ISO 55000 – The Sustainable Business Strategy for Operational and Maintenance Excellence

……..**Ian Mclean, Solution Architect, Bentley Systems, Inc.**

Introduction

Risk. Safety. Cost. Efficiency. Quality. Profitability. ISO 55000, the new international standard of asset management recognizes that the way we manage our assets has significant benefits if we can ensure reliability, integrity and performance. If not managed effectively, the consequences of asset failure be serious and in some cases catastrophic. Proper asset management provides game changing competitive advantage. In this whitepaper we'll look at the way that asset management has become an important element of corporate strategy, how ISO 55000 addresses the need for a business strategy for asset management and discuss how Bentley's AssetWise asset management software and methodology maps directly to the standard to establish and sustain a business process to manage asset performance, integrity and reliability, supported by best practices, technology and methodology for success.

ISO 55000 – What it is, and what it is not

ISO 55000 provides a basis for effectively addressing the performance of the assets on which the success of your business is based. This process correctly applied in a sustainable manner will result in your organization being more profitable, safer, and more environmentally sound. ISO 55000 speaks to the fact that asset management is not simply a function of the maintenance department. It involves and requires all aspects of an organization to lead, design, purchase, operate, maintain, and up to the opportune time for disposal of an asset. The end goal is an effective asset management system that ensures asset performance which will go a long way to achieving your business objectives.

It needs to be stated that ISO 55000 is not the magic silver bullet to cure industries pressing need of how to properly manage their assets. This is still the responsibility of the world's maintenance practitioners who must still bring their wealth of knowledge – "the business of maintenance" to the table. The standard does however focus on and clearly define the "what to do" for the correct application of asset management. Perhaps a tertiary goal of asset management is to bring forward the notion that maintainers will no longer be viewed as the necessary evil, which brings only lost opportunity and cost to the business. A clear goal of the standard then is to enforce the knowledge that maintaining asset managers bring value through equipment uptime, of optimized life to our asset base, and as having the potential to reduce cost through for example, a reduction in insurance premiums through asset due diligence as a direct result of the applied science of conditioned based proactive maintenance, reliability engineering and sound management practices. Companies that do not share this view will most definitely struggle to survive in the lean driven global economy or perhaps fall to an even worse fate. So perhaps finally with the profile associated with this global standard, good governance and the

resulting effort required to attain ISO 55000 compliance, the maintainer's day in the sun has finally arrived and the skills brought to the table are actually recognized at the boardroom table.

The Premise Behind ISO 55000

ISO 55000 evolved from the British Standard PAS 55:2008. PAS 55 states the objective of asset management as "to ensure (and be able to demonstrate) that the assets deliver the required function and level of performance in terms of service of production (output), in a sustainable manner, at an optimum whole-life cost without compromising health, safety, environmental performance, or the organization's reputation. "

On the 23rd of march, 2005 a hydrocarbon vapor cloud explosion at BP Texas city was responsible for the loss of 15 lives and injuries to 170 other. BP's own accident investigation stated the direct cause was heavier than air hydrocarbon vapors combusting after coming in contact with an ignition source. The now famous James Baker Panel Report into the investigation into BP Texas City sited something far more damaging and was perhaps the required wake up call to industry. It cited a weak safety culture, and reported that BP did not adequately follow the department of energy published safety recommendations. The report cited that the safety culture was personal safety driven and not equipment safety driven as evidence by the cost cutting and equipment deterioration. PAS 55:2008 was essentially a standard that evolved from the wakeup call from not just BP city, but from the unfortunate tragic consequences of asset failure that resulted from poor asset management at:

- Sayano-Shushenskaya Hydro Plant, August 2009 (76 lives lost)
- Middletown Clean Energy Feb. 2010 (6 lives lost)
- Macondo Well, Deep Water Horizon, April 2010 (11 lives Lost)

PAS 55 stands for Publically Available Specification 55. The PAS 55 standard was developed by the 'Institute of Asset Management' (IAM) with input and collaboration from key industry sponsors. It was developed primarily for linear or continuous assets such as rail, infrastructure and utilities whose asset performance dictated the successes and failures of the corporations that owned or managed them. Practitioners, flocked to the standard as means to prove validity of their efforts, however many found the body of knowledge difficult to manage in a practice. The global community of maintainers has been clear that the forthcoming ISO Standardization must allow for a clear understanding of the elements, terms, definitions, concepts, and performance measures for asset management common around the world.

About the Standard

The new ISO 55000 standard was published on Jan. 10, 2014. ISO-55000 is a suite of three standards comprising:

- ISO 55000 asset management overview\
- ISO 55001 asset management system requirements and
- ISO 55002 guidelines for the application of 55001.

