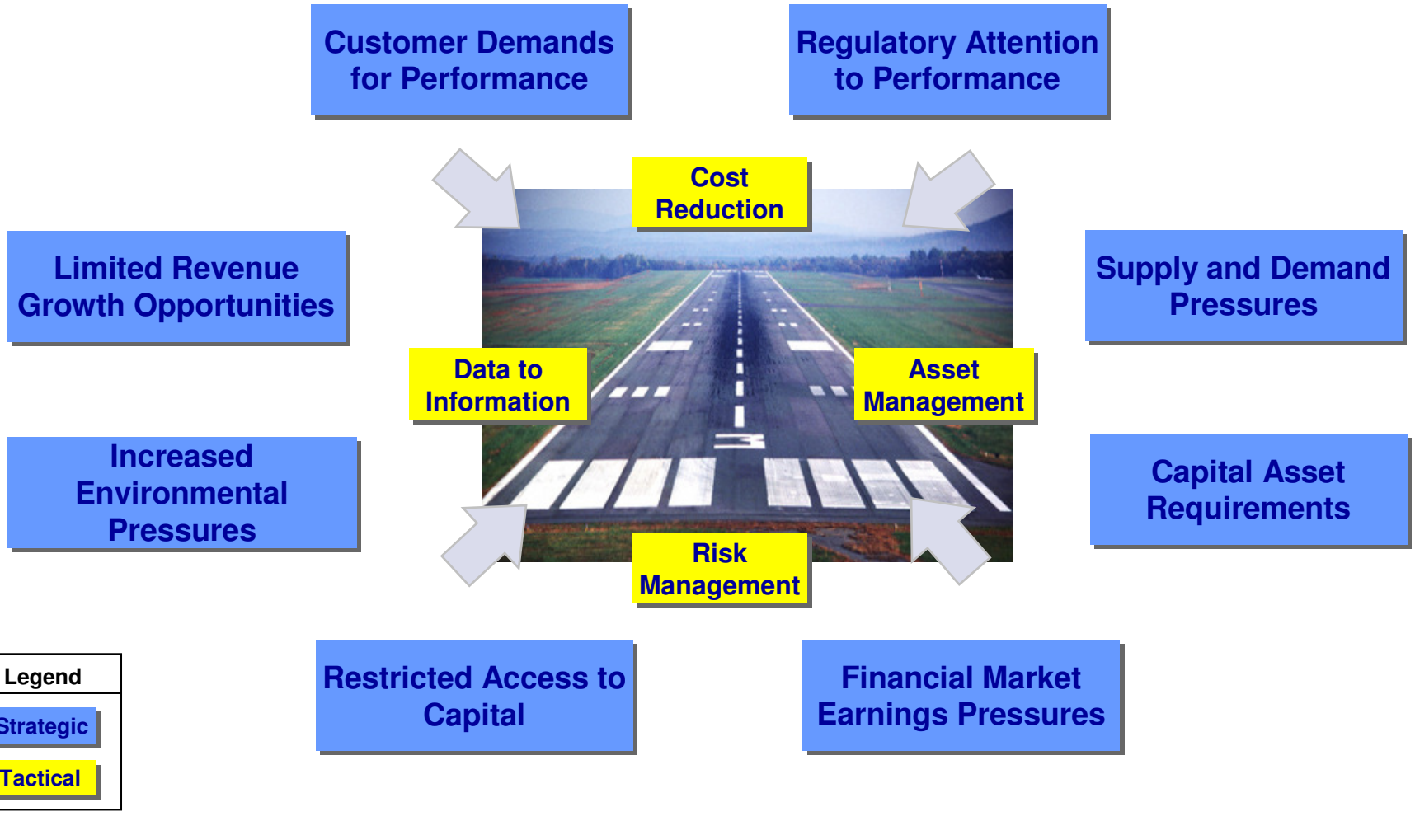
The Traditional Value of Asset Management



Major areas of concern in many industries around the world



…. however, the market is different today than it was a decade ago

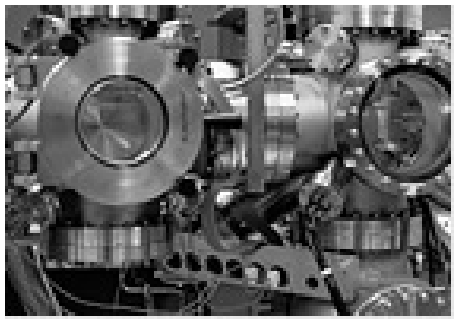
- Infrastructure at end of life
- Aging and retiring workforce
- Dynamic Economics
- Rate of Return at all time lows
- Decade of cost cutting has hit the wall
- Customer expectations are shifting
- High expectations of connectivity and service
- IT advancements change daily
- Disruptive business technologies are poised to fundamentally change the business

Asset Classes

Real Estate and Facilities

Infrastructure

Plant and Production



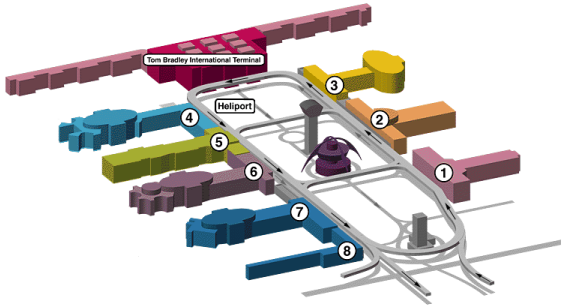
Mobile Assets

Information Technology

To drive an effective return, many organizations work to maximize their effectiveness of their capital assets across the asset lifecycle

Traditional Asset Classes	***Asset Lifecycle***							
	Asset Strategy	Plan	Evaluate and Design	Create / Procure	Operate	Maintain	Modify	Dispose
Real Estate and Facilities	**Land, Offices, Warehouses, Retail Space, Schools, Hospitals**							
Plant and Production	**Mining, Textile, Chemical, Petroleum, Electronics, Food**							
Transportation and Fleet	**Military, Airlines, Trucking, Shipping, Railroad, Public**							
Infrastructure	**Railways, Electric / Gas Distribution, Highways, Telecom, Water**							
IT Equipment and Network	**PCs, Networks, Routers, Applications, Auto Discovery, Service Desk**							

Supply Chain Management drives a need to manage the effectiveness of all investments across the value chain including a high return on capital assets



IBM's Asset Management Center of Excellence Capabilities

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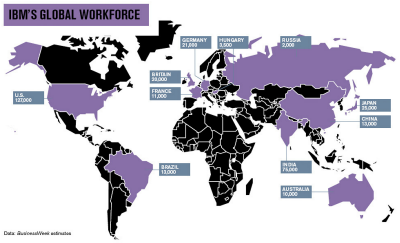
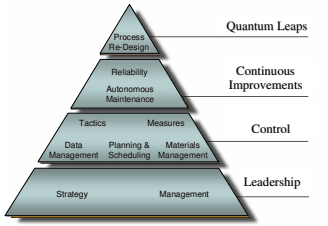
More than 800 EAM Consultants



MRO Dynamic Inventory Optimization
Supply Chain Network Design



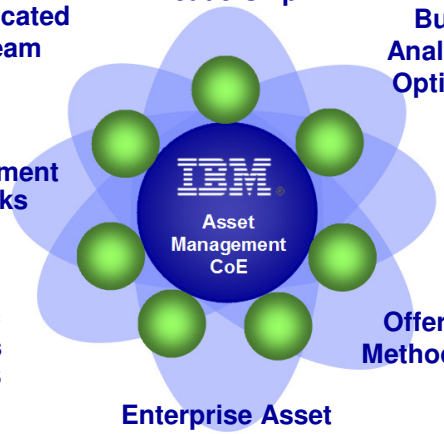
Asset Classes
Asset Management Pyramid
Asset Management Lifecycle Model
Maturity Models
Best Practices

Thought Leadership

Dedicated Team

Business Analytics and Optimization

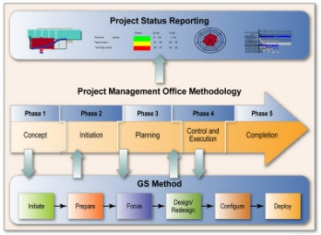
Asset Management Frameworks



Strategic Alliances ERP, MES

Offerings & Methodologies

Enterprise Asset Management



Support Leading ISVs

SAP
IVARA WORK SMART
ABB
Honeywell
ORACLE
TRIRIGA®

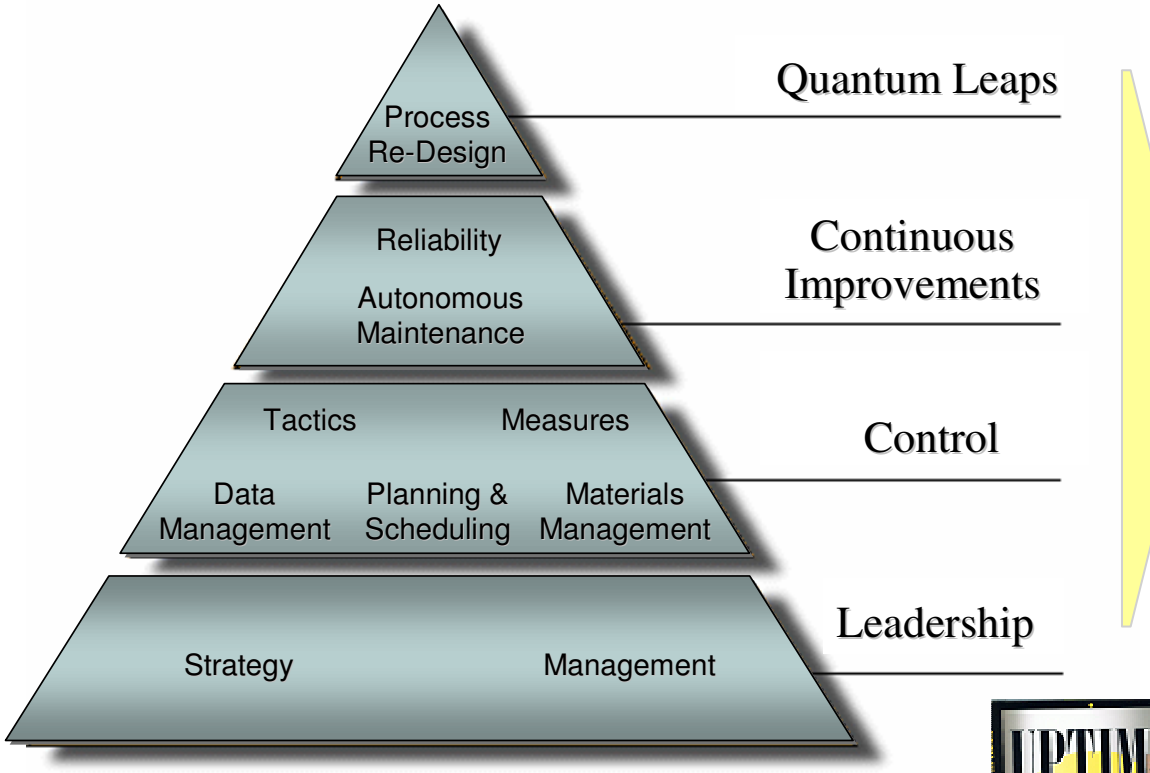
IBM maximo®

Industry Solutions Verticals
Oil&Gas,
Nuclear
Transportation
Utilities
Life Sciense
Utilites

IBM Offerings in Asset Management

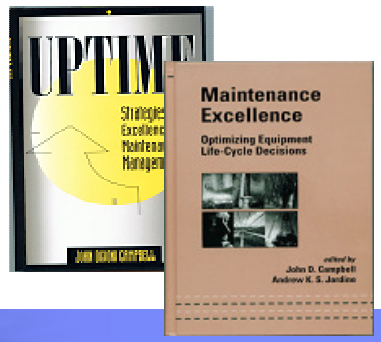
Opportunity Workshops
RCM Training/Facilitation
Accelerated Solutions Strategy
EAM Assess/Strategy
EAM Optimization
Package/Solution Selection
Maintenance Parts Strategies
Solution Implementations

