A FIELD PROVEN VISION ON ASSET MANAGEMENT

ASSET MANAGEMENT IN INDUSTRIAL ENVIRONMENTS
Interest in asset management is growing. That can be traced to various companies’ increased interest in PAS 55 (Publicly Available Specification on asset management), and on ISO’s establishment of the ISO 55000 series (the ISO standard for asset management).

The term ‘asset management’ is being used more and more in the industry. But the concept is still defined and interpreted in many different ways. What does a company consider asset management to be? Does it refer to the management of its whole asset portfolio, or simply to the lubrication of a pump?

Stork has developed a vision for the ‘how’ and ‘why’ of physical asset management. This clear vision was gradually refined through Stork’s realization of projects for different companies in different industries. These experiences have helped us establish a pragmatic – yet comprehensive – model. We’d like to thank our customers for their valuable contributions.

Certain terms used in this document will not apply to all industries. For example, the ‘manufacturing process’ will be the ‘transportation process’ for public transportation companies, and the ‘power generation process’ for the energy sector.

In addition, companies need to extend their asset management system with specific requirements, capabilities or activities that are important in their specific industry. For example, the oil & gas industry will need to address the importance of integrity in that world.

We are convinced that, apart from some terminology adjustments, the models and descriptions provided apply to all industries in which assets are important to meeting business objectives.

With this paper, which presents our field-proven vision on asset management, Stork hopes to contribute to enabling industrial companies to achieve world-class performance in asset management.

Jos Van der Aelst
Principal Consultant, Asset Management
Stork
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to asset management</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>The evolution from maintenance execution to asset management</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>The asset management concept</td>
<td>9</td>
</tr>
<tr>
<td>3.1</td>
<td>Why asset management?</td>
<td>9</td>
</tr>
<tr>
<td>3.2</td>
<td>Definition of asset management</td>
<td>10</td>
</tr>
<tr>
<td>3.3</td>
<td>Asset management goals</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>The asset management 3D scope</td>
<td>15</td>
</tr>
<tr>
<td>4.1</td>
<td>Dimension 1: Business level</td>
<td>16</td>
</tr>
<tr>
<td>4.2</td>
<td>Dimension 2: Life cycle activities</td>
<td>18</td>
</tr>
<tr>
<td>4.3</td>
<td>Combined dimensions 1 &amp; 2: Business Level and Life Cycle Activities</td>
<td>21</td>
</tr>
<tr>
<td>4.4</td>
<td>Dimension 3: Organizational level</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>Asset management model</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>Asset management organizational structure</td>
<td>28</td>
</tr>
<tr>
<td>6.1</td>
<td>Man versus machine efficiency</td>
<td>28</td>
</tr>
<tr>
<td>6.2</td>
<td>Organizing asset management for asset-driven companies</td>
<td>30</td>
</tr>
<tr>
<td>6.3</td>
<td>Asset management or maintenance management?</td>
<td>31</td>
</tr>
<tr>
<td>6.4</td>
<td>Global approach to asset management</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>Implementation of an asset management system</td>
<td>35</td>
</tr>
<tr>
<td>8</td>
<td>Conclusion</td>
<td>36</td>
</tr>
<tr>
<td>9</td>
<td>References</td>
<td>38</td>
</tr>
<tr>
<td>10</td>
<td>List of figures</td>
<td>39</td>
</tr>
</tbody>
</table>
In this paper, `assets` refer to a company's physical assets. That is, parts, components, equipment, asset systems, production lines, installations and plants - the whole physical asset portfolio. However, managing physical assets requires and affects other assets. Think here of human, informational, financial and intangible assets. Managing the relevant capabilities of these other assets is therefore part of the asset management scope.

Asset management has already been well integrated into the world of infrastructure (e.g. bridges) and utilities (e.g. transmission of electricity). The assets are in direct or indirect contact with the (end) customer. Failure of these assets is directly absorbed by, and visible to, the customer. In most cases, the asset is part of the product that these companies deliver. Managing these assets is therefore an important core business and main focus for their owners.