The standards are “applicable to organizations where physical assets are a key or critical factor in achieving business objectives and effective service delivery” (ISO-55000). The standards are built to provide a comprehensive guide to what actions must be adhered to in order to achieve compliance. They provide a clear definition of *what must be done* to achieve compliance the global standard for compliance. This whitepaper shows how Bentley’s AssetWise clearly provides the *how it can be done* in order to gain compliance with the ISO 55000 suite of standards. Additionally it needs to be noted that a separate standard is the benchmark for ensuring that organizations are capable of identifying and measuring risk in a comprehensive transparent manner with a continual process for review and improvement. ISO 31000 Risk Management and ISO 31010 provide such framework. The Bentley APM solution provides integrated Risk analysis tools to ensure that not just risk but consequence(s) of failure are transparent at the maintainable asset level, linking all streams of work to the asset failure modes. The standards the came before ISo such as SAE JA 1011/12, PAS 55 all recognized that risk is an essential componenet of successful asset management and that the risk and its identification must be understand at the basic function of the asset. ISO 55000 combined with ISO 31000 continue this absolute, in that the culmination of the sum of the individualeach maintainable assets knowledge is the starting point for asset management.

ISO 55000 Asset management overview**, principles and terminology**

The first standard, ISO 55000, provides not only an overview to the principles and terms of the suite of standards, it defines the expected benefits from adopting the approach. ISO 55000 identified is essentially the executive overview, “the high level sales pitch” or reasons for adoption. ISO 55000 will bring the asset management reliability world into far more boardrooms than ever before directly due the global legitimacy of the ISO standards organization. To use an analogy if ISO55000 is the bread of the sandwich, then ISO 55001 provides the fillings and ISO 55002 defines the preparation method. ISO 55000 is the body of elements require for compliance. ISO 55002 provides guidelines for ISO 55001, in a means to provide further clarity, or a what and by who(m) must be done while defining the boundaries of the requirements.

The ISO 55000 overview clearly reveals the true purpose of the suite of standards. Articulating the value realized and benefits of asset management related to economic, environmental, and social or other appropriate outcomes. Best in class companies have far greater cash flow through improved effectiveness in risk detection and assessment of its assets year after year. Asset management strategies that define and provide a means to detect failure at its earliest onset of state change allow for proactive corrective activities before the asset functionally fails. Simply stated, an asset which functionally fails creates negative value. An asset which is functionally failed is also in pure financial terms no longer an asset but a liability. ISO 55000(2.3) defines an asset as “something that has the potential or actual value to an organization”. It can be concluded then that companies that provide a sustainable strategy compliant to ISO 55000 will recognize positive value from its asset base in:

- Improved financial risk.
- Managed risk

- Improved services and outputs
- Corporate and social responsibility
- Demonstrated compliance
- Enhanced reputation
- Improved organizational stability

A key component of ISO 55000 is to consider the asset over its life to provide maximum value from concept to its end of life. The resulting broader view on a corporation's asset base provides for sustainable asset management maximizing value realization. ISO 55000 2.4.1 details asset management as the "collective set of activities that an organization uses to realize value from assets in the delivery of its outcomes and objectives".

How to Develop and Sustain a Successful Asset Management System

The journey to operational and maintenance excellence encompasses many facets essential to success. From establishing the business process and developing technically valid equipment maintenance program using leading practices to developing people and ensuring accountability to roles and responsibilities. You want to ensure you are including all of the necessary elements critical to success.

Why the Need for an Asset Management System (ISO 500 2.5.2)

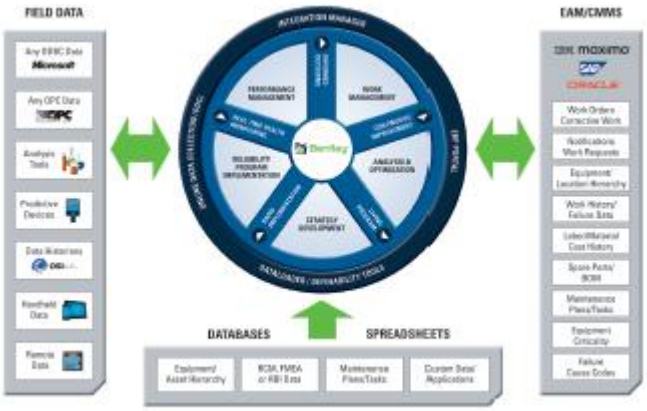
There are so many benefits that can be derived from an asset management system. If it was to be boiled down into one word it would be, "clarity".