IBM's understanding of Asset Management can help their clients look a level deeper, focusing on 10 Strategic Categories Based



Select IBM Offerings in Asset Management

- Opportunity Workshops
- RCM Training/Facilitation
- Accelerated Solutions Strategy
- EAM Assess/Strategy
- EAM Optimization
- Package/Solution Selection
- Maintenance Parts Strategies
- Solution Implementations



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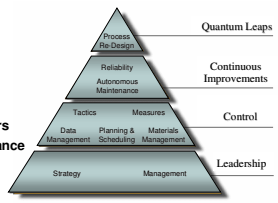
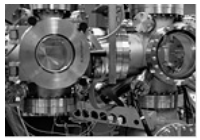
1. Strategy
2. Organization/Management
3. Data Management
4. Maintenance Tactics
5. Materials Management
6. Planning and Scheduling
7. Key Performance Indicators
8. Reliability Center Maintenance
9. Autonomous Maintenance
10. Process Re-design





Rating Levels	VI Innocence	IV Awareness	III Understanding	II Competence	I Excellence
1.Strategy	Mostly Reactive Breakdown Maintenance	Prevent Maintenance Improvement Program	Annual Improvement Plan	Long Term Improvement Plan	Established and Communicated Maintenance and Asset Strategy
2. Organization / Management	Highly Centralized	Partly Centralized for Some Trades	Decentralized Mixed Trade Teams	Level of Multi-Skilled Staff	Multi-Skilled Independent Trades
3. Data Mgmnt / IT	Manual or Ad-hoc specialty Systems	A "System" that Allows for Some Scheduling and PartsTracking	Fully Functional A Stand Alone Sy	Fully Functional Asset Mgmnt System liked to Financials and/or Inventory Systems	Fully Integrated to common databases Data Standards in Place
4. Maintenance Tactics	Annual S/D Inspections Only	Time Based Inspections	Time sed In	Some CBM Some Prev. Maint. Few Surprises	All Tactics Based on Analysis
5. Materials Management	*Absence of storeroom management practices	*Some storeroom contr *Lack of performance measurements *Turns less tha	n computerized k levels set – no Maint. nput. Lead time and Safety Stock Levels set – Rare;	*Alliances developed *(Free Issues) *Streamlined processes *Material Delivery Process Established *Automatic Matching of Invoices *Compurtized inventory control system	*Service levels 95%+ *On line material requisitioning *Turns exceed 1.5
6. Planning and Scheduling	Little or No Formal Planning, Scheduling, or Engineering Support	Some Troubling Shooting Support Inspection Scheduling	Maintenance Planning Group Established Ad-hoc Engineering	Solid General Planning and Scheduling Job Planning with Engineering Support	Long Term Major Project Planning for both Maintenance and Engineering
7. Performance Measures	No Systematic Approach. Maint. Cost Not Available	Some Downtime / Reliability Records Maint. Costs Not Segregated	Downtime by Cause Maintenance Costs Available	Mean Time to Failure / Repair Records Available Separate Maintenance Costs	OEM Benchmarking Full Cost Database
8. Reliability Centered Maintenance	No Failure Records	Collect s Failure Data but make little use of it	Failure DB Established. Used for Analysis	Some FMECA used	RCM Program in Place Risk and Root Cause Analysis Program
9. Autonomous Maintenance	Directed Workforce No Teamwork Maint & Production relationship strained	Directed Workforce No Teamwork Good cooperation of Maint. And Production	Directed Workforce Some Teamwork Maint./ Production cooperation at working level	Self Directed teams Maint. / Production cooperation at all levels. Team work at organization levels	Decentralized teams Business based decisions Excellent cooperation with Maint. / Production Teamwork a hallmark of entire organization
10.Process Redesign	Processes not documented. Some procedures available High Reactive Work Percentat	Some processes documents. Moderate amount of procedures available High PM Workload	Processes Documented Planning and Scheduling disciplines are prevalent Medium amount of Reactive and PM Workload	Processes documented Evidence of periodic review. Procedures well documented and organized	Processes documented and coodinated with support areas (Inv. / Purc) Evidence of regular review cyc

Typically there are four initial areas that drive ROA - Driving costs down while we drive production, safety, environmental and regulatory compliance up

High Value Areas

- Effective planning and scheduling of work
- Spares & support materials management driven by planning & scheduling activity
- Proactive definition of what maintenance should be done to manage reasonably likely failures
- Optimization

Key to Success

Mindset

From traditional thinking to scientific, business-based thinking

Integration

Maintenance Planning and inventory must work as one

Eliminate Barriers

Cooperative approach among production, operations and engineering

Strategic Approach

Leading a well planned and managed change program

Knowledge

Understanding best practices in planning, scheduling, proactively identifying maintenance requirements

What is some of the thought leadership associated with asset management?

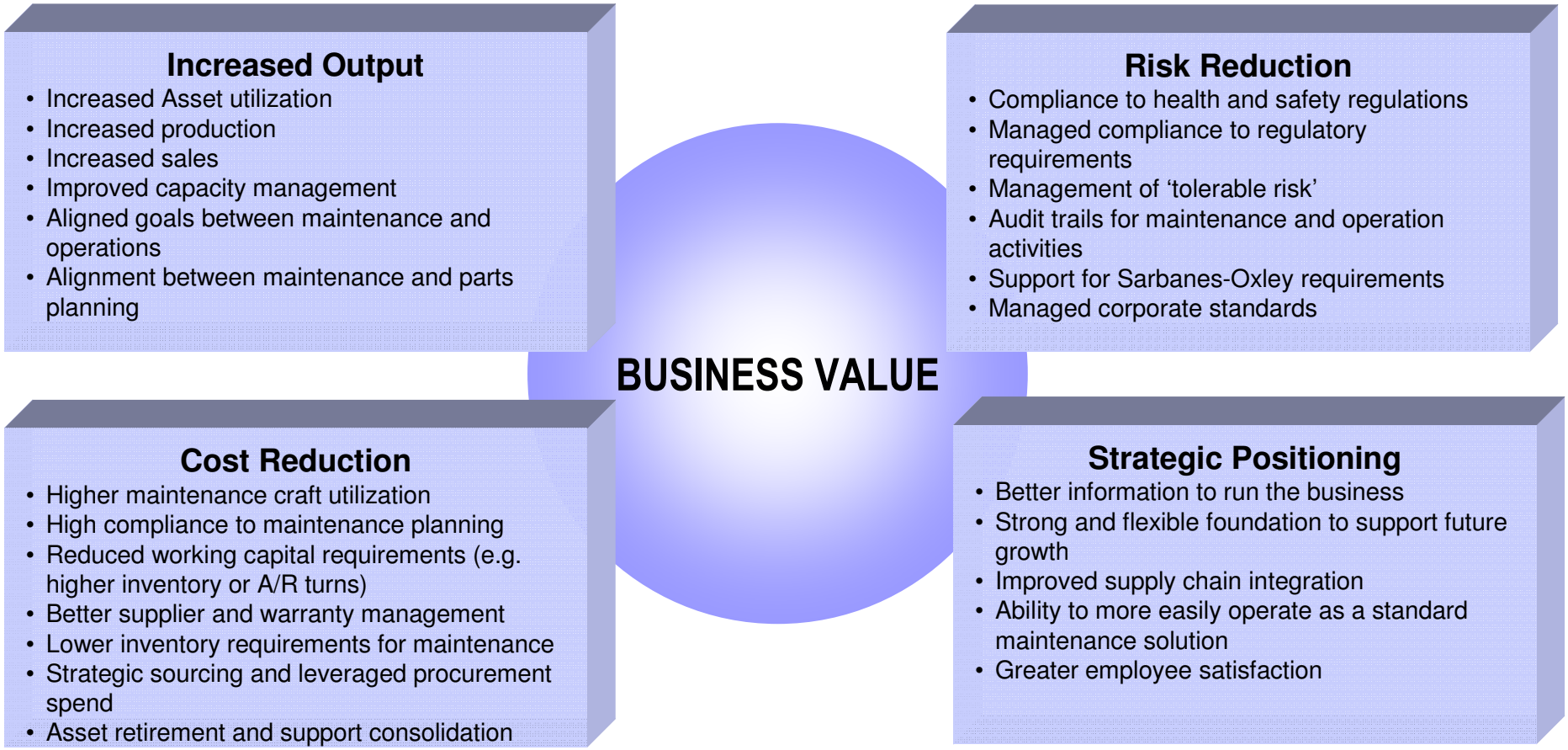
Maintenance Philosophy Related Issues

Traditional Approach	New Approach
Maintenance is about preserving physical assets	Maintenance is about preserving the functions of assets
Routine maintenance is about preventing failures	Routine maintenance is about avoiding, reducing or eliminating the consequences of failures
The primary objective of the maintenance function is to optimize plant availability at minimum cost	Maintenance affects all aspects of business effectiveness and risk – safety, environmental integrity, energy efficiency, product quality and customer service, not just plant availability and cost
The maintenance department on its own can develop a successful, lasting maintenance program	A successful, lasting maintenance program can only be developed my maintainers and users of the assets working together

There is an opportunity to up the value perception of maintenance and its' contribution to ROA

Source: John Moubray, Maintenance Management – A New Paradigm

Anticipated Benefits to be Realized from an EAM/CMMS Initiative…..



Potential sources of benefits which drive business value within a typical EAM project.

What are the Benefits for Asset Intensive Companies?

Business Scenarios	ROI Points	Customer Examples
Labor Utilization	**Up 10-20%**	• A major US railroad saved US $5M by better tracking labor to specific work
Asset Utilization	**Up 3-5%**	• A large OEM reduced overhaul process time from 56 days to 21 days
Equipment purchases	**Down 3-5%**	• A fleet management company saved US $9.5M by meeting 100% availability with less
Warranty recoveries	**Up 10-50%**	• A consumer products company increased warranty recovery 50%
Inventory needs	**Down 20-30%**	• A large passenger railroad was able to identify US $18M in excess or obsolete inventory
Inventory carrying costs	**Down 5-20%**	• A nuclear power conglomerate reduced inventory value and associated carrying costs by 26%
Material Costs	**Reduced 10-50%**	• A rail maintenance service company reduced costs 20% by optimizing material purchases.
Purchasing labor	**Reduced 10-50%**	• A fleet management company reduced purchasing staff by 20%

"By unifying the management of all our IT and operational assets using IBM solutions, we can maintain an industry leadership position and improve quality of service for travelers. IBM asset management software has also helped us realize a higher percentage of recoverable fees and directly improve revenue as a result."
McCarran International Airport

Quantify & Prioritize the Gaps

What is a 1% improvement worth to your organization?

-Energy (what do we spend on utilities?)

-Asset availability (are we operating 7/24?)

-Operator/trades utilization & efficiency (are we labour intensive?)

-Asset life (are we capital intensive?)

-Response time (how spread out are our facilities?)

-Safety (what do we pay in workers comp?)

-Production line speed/output (can we push through more volume with better asset performance?)