This paper focuses more on industrial companies: chemical, oil & gas, power generation, manufacturing, metal, food & pharmaceuticals and others. The assets in these companies generate or manufacture products or goods. The generated product, rather than the asset, is in direct contact with the (end) customer.

Assets can be key to realizing manufacturing goals. But, depending on the industry, other processes (such as supply chain processes) can be equally or even more important to realizing business objectives (see figure 1). When setting up an appropriate asset management system, the importance of asset management in the value chain (see Porter [1]) must be taken into account.
Figure 1: Asset management in different company types

- **Asset is in direct contact with customer**
  - Asset ~ product
    - Buildings
    - Infrastructure (bridges, etc.)

- **Asset in contact with customer**
  - Asset is part of product
    - Public transportation (tram, bus, railway)
    - Transport of electricity, gas

- **Asset generates the product**
  - Electricity generation
  - Utility (e.g. compressed air, water purification)

- **Asset is most important in generating products**
  - Oil & gas
  - Petrochemicals, chemical

- **Asset & other processes are important in generating products**
  - Manufacturing companies
  - Pharmaceutical, food products

- **Asset is less important in generating products**
  - Manual welding, etc.
  - Handcraft
Is asset management something new in the industry, or is it a synonym for maintenance management? Didn’t companies already manage their assets before the term ‘asset management’ came along? Of course they did. But companies increasingly understand the importance of assets in achieving company objectives. And asset-centric thinking has brought new insights and approaches.

The way in which industrial companies manage assets has changed a lot over the years. Figure 2 presents the evolution in thinking about reliability, and the resulting organizational involvement.

The main focus of a maintenance department was to guarantee the ‘reliability of its intervention’ when the asset was not functioning. Making sure that a failure was resolved rapidly and qualitatively was maintenance’s core business. This is still a prerequisite for maintenance, but it is not enough to meet asset management objectives.

But organizations also want to reduce repetitive failures and become more effective and efficient. So they work on ‘reliability of the technique,’ and later ‘reliability of the function’ of the asset. Many organizations have already made this transition, by adopting techniques like Reliability Centered Maintenance (RCM). The organizational scope of asset management is no longer simply maintenance, but also involves operations.

From the perspective of Total Cost of Ownership (TCO), companies look at the whole life cycle of the asset. The ‘intrinsic’ or ‘built-in’ reliability, maintainability and safety of assets can critically affect TCO. Therefore, the role of the engineering department is crucial.

Companies need to guarantee the reliability of the intervention, the technique, the function and the lifespan of assets. But they also need to assure the reliability of the policy and strategy. Many financial, safety and environmental disasters can be traced back to an inconsistent or absent asset management policy and strategy.

Asset management plays an increasingly active role in realizing a company’s strategy. Making decisions on the use of assets, on the investment and disinvestment policy, and on managing the asset portfolio (for existing and new assets) is an integral part of asset management. Companies recognize the increased importance of managing assets over the whole life cycle, with respect for stakeholders’ requirements. This leads to a more profound professionalization within this field of action.

With this document, we intend to contribute to a structured approach for managing assets by providing a powerful framework. All levels within the organization – from the employee on the shop floor to the C-level executive – must have a thorough understanding of asset management’s role in their business. That includes everything from effective physical intervention on the asset, to strategic decisions about the utilization of the asset portfolio.
Figure 2: Evolution from maintenance execution to asset management
Asset management in industrial environments
3 CONCEPT

THE ASSET MANAGEMENT CONCEPT

3.1 Why asset management?
Companies are under growing pressure to continuously improve their productivity. Business requirements and risks are changing rapidly. In the current, volatile economic climate, this presents some significant challenges:

- increased safety and environmental requirements
- cash flow requirements
- higher demands from market and shareholders
- growth recession versus growth acceleration
- rationalization and globalization of business
- rising energy costs
- growing quality requirements/standards
- fluctuating customer demands
- shortages in technical skills

To face and manage these challenges, assets must perform at their best over their whole lifespan. In several sectors, asset management entails preparing different scenarios to meet changing targets. This is particularly true in industrial sectors, such as the automobile assembly industry. This industry must pay special attention to rapidly changing marketplace demands. And required asset output is directly related to the economic situation. Properly managing assets is essential, and is therefore inevitable.
3.2 Definition of asset management

There are various definitions for asset management. The ISO 55000 [7] describes asset management as: “Coordinated activity of an organisation to realise value from assets.”