Clarity to recognize

- Barriers between functions such as projects, operations and maintenance. A Primary role of leadership is to remove the barriers between these historical silos to allow the process to become holistic in essence function as a whole or one unit. Assetwise Ivara follows a proven business process that enables the tearing down of historical silos through the correct application of the WorkSmart methodology and the defined roles and responsibilities required to execute the process.
- Roles and Responsibilities are delivered by the lean business flow required by the WorkSmart methodology become job descriptions; providing clarity to roles, needs both skill and in number. This is a clear benefit to Human resources and other parts of the organization such as training etc.
- True cost of an asset.

Realizing the full strategic value of maintenance to a company's bottom line cannot be done through incremental improvements in efficiency. Organizations need to be thinking about how they can improve maintenance effectiveness. The real value is in recognizing how to do the right work – that is the maintenance tasks that represent the minimum amount of work to ensure that a given asset delivers the performance needed at the lowest possible cost. To ensure lowest possible cost the financial system and the asset system need to speak with a level of fluency

such that the end user only sees the system they are in control of. Assetwise Ivara has the capability to integrate directly to many financial information tools such as SAP FI. Integration of an organization's asset management plans with its financial system is a clear need to drive not only end of life cycle decisions but day to day decisions. Ivara provides a level of clarity of the asset maintaining costs at the fundamental root of the asset plan to determine the health signature of the asset and the cost of the maintaining the asset health. This allows for a clearer assessment of not only how the asset is performing but at what maintaining cost it is performing at. ISO 55000 is clear in that "Robust financial information relating to assets creates a new resource for the organization's finance function"; and that "the organization's risk-based decision-making processes can also become more effective by addressing both asset and financial risks together, and by balancing performance costs and risks. As a goal of the ISO 55000 is redefining the asset management place in the boardroom this key component alone should garner warranted interest.



An element of the standard is to ensure that leaders actually look at the managing system in order to monitor and to improve the management of the corporation's assets. Bentley Assetwise Ivara provides many tools within in standard capability for compliancy, transparency and recording of events to provide proof of compliancy to the standard.

Asset Management System: Seven Specific Elements (ISO 5500 2.5.3.1.)

The asset management system has been organized into seven specific elements. They are as follows:

1. **Organizational Content**: Vision Mission and values of an organization.
    - Assetwise Ivara use this to define strategy development.
2. **Leadership**: Leaders need to be involved.
    - Assetwise Ivara recognizes this need throughout the process or Work Wheel.
3. **Planning:** High level System planning

- Assetwise Ivara constantly utilizes the strategy to drive all plans and decisions built from the strategy development results.

4. **Support:** All levels of the organization aligning to provide input on the continuing improvement of its asset management plan.

    - Assetwise Ivara recognizes this need

5. **Operation:** Control of all activities related to asset management inclusive of outsourced activities.

    - Assetwise Ivara considers all work equal regardless of who needs to complete the work; the correct approach is only the right work at the right time.

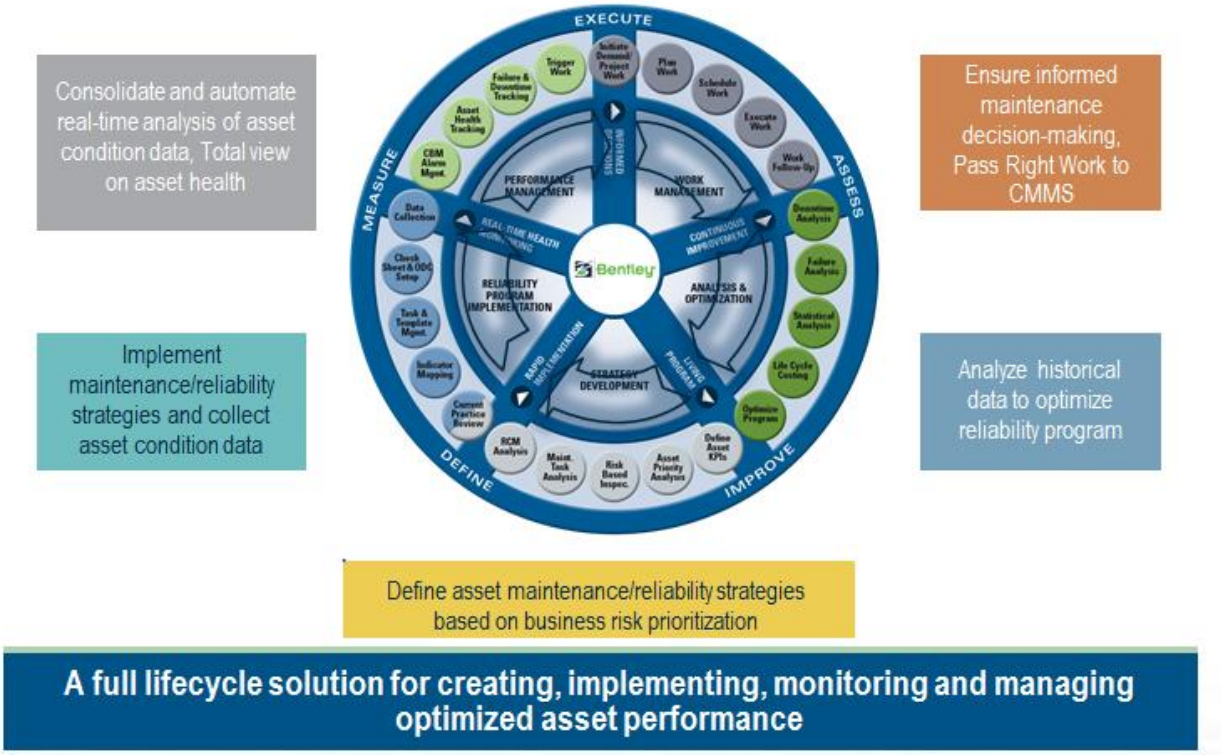
6. **Performance Evaluation**: Top management should review and monitor asset management