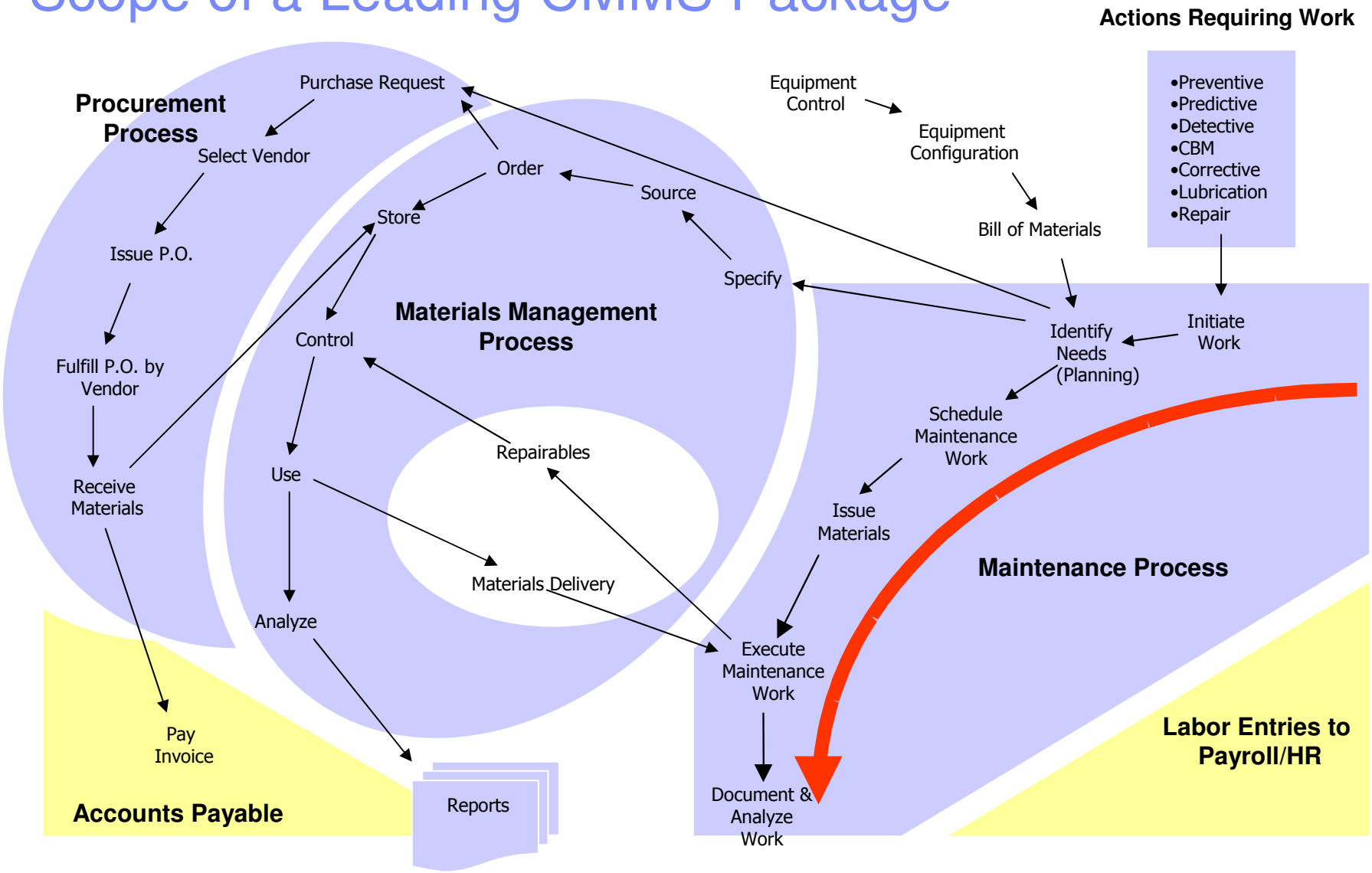
-Spare parts inventory level/turns (are we inventorying the right spares to avoid catastrophic downtime?)

-Inventory service level (are parts there when we need them?)

-Quality of output, i.e. rejects, rework, returns, loss, giveaway, shrinkage, yield and waste (what is cost of poor quality?)

Focus on improving high-impact areas for your Operations.

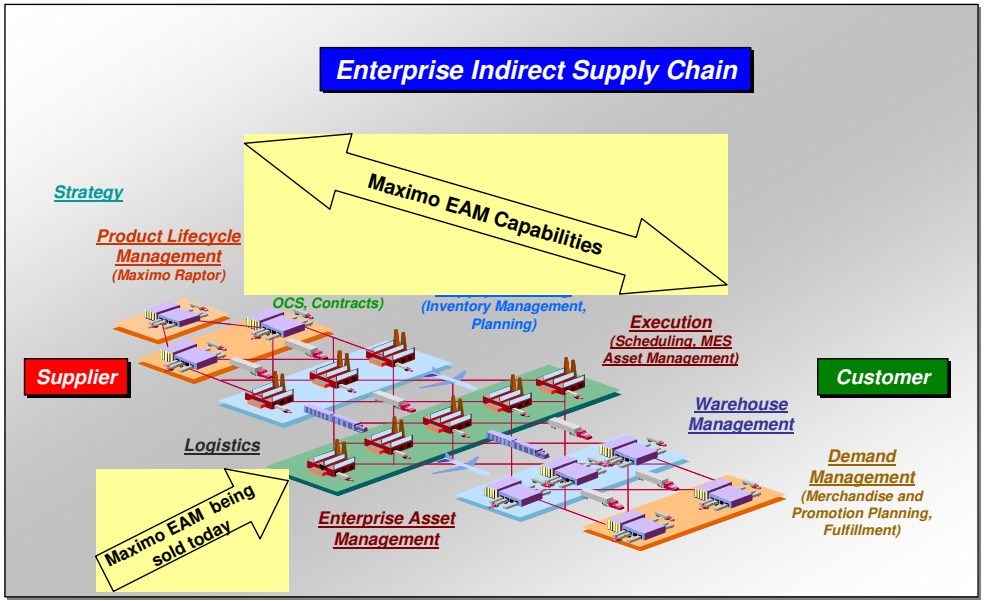
Scope of a Leading CMMS Package



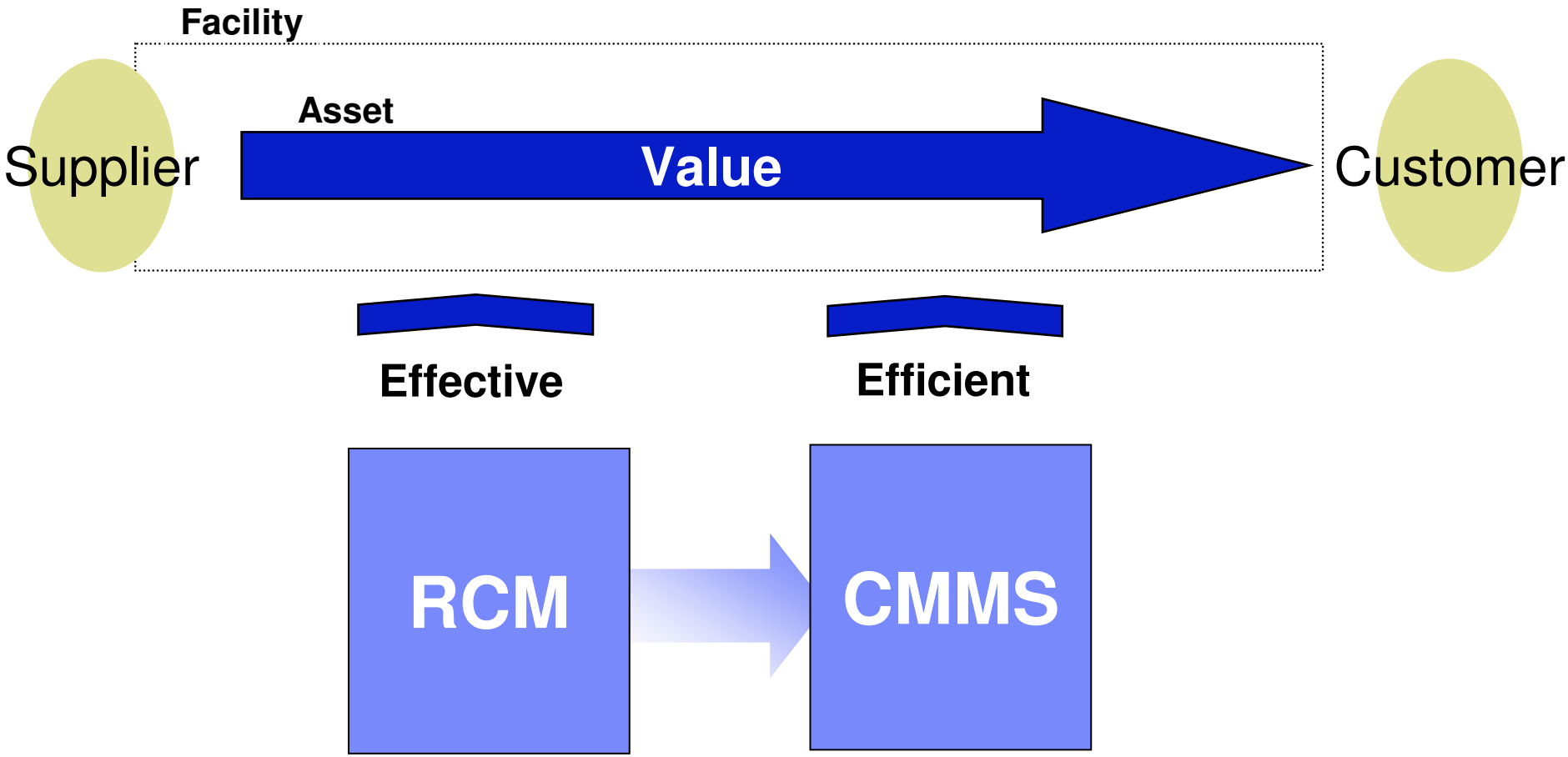
Our Vision: Beyond Asset Management

Beyond Traditional Asset Management:

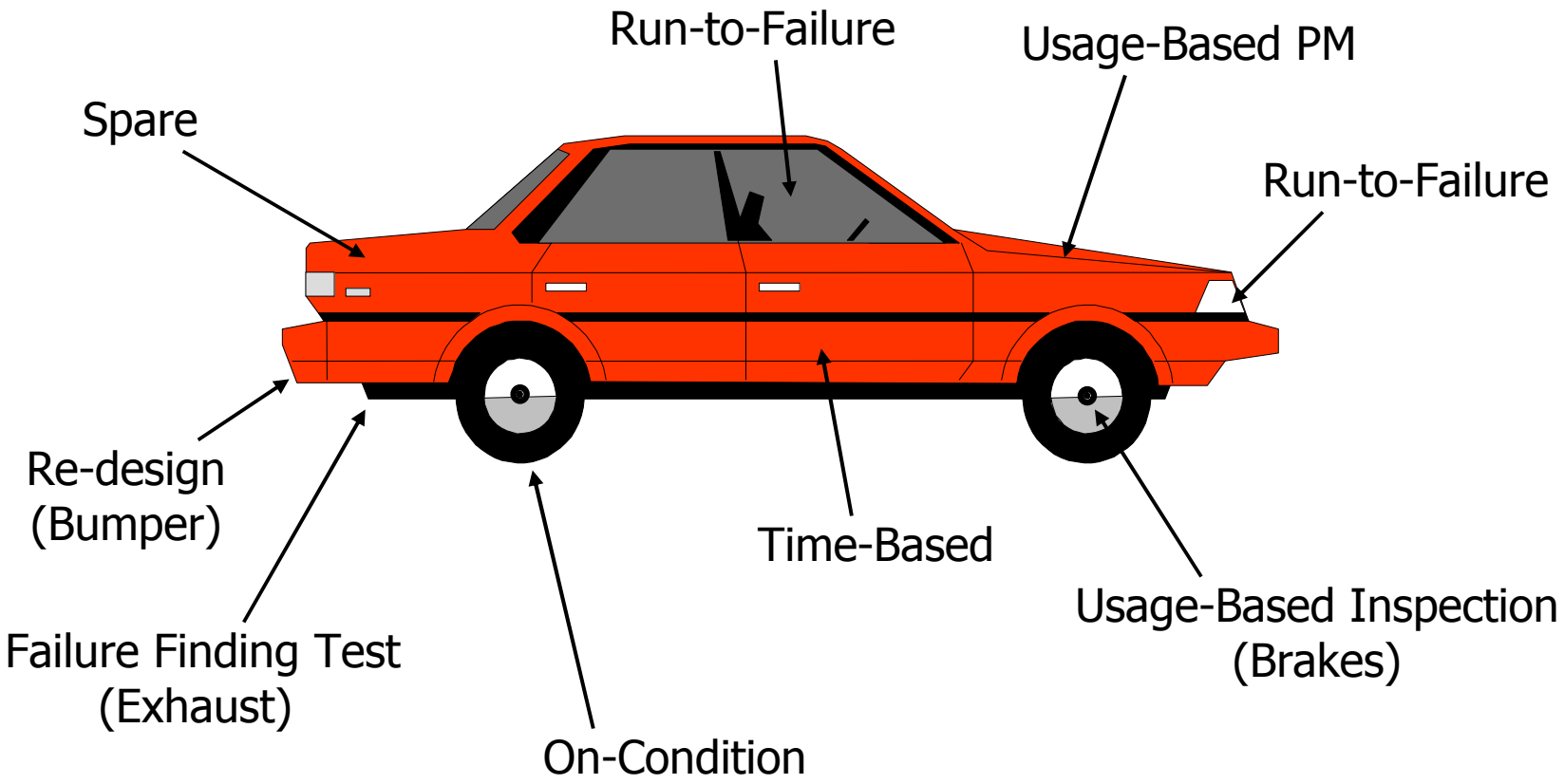
- Goal oriented Total Life-cycle Asset Management focus on ROA
- Thought Leadership in Asset Management Leading Practices
- RFID Integration: *dynamically track asset location.*
- GIS and Maximo Spatial: *manage spatial relationships of assets.*
- Online Commerce System (OCS): *procurement and electronic commerce.*
- DIOS Inventory Optimization: *reduce inventory carry costs, increases serviceability.*
- Reliability Centred Maintenance (RCM)
- Property (PPMS).
- Sustainability
- Cognos
- iLog
- etc.