Brief – but comprehensive – ones are given in PAS 55 (Publicly Available Specification):

*Asset management is simply the optimum way of managing assets to achieve a desired and sustainable outcome.* (PAS 55-1 2004) [2]

*Systematic and coordinated activities and practices through which an organisation optimally manages its assets and asset systems, their associated performance, risks and expenditures over their life cycle for the purpose of achieving its organisational strategic plan.* (PAS 55-1 2008) [3]

Whatever definition is used, they all refer more or less to the following elements. Asset management involves the terms:

- **Optimal**: cost/benefit balance in relation to the risk profile
- **Integral**: an all-encompassing approach to assets, going beyond asset maintenance
- **Managed**: managing asset conditions and performance by directing, organizing and carrying out systematic and coordinated activities and processes
- **Desired performance**: creation of value conforming to the desired and/or required performance (not necessarily the maximum)
- **Sustainable**: not only short-term management, but also long-term management
- **Business strategy**: asset management as an integral part of the business strategy

Asset management spans an asset’s entire lifetime, from concept and business case to dismantling. Figure 3 shows the asset activity cycle, in relation to the supply chain cycle.

The asset activity cycle is the life cycle of an asset, from concept to disposal. Assets must be designed, operated, maintained and managed to satisfy the requirements of the supply chain (customer perspective: e.g. Just In Time, flexibility, quality, etc.), while complying with safety and environmental regulations.

![Asset activity cycle and supply chain cycle](image-url)
3.3 Asset management goals

The ultimate goal of a (private) company is to create value and make a profit.

The way in which asset management contributes to the overall business objectives must be made explicit to shareholders and other stakeholders. There is a strong link between asset management goals and financial indicators, such as Economic Value Added (EVA) and/or Return on Capital Employed (ROCE). ROCE is influenced by the output of the 'generating' assets, expressed in manufacturing companies as Overall Equipment Effectiveness (OEE) or Overall Asset Effectiveness (OAE). Along with other elements, the number of good, qualitative products influences the sales turnover. The Total Cost of Ownership (TCO) of assets is part of the total operating costs (see figure 4).

Figure 4: Asset management influencing financial indicators
Based on these business indicators, six main goals can be identified for industrial companies:

- **Asset - output**: provide the correct number of ‘conforming’ and ‘quality’ products at the right time. Asset output is often expressed as OEE.
- **Asset - input**: optimize and manage ‘input’ losses:
  - energy losses
  - (raw) materials
  - labor/overhead (e.g. extra activities due to limited function of the asset)
- **Asset integrity and compliance**: meet safety, health and environmental requirements
  - comply with (internal and external) rules and legislation
- **Asset lifetime**: achieve the required asset lifespan
- **Costs**: realize the goals at the optimal cost in the short and long term (from the perspective of life cycle cost and risk management)
- **Innovation and improvement**: improve and manage assets and asset management continuously

Defining objectives for each goal, and achieving these goals, is illustrated in figure 5. The arrows indicate achievement, and the vertical lines indicate the target. The efforts, investment and costs should always be weighed against the benefits or the profits – the optimum in relation to the risk profile. The goals, as listed, are consistent with the TCO concept. TCO includes all the costs of acquiring, owning, operating, maintaining and disposing of an asset: direct costs, indirect costs or losses.