    - Assetwise Ivara recognizes this need and provides both leading and lagging indicators to drive transparency and define areas that require further or perhaps closer review. Assetwise Ivara recognize that the indicators should be more than lagging results from the past; proactively they should define when a process or asset is trending non normally to allow for a leading proactive solution.

7: **Improvement:** All Quality systems have a fundamental element of continuous improvement; it needs to part of the culture of an organization.

    - Assetwise Ivara recognizes this need and refers to this process as Asset Performance Management (APM). Bentley systems Assetwise Ivara Provides answers to all the elements in the continuing improvement wheel the drives the

right work at the right time.



The Asset Performance Management (APM)

- *Supports*
  - *ISO 55001*

The Asset Performance Management Cycle represents the business process of APM, those activities that must be consistently executed to ensure optimal equipment reliability on a sustainable basis. The successful implementation of the APM cycle within any organization is highly dependent on following through with the other 3 foundational elements of the Ivara Work Smart methodology – Business, Organizational and Technology Alignment. There are five (5) elements that make up the APM cycle – Strategy Development, Reliability Program Implementation, Performance Management, Work Management and Analysis and Optimization.

Business Alignment

- Supports
  - ISO 55001

Business Alignment focuses on ensuring the overall objectives of the business drive all asset performance decisions. The current state of the organization is reviewed in terms of asset management policy, strategy, objectives and practices and a business case for improvement is developed. Gaining the endorsement of senior leaders to support APM improvement is critical at this stage as is positioning the organization for successful and sustainable change. High level objectives to determine ultimate success are established, agreed upon and communicated throughout the organization and key milestones are identified for periodic assessment of improvement results.

Organizational Alignment

- Supports
    - ISO 55001

Organizational Alignment focuses on institutionalizing the Asset Performance Management process to drive continuous improvement of asset performance within an organization. All of the activities involved in an effective APM process are clearly defined and assigned to specific roles within the organization. Competent individuals are assigned to all of the roles and any existing skill gaps are identified and addressed with appropriate training and mentoring. Roles and responsibilities become clearly understood and individuals learn how to use process measures to manage their own performance as well as the performance of their direct reports.

Define Processes and Roles

- Supports
    - ISO 55001

Training and Coaching

- Supports
    - ISO 55001

Manage Adherance

- Supports
    - ISO 55001

Technology Alignment

Define and Initialize Detailed Solution Design, Build System, & Test and Implement.

- Supports
    - ISO 55001

Technology Alignment involves establishing the technology infrastructure, systems, and interfaces to support improved asset performance. Assetwise Performance Management software is designed and configured as well as interfaced to other systems (e.g. CMMS, PdM Software database(s), Production systems, etc) to support execution of the APM business process. Handheld units, remote tablets and ODC data sources are configured to support efficient equipment condition and performance data collection. Customization of the Assetwise Ivara APM Enterprise software is performed as needed to support the APM process. The objective of technology alignment is to ensure that all data collected is consolidated and transformed into asset intelligence to support effective and efficient decision making.