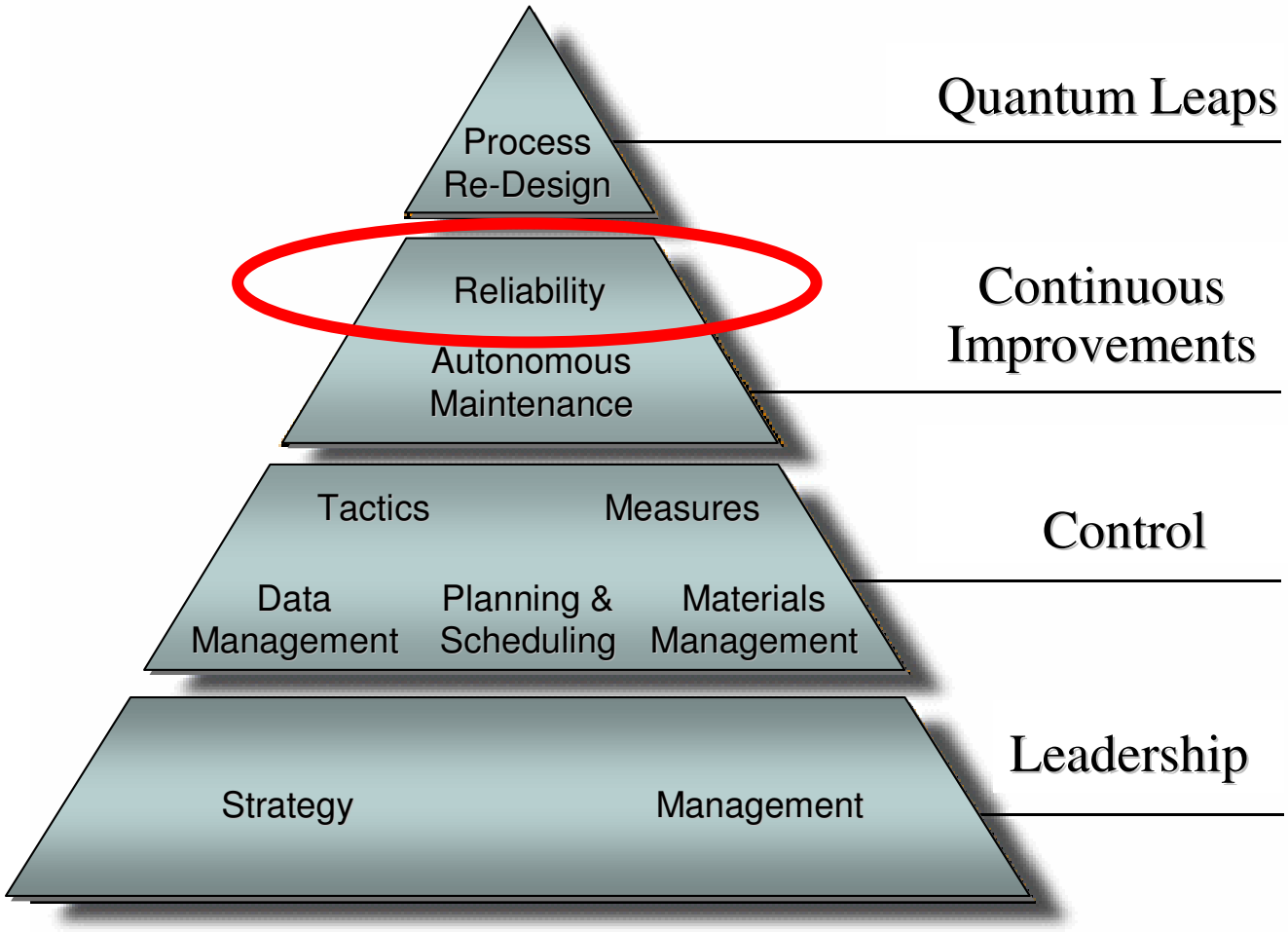
Driving Value in Asset Management



Maintenance Tactics



So what about a focus on Reliability?



Adapted from *Uptime: Strategies for Excellence in Maintenance Management*
By John Dixon Campbell

Airline industry experience

- 1960's
  - 60 crashes per million take offs
  - 40 were equipment related
  - 85% of maintenance was fixed interval (overhauls)
- Today
  - 0.2 crashes per million take offs
  - 0.3 are equipment related
  - < 20% of maintenance is fixed interval (overhauls)

- RCM payback in other industries is usually less than 3 months and has been as low as 3 weeks

What is a Reliability Program?

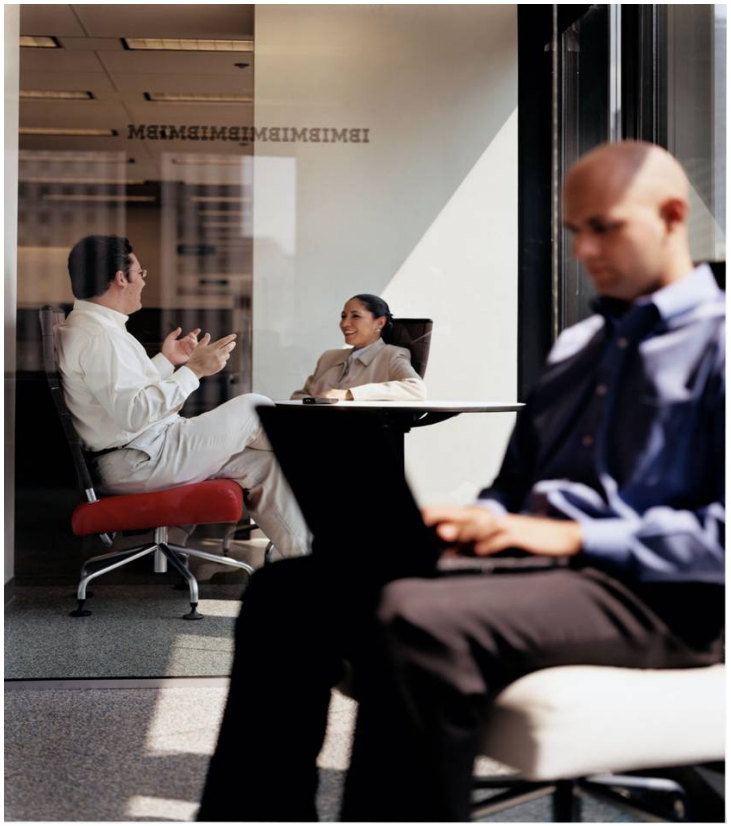
"It is a process to determine what must be done to ensure that any physical asset continues to do what its operators want it to do in its present operating context."

Reliability is not just "doing things right" its about "doing the right things".

What is a Reliability Program?

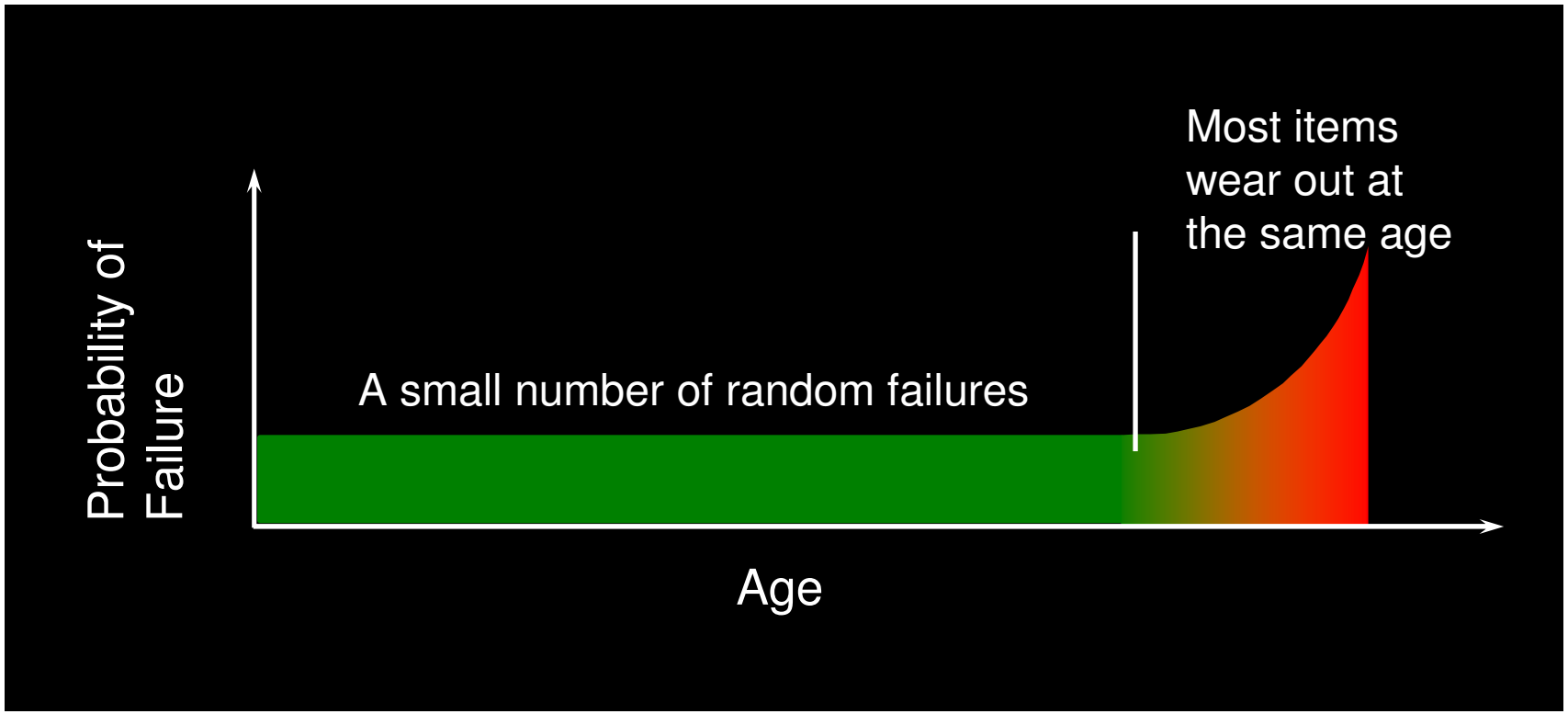
Example Leading Program includes:

- All significant failures are investigated to determine root cause
- Proactive cross-functional teams focusing on tasks from a well established FMEA program
- MTBF (Mean Time Between Failures) & MTTR (Mean Time To Repair) is measured for all critical equipment.
- Equipment histories are analyzed for failure trends.
- Consistent methodology is used to predict most likely failure modes.
- Equipment improvement and redesign is done to improve reliability.
- All PM tasks are based upon specific failure modes.
- Proactive maintenance of at least 60%; emergencies less than 5%.
- PMs represent 45% of man-hours.
- Compliance to PM schedule of 95%.
- Selection of PM based on failure mechanism (e.g. vibration, thermal, repetitive stress, abrasion/wear).
- High utilization of condition-based technology.
- Utilization of equipment histories.
- Mechanism to collect/track measurements (PdM etc.).

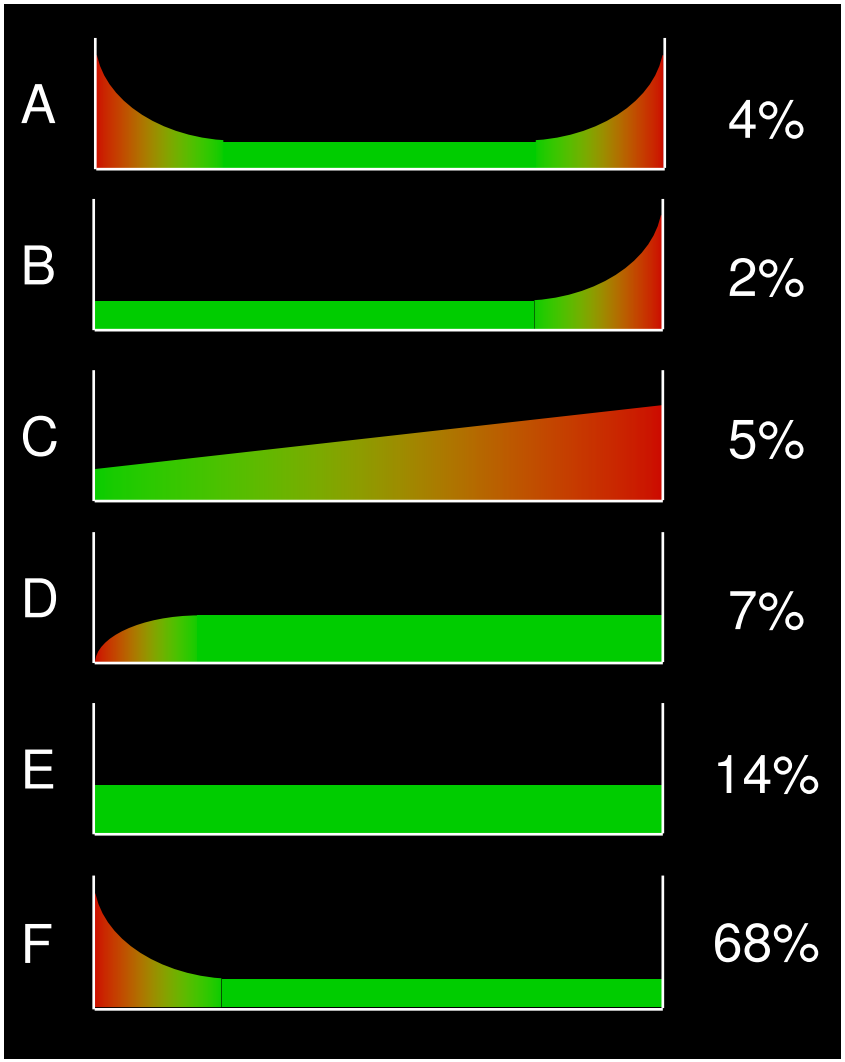


Early view of failure

Traditional Age Model



1970's – we learned a lot



Pattern A: The "Bathtub Curve"
High infant mortality, then a low level of random failure, then a wear out zone.

Pattern B: The "Traditional View"
A low level of random failure, then a wear out zone.

Pattern C:
A steady increase in the probability of failure.

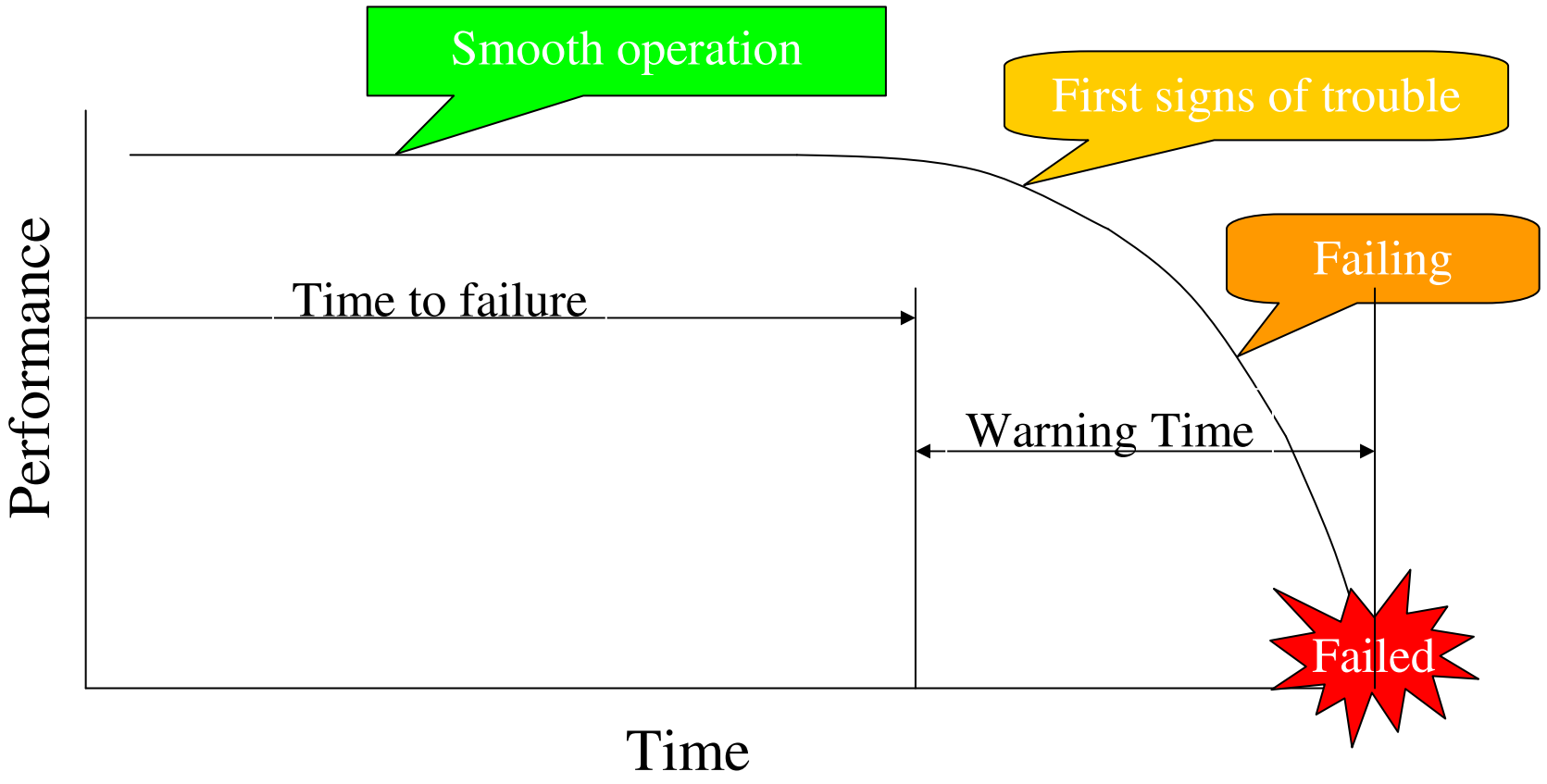
Pattern D:
A sharp increase in the probability of failure settling down to random failure.

Pattern E: Random Failure
No relationship at all between how old it is and how likely it is to fail.

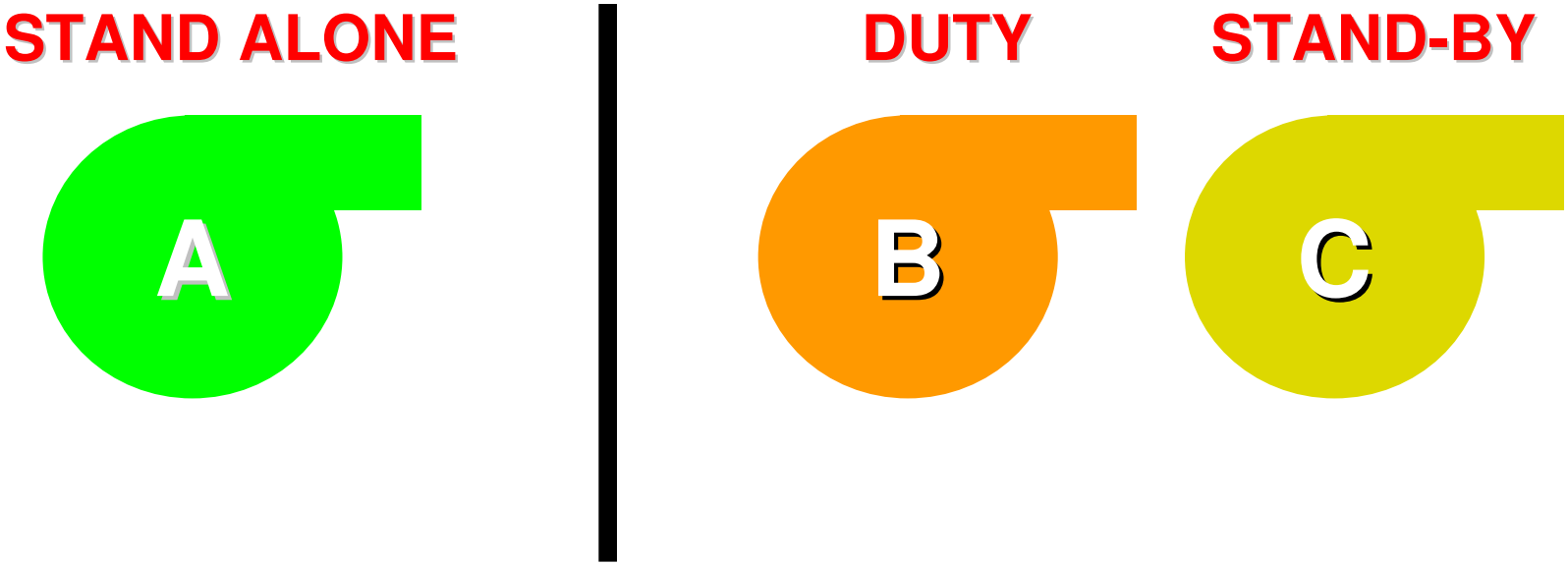
Pattern F: The "Reversed J" curve
High infant mortality, then random failure.

Graphs of conditional probability of failure over time. From Nowlan and Heap & Moubray.