Define Policy and Strategy

- *Supports*
    - *ISO 55001*

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The first step to business alignment is to ensure that the Asset Management policies accurately reflect the corporate, stakeholder and societal objectives that the organization is trying to achieve. Senior level operational executives analyze the policy requirements. Goals may be widely different and even conflicting such as investment opportunities, financial performance challenges and risks to personal safety and/or the environment. Activities in this step include:

- Analyzing policy requirements
- Developing an asset management policy
- Analyzing strategic requirements
- Analyzing current and future user requirements
- Develop the Asset Performance Management Strategy

An official Asset Management policy (with sign off from senior management) ensures that the organization's top management authorizes an overall asset management policy, which is consistent with the organizational strategic plan, other policies, risk management plan and continuous improvement program. APM Policies must document the framework that enables the APM strategy, objectives and plans to be realized within the auspices of applicable legislation, regulatory, statutory and other requirements to which the organization subscribes.

Analyzing strategic requirements establishes strategic goals, aims and objectives for Asset Management to align with the organization's overall strategic direction and meet international, federal, regional and municipal laws, rules, and regulations. Key employees document a baseline of current Asset condition incorporating the full spectrum of asset performance requirements inclusive of required output, quality, safety and environmental adherence capabilities. Then documented is the planned asset investment horizon inclusive of capital projects, operations and maintenance (O&M) efforts, and asset replacement plans to assess overall asset life cycle costs and the resulting forecasted asset condition. Evaluate if there are other optimal asset investment options, such as determining when in the asset's life cycle the O&M investments should be decreased, to optimize the overall life cycle costs of the asset. Ensure the process periodically reviews the implications of the Current and Forecasted Asset Condition and includes an opportunity to incorporate changes to APM strategy based on new/changed implications of asset conditions to the organization. Outputs include a Strategic Requirements List with risks and constraints and the Asset Capabilities Baseline Gap Analysis.

A strategic market analysis of current and future customer requirements, inclusive of economic and physical product needs, should be compiled and documented from a supporting capital asset perspective. The process periodically reviews the Current and Future Customer Needs and includes an opportunity to incorporate changes to APM strategy based on new/changed customer needs to the organization. Define and document the Legal, Social, Environmental and Economic Factors and Trends which influence and potentially constrain/expand the requirements of the APM strategy. Ensure a process exists to periodically review the Legal, Social, Environmental and Economic Factors and Trends and includes an opportunity to incorporate changes to the APM strategy based on new or changed macro trends within the industry.

Whether markets are becoming more or less competitive, if demands for our products are highly seasonal, which external factors influence demand for our products, etc. we need to establish, use and continually update historical data/facts from internal and external sources based on behavior of markets, customers and competitors.

We use this historic information to produce forecasts of future demand levels, market activity, product/service costs/prices and incorporate appropriate tools/techniques to manage and organize historical data, lead indicators and user assumptions.

Forecasting and communicating relevant business intelligence on current and future external products and technological developments helps to uncover new options, look for alternatives that might deliver greater value to customers.

Incorporate demand and cost variables in the demand and cost model. Periodically update the demand and forecast processes with changes that improve their effectiveness/appropriateness given current and future business climates.

An Asset Performance Management Strategy focuses on the development of organizational policies which address issues such as personal safety, environmental compliance, asset reliability, plant operating efficiency, equipment maintenance costs, work management and MRO inventory management. KPIs at this stage can include:

- Health & safety (gravity, frequency)
- Environment ISO 14000 metrics, regulations respect, improvements projects, non-conformity number;
- Finances metrics; Cost/unit, maintenance cost/unit, operational cost, Maintenance cost/replacement value, EOQ, Overtime, % Operator maintenance cost, inventory turnover
- Process Efficiency & effectiveness, % non-quality, OEE, Availability, % Proactive work, %Wrench time, trades level, % work planned, breakdown analysis, % rework

Developing Risk Based Plans

- *Supports*
    - *ISO 55001*
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With policies and strategies agreed upon and in place, the site manager can create and refine an implementation plan, which espouses the APM policies and strategies set out. This includes preparation, monitoring, performance measurement and optimization of both the financial and business APM plans. Activities are:

- Planning the implementation of the Asset Performance Management Strategy
- Appraising investment options
- Applying whole life costing
- Creating and acquiring assets
- Planning for contingencies
- Developing and communicating the Asset Management plan

A prioritized implementation plan realizes the APM strategy. Periodically update APM strategy implementation plan includes the APM process performance improvement recommendations made through monitoring and measuring the APM strategy performance. Using the implementation plan, good financial projections can be made incorporating any assumptions made, fixed & variable expense budget, income statement, balance sheet, and breakeven point analysis. A thorough business plan is required at this stage and key performance indicators measure for the effectiveness of the APM Strategy implementation plan. Use the key performance indicator measures list to regularly monitor whether the APM Strategy implementation plan is being effectively deployed. (i.e. Is the implementation plan rollout ahead,

behind or on schedule?) The strategy identifies and describes the improvement projects required to accomplish the Asset Performance Management Strategy. Project champions for each improvement project are assigned responsibility for funding and sponsoring the project.

Key outputs include:

- Documented and updated cascaded business plan (division sectors of the APM strategy according to H&S, Environment, Finances, internal business process & employees metrics) with goals
- Documented Review of APM performance and monitor APM action plan updated
- Asset Prioritization
- Roles & Responsibilities documented and updated
- Reliability assessment report
- Performance analysis report

Possible KPIs include:

- Maintenance budget as percent of operating costs
- OEE
- Plant Availability
- Quality reject rate
- Services customer survey satisfaction
- OSHA recordable injuries per 1 000 000 labors hours
- Environmental incident frequency
- Energy cost
- Annual expense as a % of total Maintenance costs; 5 categories Maintenance labor, material, contractors, overhead labor charges
- Total maintenance and repair cost compared to facility and equipment replacement value.
- Inventory turnover per year
- Non stores Purchases as a % of purchases to stock
- Maintenance stock outs
- Store issues/total Material
- Equipment maintenance performed by equipment operator
- % critical equipment and PM work performed by operators.
- APM action plan compliance
- Training dollars spent per maintenance employee
- Number of assets with formal program review with RCM, MTA, RCA, analysis
- Assets GMAO hierarchy updated
- % Roles & Responsibility implemented
- Maintenance organization breakdown
- Breakdown of maintenance Workforce
- Maintenance total plant workforce ratio
- Total number of craft
- % assets prioritized

The Appraise Investment Options stage focuses on broad criteria that factor into the decision-making investment process such as: economic, environmental, socioeconomic, and non-technical barriers. Sensitivity analysis and presentation of sensitivity analysis with respect to these factors should be considered. Define criteria for identifying and evaluating investment options, then identify investment options for achieving the APM Strategy and APM objectives, analyze the costs, risks and benefits of investment options, select and justify the most appropriate options.

Applying whole life costing principles optimizes total cost of ownership by balancing initial capital cost against operating costs/risks over the life of the asset system. This promotes perpetual business needs-analysis and communication of these needs to stakeholders, management and staff. It also focuses decisions to be made about the assets that are aligned with business policies and strategies from the outset of the APM program. To determine activities and cost, first establish criteria to be used to evaluate, select and justify APM activity and asset value costs. Criteria includes; purchase and commissioning costs, maintenance and operational costs and disposal (decommissioning) costs. Health and safety, regulatory requirements and risks are often included as well. Then use the established evaluation criteria and validate the whole life costing model by applying it to representative assets for all the key stages of the APM lifecycle. The assets are usually analyzed following their order of priority. Finally, develop business cases using unit cost data, including a cost/benefit analysis for each key assets taking into account market and technology trends and site overall life projections. Decision support tools will be required for this phase. Periodically re-evaluate these asset specific business cases, updating the model. Establish a triage mechanism with sensitivity ranges to indicate which assets warrant unit cost reviews.
Update whole life cost calculations when unit costs change, recalculate costing values, update and communicate changes. Perform the periodic asset unit cost reviews to determine APM process improvement opportunities.
Leverage the Asset Management Plan as the basis for ongoing cost-benefit risk analysis of physical asset acquisitions and, through the use of KPIs for asset acquisition, prioritizing capital projects by their overall organizational impact. This also includes review of business cases that uncover risks in the implementation plan and assesses the impact of those risks to operations and the APM process.

Plan for contingencies by identifying what asset-related risks exist which may lead to possible disruptions to the organization's critical APM activities. This involves planning the most appropriate response to incidents/ emergencies and making sure suitable resources are available to respond to incidents and emergencies as planned.

Finally, develop and communicate the plan(s). Scope in detail the activities/projects. This involves defining objectives & KPIs, monitoring and reviewing the planning & communication process and establishing asset group strategies with specific asset policies. The APM Plan must delineate how all projects are resourced, managed & evaluated throughout delivery.