Warning time



Now let's put these identical pumps into operating context…



STAND ALONE

A

- Function : To pump 300 l/min of water
- Functional Failure : Unable to pump at all
- Failure Mode : Bearing seized
- Failure Effect : Downstream process

DUTY

B

- Function : To pump 300 l/min of water
- Functional Failure : Unable to pump at all
- Failure Mode : Bearing seized
- Failure Effect : If B fails switch to C

STAND-BY

C

- Function : To pump 300 l/min of water
- Functional Failure : Unable to pump at all
- Failure Mode : Bearing seized
- Failure Effect : Failure not evident to operators if B is still working

Manufacturer's Recommendation:

Vibration analysis and replacement on high reading

Predict / Prevent

Run to Failure

Testing

RCM

- DEFINITION
- RCM is a process used to determine what must be done to ensure that any physical asset continues to do what its users want it to do in its present operating context.

- RCM PROCESS
- What are its functions (what do the users want it to do)?
- In what ways can it fail (the failed states)?
- What causes it to fail (the failure modes)?
- What happens when it fails (the effects)?
- In what ways does the failure matter (hidden, safety, environment, operational)?
- What can be done to prevent or predict the failure?
- If we can't prevent or predict the failure – then what can we do?

Consequences

- Hidden
- Safety
- Environment
- Operational
- Non-operational

RCM decision outcomes

- Predictive Maintenance (PdM) – condition monitoring
- Preventive Maintenance (PM) – age or usage based restoration or replacements
- Failure Finding Tasks (FF) – periodic checks to see if normally “dormant” devices are still functional
- No Scheduled Maintenance (NSM) – run the asset to failure if consequences (risks, costs, customer disruption) are more acceptable than being proactive (i.e.: it costs less & has acceptable reliability impact)
- One time changes – design, procedural or training outputs that normally avoid the failures altogether or manage the consequences better than maintenance

SAE Standard for RCM

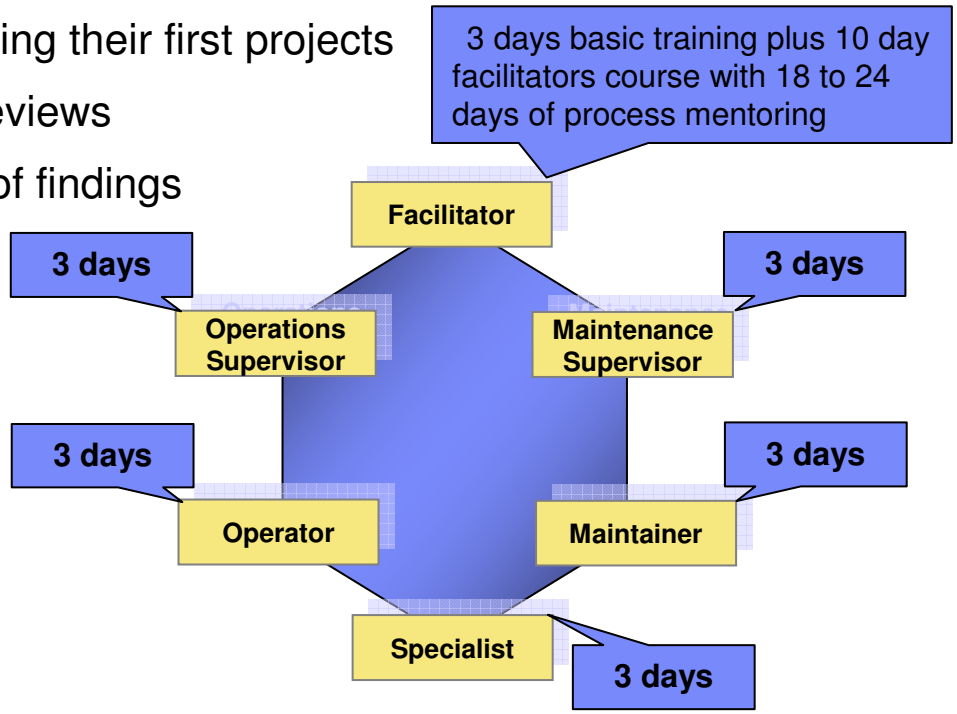
- There are many variations of RCM processes on the market
- Some are better than others but how can you tell?
- SAE decided to produce a standard to help in deciding which methods to use
- JA – 1011 “Evaluation Criteria for Reliability-Centered Maintenance (RCM) Processes”
  - Brief document
  - Set’s minimum criteria to be met
- The standard is voluntary
- It is the only non-military standard for RCM processes

Doing RCM

- Need people who know the asset, how it works (the can), fails (states, modes & effects) and who know what's needed from it (the want)
  - Operators
  - Maintainers
  - Engineering specialists (advisory role)
- They need to work together since no one of these groups has all the answers
  - Typically organized into multi-discipline teams
  - Use facilitated meetings to carry out analysis (follow a rigid process)
- Analysis must be done in "bite sized" chunks
  - Too large and meetings drag on and never conclude
  - Too small and the exercise becomes too trivial to be taken seriously
  - Whole operations can be done, but many opt to do only "pain points"

Preparing for RCM

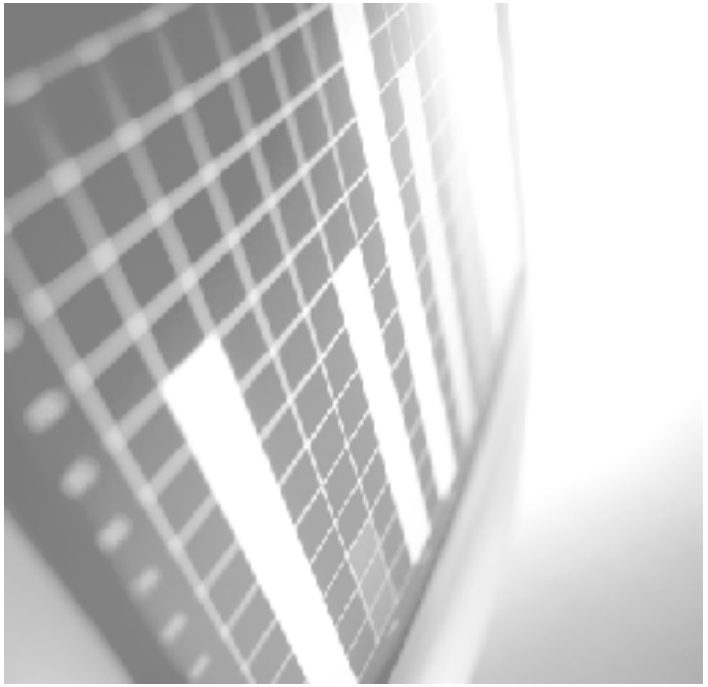
- Training (RCM II) - **Offerings support for each of these steps**
  - 3-day RCM training for analysts (should include ALL maintainers and MOST operators)
  - 10-day training for facilitators
  - Mentoring for facilitators during their first projects
  - Mentoring for subsequent reviews
  - Implementation assistance of findings



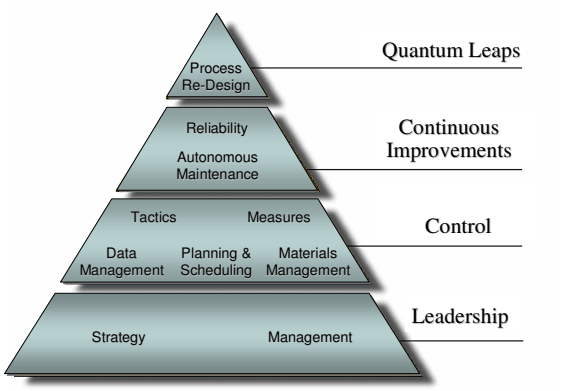
What benefits can be expected?

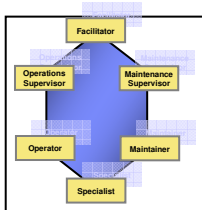
- **Direct (measurable)**
  - Lower risk to safety of employees and public - using corporate safety targets
  - Improved environmental compliance
  - Improved operating performance - using top ten performance metrics to set targets
  - Greater maintenance cost-effectiveness - end up with the safe minimum amount of maintenance
  - Auditable, sensible and defensible task requirements

- **Indirect (intangible)**
  - Participant contribution enhances buy-in - makes field implementation less challenging
  - Better teamwork - RCM teams are generating idea and information sharing already
  - Increased knowledge of assets - already evident to participants



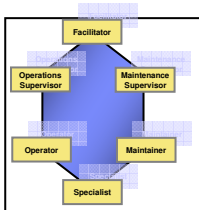
How can a Leading Reliability Program apply to you?





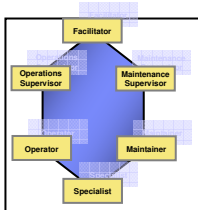
Optimize Reliability Program

- **Extend to other assets as appropriate**
- **Optimize workflow execution**



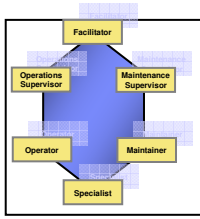
Proactive Maintenance

- **Establish Key assets and subsystems to address**
- **Facilitate FMECA and RCM2 and execute mitigating actions**



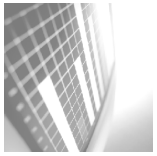
Reactive Maintenance

- **Pareto Asset opportunities**
- **Facilitate RCFA and execute mitigating actions**



Leverage Teams to Establish Reliability Focus Areas

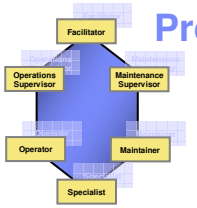
- **Critical Processes and priorities**
- **Identify 'Bad Actors'**