Manage Objectives

- *Supports*
    - *ISO 55001*

The Asset Performance Management process established an environment of continuous improvement. When managing objectives properly, we attain accountability and responsibility and we encourage ongoing improvement. Activities include:

- Establish a balanced scorecard
- Establish and monitor accountability
- Periodically assess the program

- Update strategies, objectives and plans

The balanced score card drives the business and provides a simple process to use communications and measurements tools. It should measure the direct and powerful link between corporate communication programs and corporate goals. The corporate communications plan focused on the right goal and helps those of your organization ready to develop plans to help the organization reach these goals. In this way you will show true value to your management team and board of directors and your team will be seen as a strong contributor to your company's business success.

Establishing and monitoring an accountability model is an important step to make the Asset Performance Management Strategy work. The goal of this activity is to ensure the process involves making people accountable from the board level to the plant floor level. Track asset performance, measure people's ownership and level of involvement; allow structured activities to aim objectives. Then periodically assess the program.

Lastly, update strategies, objectives and plans as required. This activity is key to continuous improvement. By continuing to measure itself against predetermined performance targets, an organization can identify the need for improvement. The improvements come in the form of modified APM strategy, refined APM objectives and plans.

The Asset Performance Management Cycle

The Asset Performance Management Cycle

- *Supports*
  - *ISO 55001*
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The Asset Performance Management Cycle represents the business process of APM, those activities that must be consistently executed to ensure optimal equipment reliability on a sustainable basis. The successful implementation of the APM cycle within any organization is highly dependent on following through with the other 3 foundational elements of the Ivara Work Smart methodology – Business, Organizational and Technology Alignment. There are five (5) elements that make up the APM cycle – Strategy Development, Reliability Program Implementation, Performance Management, Work Management and Analysis and Optimization.

Strategy Development

- Supports
  - ISO 55001

Strategy Development identifies business risks and performance targets. It also determines through formal work identification, the appropriate actions to be taken for sustainable, reliable and safe operation of production assets.

To identify business risks, we conduct a formal Asset Risk Prioritization to objectively quantify safety, environmental, operational and non-operational risks and to provide a basis for prioritizing and nominating assets both for improvement projects including RCM, FMEA, RCA as well as non-maintenance improvement projects to restore required capability.

We identify the specific asset performance targets required to satisfy the business requirements. These can be measured in terms of Overall Equipment Effectiveness (OEE), in Availability, Asset Utilization, Mean Time between Failures (MTBF), Mean Time to Repair (MTTR) or other Key Performance Indicators (KPI's).

The approach to work identification is selected based on the relative risk that the system/asset poses to achieving the goals of the business. Through effective application of work identification practices, equipment reliability programs are developed based on the knowledge and experience of equipment operators, maintainers and engineers. Where possible the information developed through formal work identification is leveraged for application to similar equipment in a similar operating context. This ensures consistency of approach and also significantly shortens the timeline to implementation of an improved reliability program for production equipment.

The Work ID methodologies include:

- Reliability Centered Maintenance (RCM2) for high priority assets, (low performance assets that have high business risk)
- FMEA, FMECA, MTA (Maintenance Task Analysis) for certain high/medium priority assets leveraging operator and maintainer knowledge and experience.
- Current Practices Review to identify basic maintenance and regulatory compliance tasks, reduce non value added work.
- Identify non-maintenance change recommendations including re-design, training, procedure changes etc.

Action plans identify the recommended action to follow based upon the analysis undertaken and are the basis for the implementation of an overall asset management program.

Reliability Program Implementation

- Supports
  - ISO 55001

Reliability Program Implementation is the implementation of recommended actions for the asset reliability program. This includes the creation of indicators in EXP for asset condition monitoring and failure finding actions, building of standard tasks and jobs for scheduled restoration and discard actions, creation and validation of condition monitoring routes, set up triggering of routes in EXP and PM jobs in EXP/CMMS and the collection of condition readings. With Assetwise Ivara APM, you are leveraging mobile solutions as well as online data collection –which is often the difference between success and failure in program implementation.

Performance Management

- Supports
  - ISO 55001
  - PAS 55 4.5.1,4.6.1, 4.6.2, 4.6.5, 4.6.6

Performance Management involves the monitoring of asset health and equipment performance with the aim of identifying performance gaps. These performance gaps are used to trigger corrective work and on-going program improvement. The wide-ranging collection of asset health and performance data that needs to be collected as a result of a technically based failure mode analysis and the developed action plans.

The data is consolidated from various sources including handheld data loggers, CMMS/EAM/ERP databases, data historians, on line and real time data sources. The processing of this data is used to develop simple and complex indications of potential failure as well as asset and process key performance indicators.

The management of on condition alarms that exceed defined threshold values and that indicate potential failure modes. These alarms are proactively identified, acknowledged and managed to maintain overall asset health and performance.

Assetwise Ivara APM automatically triggers work from condition based threshold alarms, as well as calendar based and meter based work. The manual creation of work requests, notifications or work orders by the asset stakeholders is also included as part of work initiation. These could include demand work, project work, condition based maintenance, preventative and predictive maintenance tasks.

Work Management

- Supports
  - ISO 55001
  - PAS 55 4.5.1, 4.6.2, 4.6.5

Work Management is the planning, scheduling and execution of the validated work and follow up activities once the work is complete. The EAM module in EXP identifies overall job and task procedures, resource requirements including labor and materials, special equipment, safety, environmental requirements and permits. Compiling, prioritization and scheduling of planned work packages with operations and maintenance groups. The execution and supervision of scheduled work packages and the follow up activities that identify procedure and planning changes as well as corrective work based on condition inspections and PM work are all conducted in Ivara EAM.

Analysis and Optimization

- Supports
  - ISO 55001
  - PAS 55 4.5.1, 4.6.2, 4.6.3, 4.6.5

Analysis and Optimization involves the retrieval of data from multiple information systems for the purposes of in depth analyses and simulations to support reliability program optimization. EXP tracks downtime and failure events and overall performance gaps against determined asset performance targets. The analysis of failure events using Root Cause Analysis (RCA) and techniques such as Wiebull Analysis are employed using EXP. The further analysis of MTBF, MTTR data can be used to recommend overall changes to the overall asset management program. All of the resulting recommendations from RCM, MTA, RCA, Wiebull and others provide recommendations for improvements. EXP facilitates the decision process for determining which of those are accepted and which are not. In some instances the result may be to change the asset performance targets. In either case this step “closes the loop” to drive sustainable results in the face of changing business conditions and to drive continuous improvement.

Fully Integrated Management System Approach (ISO 55000 2.6)

The Bentley Assetwise Ivara product requires information from a health safety and environmental point of view, quality systems, Operational systems and maintenance and engineering in order to build the body of knowledge within its system to drive the right work at the right time. In many ways the tool and the required business process together form a fully integrated management system approach to defining the right work at the right time. It also provides a means to define when it is the right time to end the life of an asset at the right time. It is an approach that is inclusive to the holistic process rather than exclusive. The implementation of Bentley Systems Assetwise Ivara will go a very long way to providing the how to details to the ISO 55000 “What to do standard”. It is not a silver bullet, but case study after case study show that the Assetwise Ivara holistic system delivers results, and sets the path not only for

compliance to the new 55000 suite of standards, but will go a long way to improving the bottom line to any company serious about asset management.

Maintaining asset functionality over the life of the asset is the primary reason for a comprehensive asset management plan. Therefore understanding the health of asset is in its lifecycle must also be part of an asset management plan to make educated decisions for the greater good of any corporation. The effect of an asset failure either catastrophically or functionally defines the risk a corporation faces to promote strong asset management practices. ISO 55000 asset management and ISO 31000 risk management provide the framework requirements to ensure that a corporation protects its shareholders and or investment. Gone are the days where maintainers were deemed a necessary evil that were to be placed in the backrooms until breakdowns, outages and turnarounds dictated their necessity. Maintaining assets should not be a black art. ISO 5500O removes much of the mystery of successful maintaining by placing structure and a transparent audit trail for what must be done. It ensures that who must do the work is performed by competent trained individuals who understand when and why their required actions need to be taken to promote sound maintenance practices. It provides governance for leadership and places checks and balances in place to ensure that asset management remains a continual process and not a one off short term project. It defines the need for an asset management system that mirrors the requirements contained within the ISO suite of standards. Bentley AssetWise has demonstrated its ability to be a single source solution for companies to not only achieve compliance to PAS 55, the standard on which ISO 55000 was built from, but to continually reap value in terms of bottom line P&L improvements. Bottom line improvements arrive from prioritized defensible risk management which lead to improved OpEx and CapEx planning. Often planning improvements lead to the discovery of “free or open capacity allowing organization to do more with less. Comprehensive Systems allow for coordinated activities which promote greater engagement of the workforce, and increased value by means of competency development. The Bentley Assetwise approach provides the framework, flow and continual improvement tool for any organization to add to or to sustain its value proposition. The integral range of tools such essential business processes, alignment activities and system integration yield very significant performance benefits. Look to Bentley Assetwise APM as your means to realize the benefits of an optimized asset management system congruent with the ISO standards, ISO 55000, 55001, & 55002 - Asset Management and, 31000 & 31010 – Risk Management.