Establish a KPI Baseline

- **OEE**
- **Cost, Output, Safety, Environment**

Steps to Driving a Successful RCM

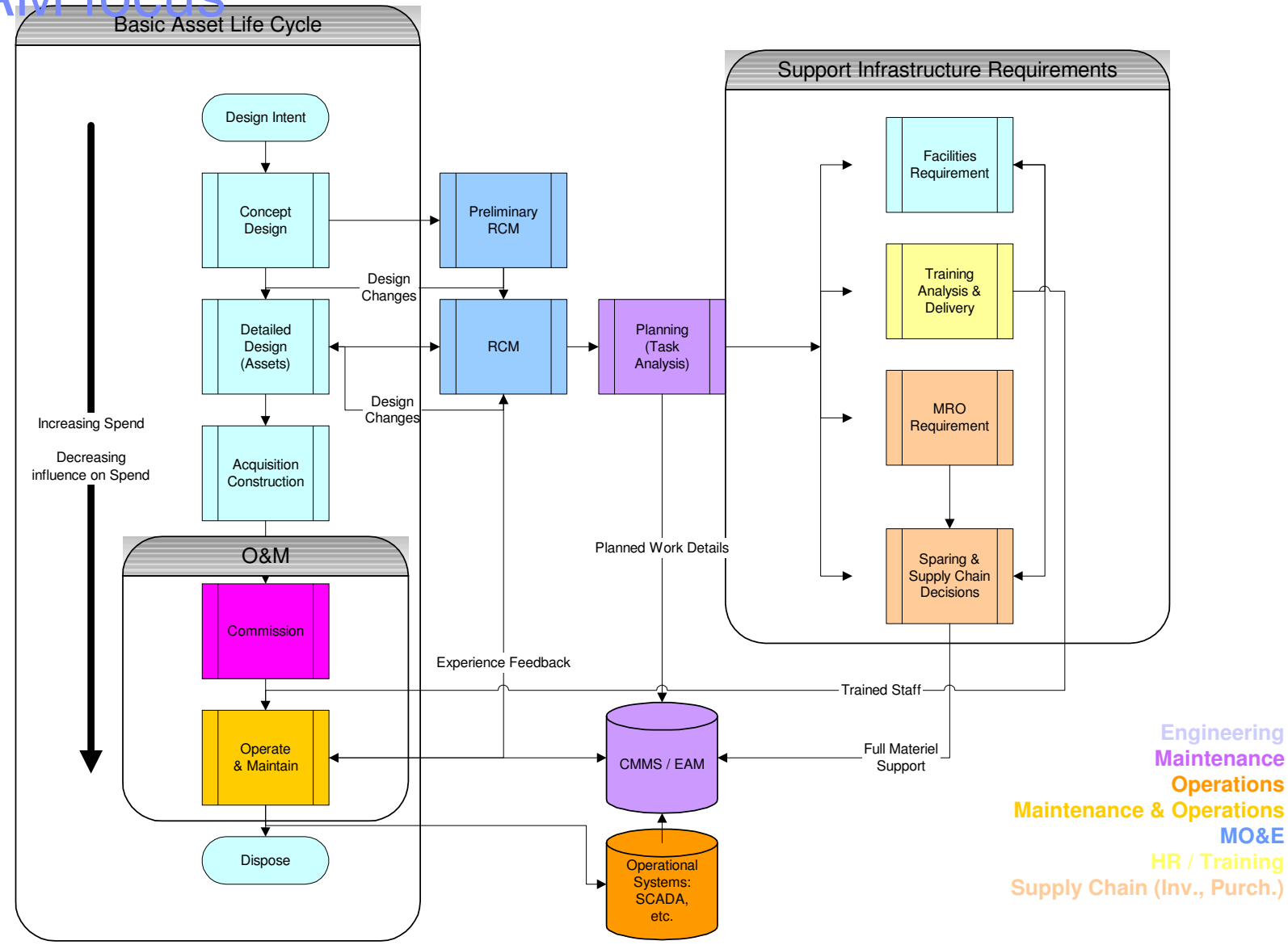


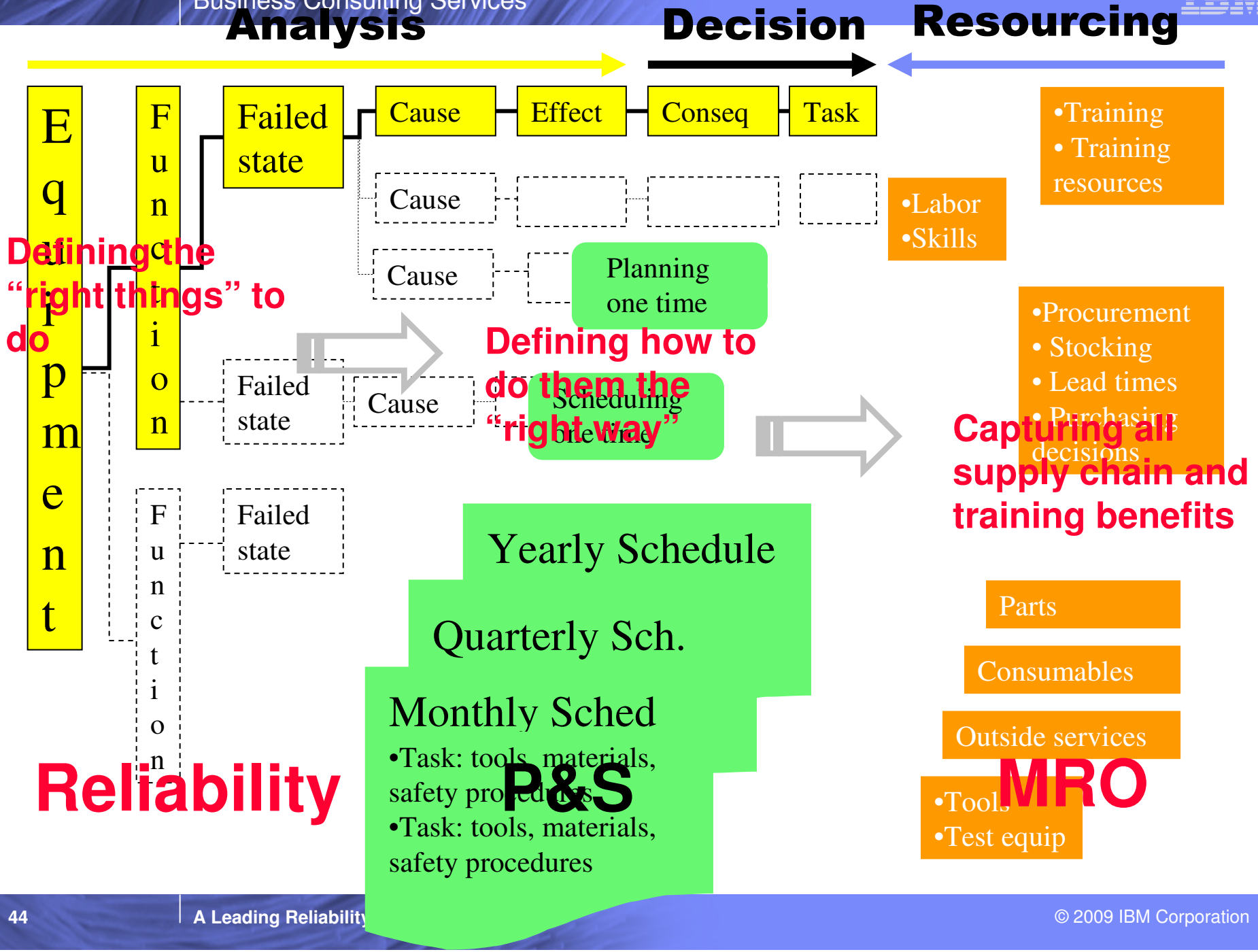
Proactive Maintenance

- Initiate Overall RCM2 Program Plan
- Train Initiative Participants RCM Introduction
- Gather Asset Information & Documents Etc.
- Train RCM2 Facilitators
- Perform Asset Prioritization
- Define Operating Context On Selected Asset
- Complete An Asset Analysis
- Gain Executive Approvals
- Package Tasks and Frequency Into CMMS
- Monitor for Continuous Improvement Through Lifecycle

Start a 'Pilot Program' on a few assets and prove that it works and expand across the enterprise

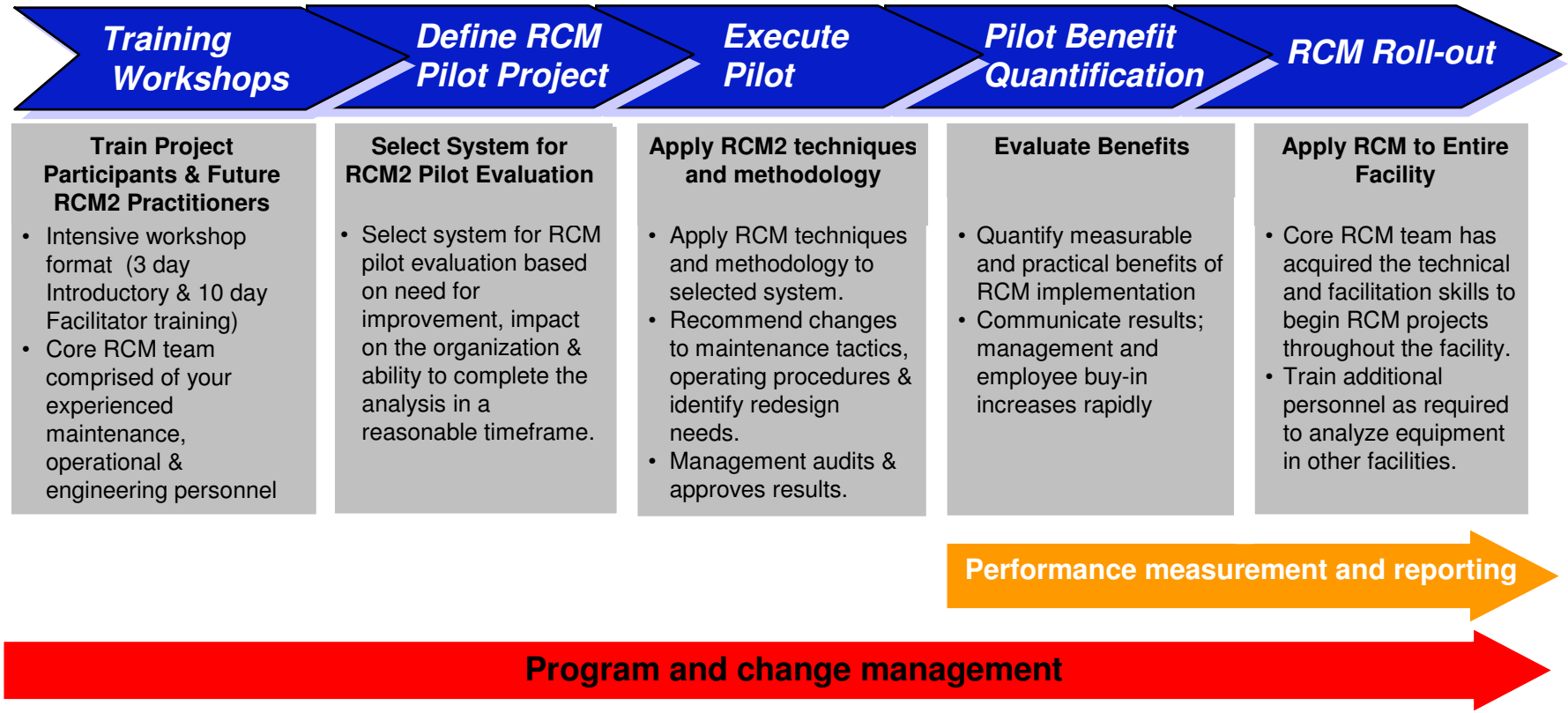
A TLAM focus





Start to achieve RCM goals! A route-map

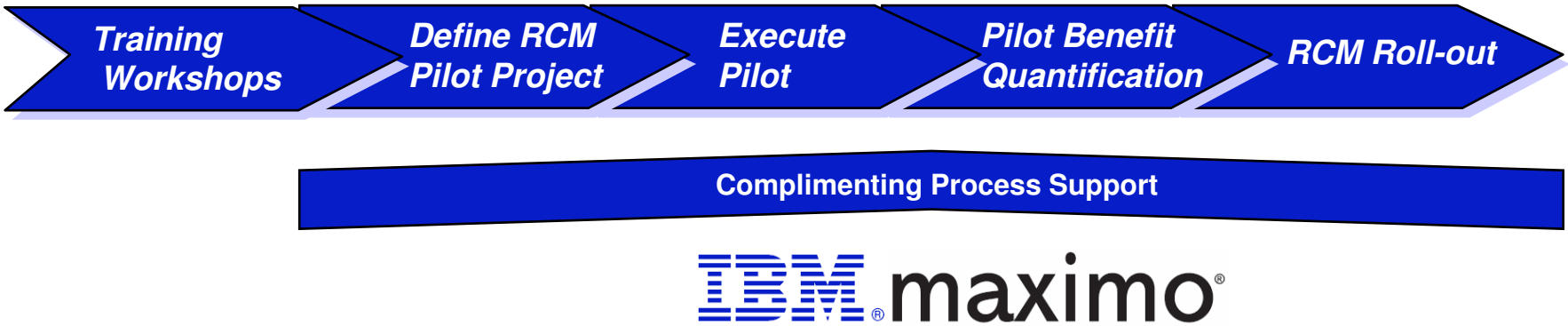
- Appoint a 'facilitator' mode based on the conviction that 'learning by doing' is the only lasting and effective approach
- Due to the variability in complexity, type and operational context of equipment facilitator's primary responsibility is to train your personnel in the RCM2 methodology, demonstrate how it can be applied and assist to hone your team's skills and judgment in applying RCM2



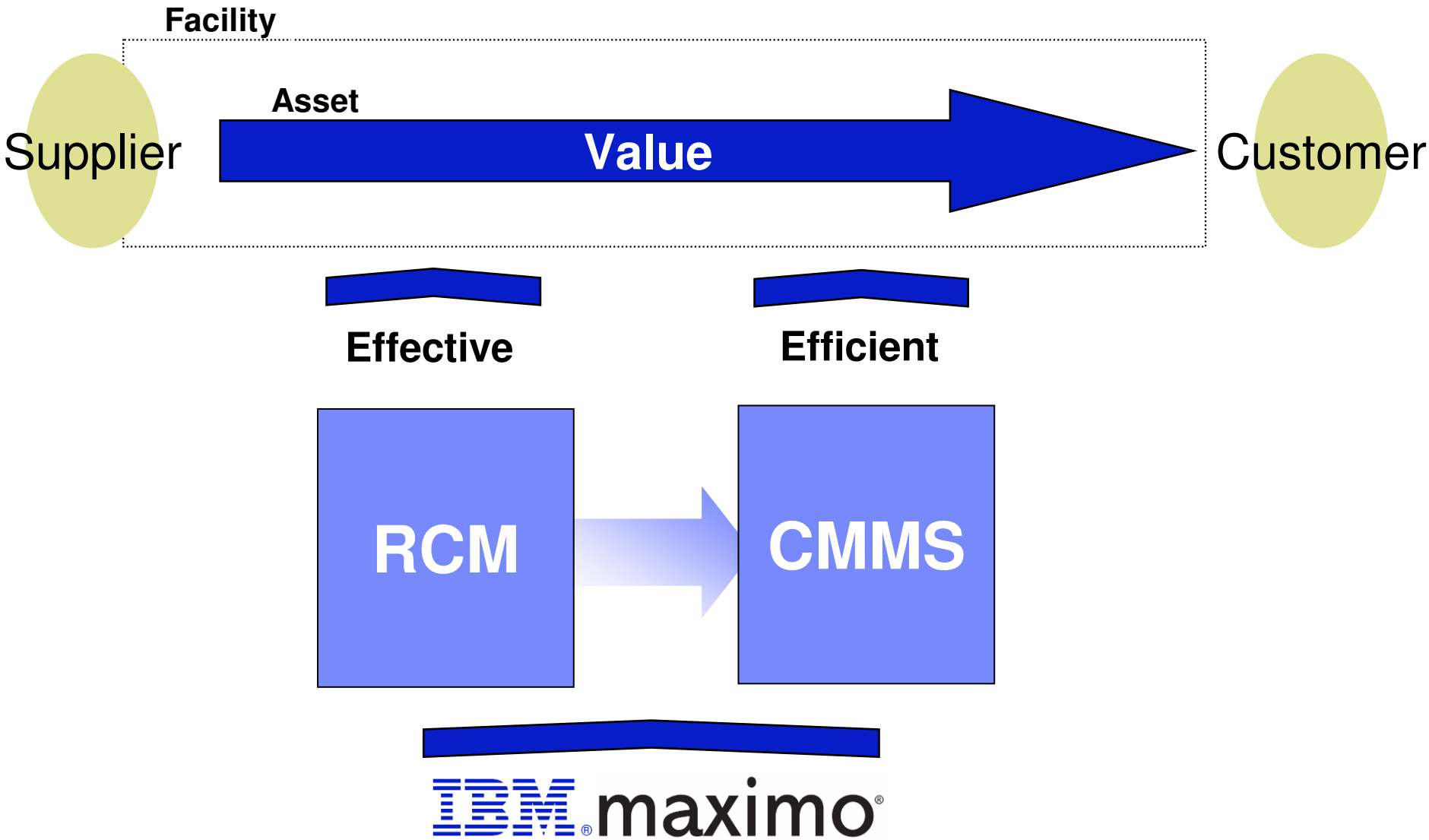
Driving successful RCM results execution

- The most common reason for **not** achieving results from RCM programs seems to be the failure to connect and integrate them fully and completely with overall asset maintenance strategies and supporting information systems.

- Modern enterprise asset management (EAM) systems can be used to:
  - prioritize and target RCM programs;
  - provide the data required to support the questions generated by the RCM process;
  - hold the decision data for archived reference; and
  - act on the results of the analysis.



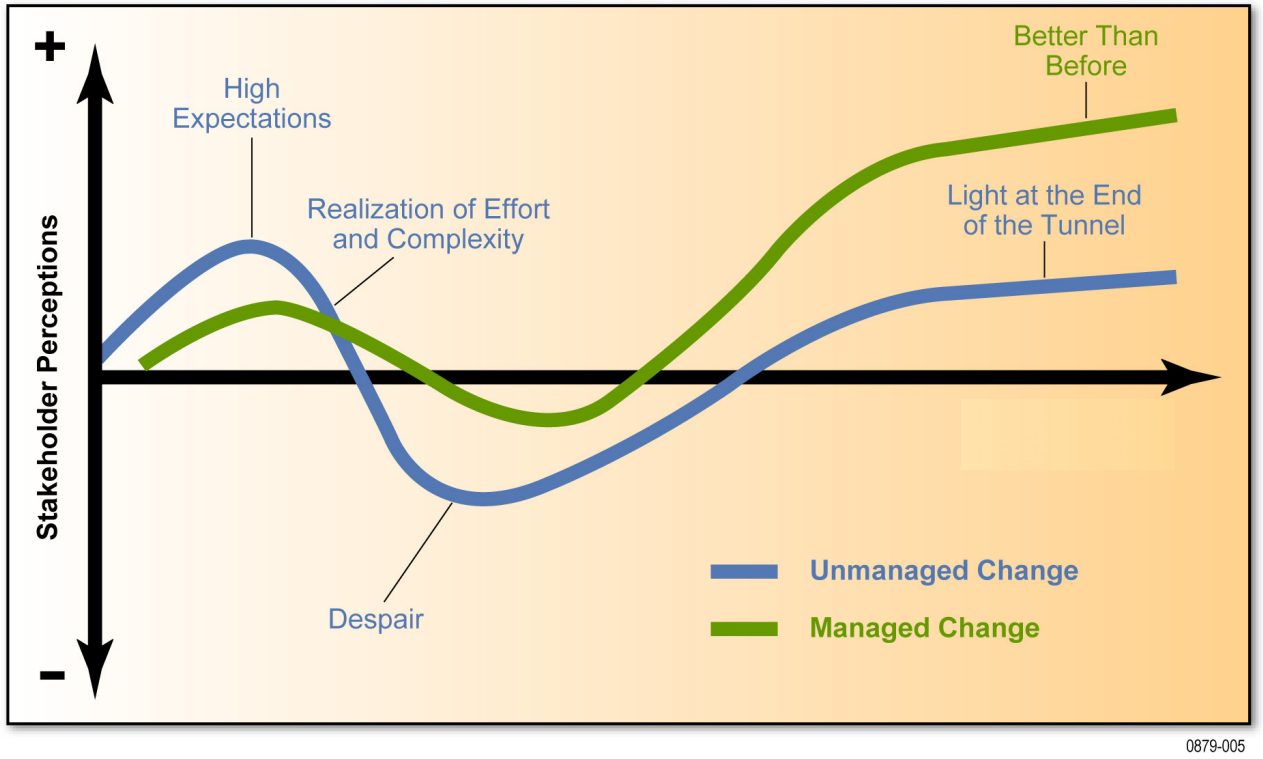
Driving Value in Asset Management



How can IBM's Asset Management Practice help you with Reliability?

- Mentoring
  - Key KPIs including how to establish a focus on OEE
  - Process improvements (i.e. Planning and Scheduling, Parts Management)
  - Program execution
- Training
  - Establishing a baseline and improvement program for Maintenance Excellence
  - Reliability training, including RCFA, FMEA training
  - Reliability training, including RCM2 participant and facilitator training
- Facilitation
  - Assistance and leadership in facilitating reliability programs
    - RCFA, FMEA, RCM2
  - Benefits Realization from your CMMS (IBM Maximo)

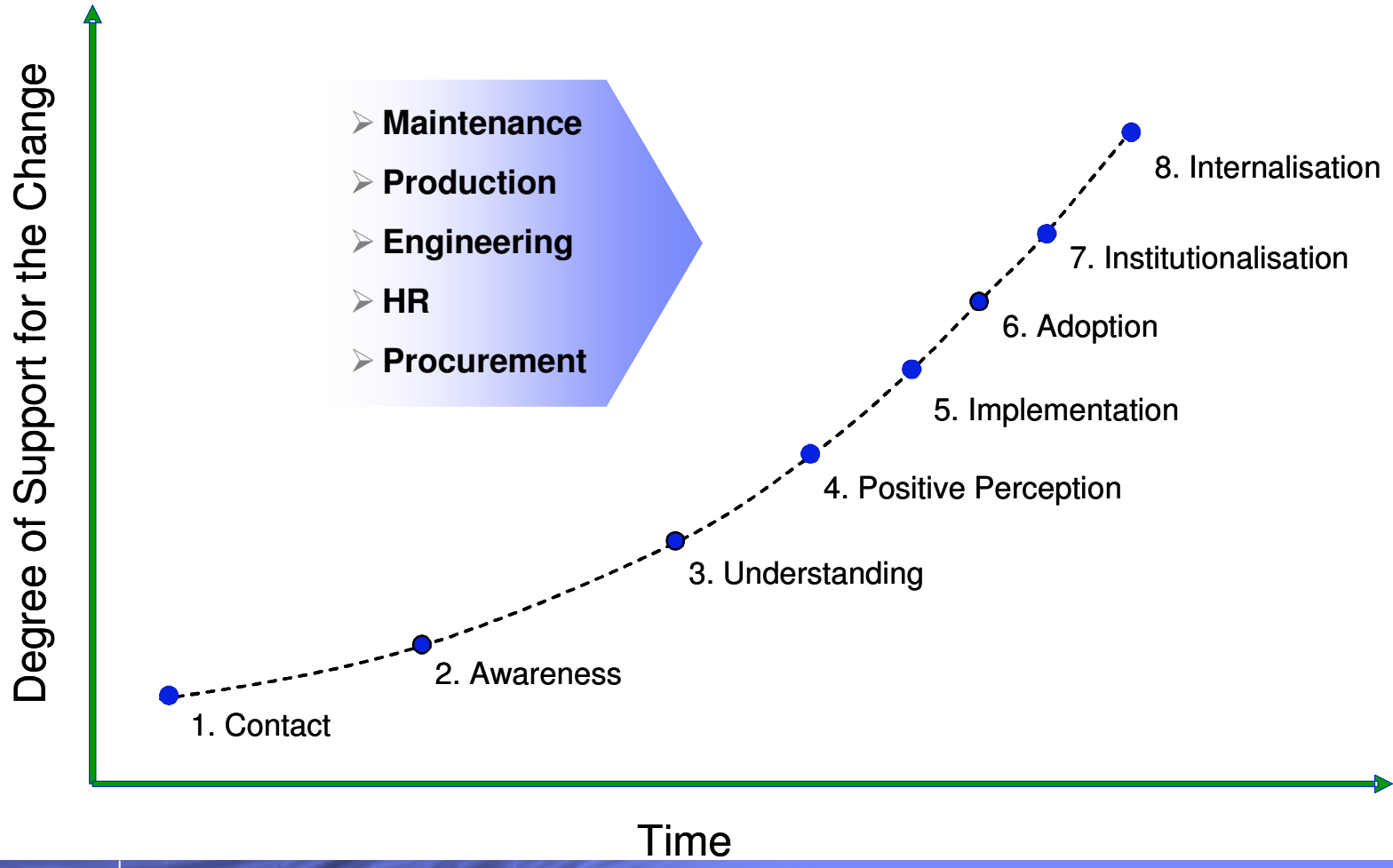
Change Management



- Sponsorship
- Governance
- Stakeholder involvement
- Communications
- Training
- Readiness assessments

Managing the "people" side of a project is a key factor to overall success and constituent participation

Measuring where each Stakeholder group is in their acceptance of the process change is key in understanding to what degree risk actions should be taken to drive success



Driving Value in Asset Management