Every company must define its own risk profile. The risk profile describes what level of risk the organization considers acceptable or not. This directly influences cost/benefit decisions. Asset management is about making decisions based on an optimal balance between cost, risk and performance, with respect to short- and long-term requirements.
An important ratio that reflects this optimum is the manufacturing cost per unit of goods, namely:
- € / ton
- € / km
- € / unit of product
- etc.

The lower the cost per unit, the more profit potential. Companies benchmark these costs internally and externally. This is the yardstick by which a company's competitiveness is judged.

Asset management strives to achieve the lowest possible TCO by keeping the manufacturing costs per unit as low as possible during the operational lifetime of the asset. Without jeopardizing safety, health and environmental requirements (License to Operate). This is achieved in a sustainable manner, so that the future is secured.

Figure 5: Asset management goals
Despite the existence of definitions for asset management, the concept is interpreted in many different ways. Companies use their own proprietary specification of asset management. They have already organized the whole asset management scope in some way or another. Sometimes, a company does not have the complete authority to define and/or execute all the relevant processes, including the complete asset portfolio strategy.

Companies must therefore clearly define what they consider asset management to be. They need to ensure there is no confusion, internally or externally. The required processes must be in place to make it work effectively and efficiently. What are the boundaries of the company’s asset management system? What will be documented and implemented in other business systems and processes?

The scope of asset management can be described in three dimensions:

- Business level: defining assets, from equipment asset management to portfolio asset management
- Life cycle activities: the primary asset life cycle processes
- Organizational level: from policy to implementation

Regardless of the company’s own definition of asset management, it is imperative to define and implement business functions and processes that cover the full range of the three dimensions in some kind of management system.

Figure 6: The asset management 3D – scope
4.1 Dimension 1: Business level
All levels of a company must understand and support asset management. Figure 7, derived from PAS 55-1 2008 [5], describes the main levels of defining an asset from the business point of view.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Example</th>
<th>Asset Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different products</td>
<td>Energy company</td>
<td>Different investment opportunities, performance challenges and risks</td>
</tr>
<tr>
<td>Different sites / Networks</td>
<td>Electrical generation plants</td>
<td></td>
</tr>
<tr>
<td>Similar products</td>
<td>Waste treatment</td>
<td>Integral, sustained and optimised planning and performances</td>
</tr>
<tr>
<td>Similar sites</td>
<td>Nuclear plant</td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>CHP plant</td>
<td>Sustained performance, cost and risk optimisation</td>
</tr>
<tr>
<td>Lines</td>
<td>Steam generation</td>
<td></td>
</tr>
<tr>
<td>Assemblies</td>
<td>Generator</td>
<td>Optimise life cycle activities</td>
</tr>
<tr>
<td>Individuals</td>
<td>Pump</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7: Business dimension of asset management
– **Corporate management level**: At the business level, asset management is about the buying and selling of assets. These strategic choices have to do with market opportunities, competitiveness, product development and other (external) factors. Within the financial world, the notion of asset management commonly refers to this level, where buying and selling of shares amounts to buying and selling (parts of) businesses.

– **Portfolio asset management**: This refers to the best use of the assets: which assets to use, when and where to invest and/or to disinvest? This level concerns the whole asset portfolio of a company.

– **Business unit asset management**: This perspective will ensure the optimal deployment and use of the assets in a cluster of similar plants (e.g. same technology) or a cluster of companies with similar products (e.g. product is waste treatment). Consolidation of asset utilisation between the various sites is crucial in achieving the overall business objectives.

– **System asset management**: This level deals with systems and installations (e.g. product line) with a clearly defined (output) function in the company. This can range from a product line to an entire plant.

– **Equipment asset management**: This level deals with the technical aspects of components or equipment.

Asset management seeks to maximize the return-on-investment over the entire life cycle of an asset. By adopting an integrated view of assets, encompassing all business levels, organisations can ensure that optimum value is delivered.

Asset management includes investment and disinvestment decisions, planning decisions for the use of assets throughout the business unit strategy, and plant and equipment asset management.
4.2 Dimension 2: Life cycle activities

There is a clear interdependence between the activities of the asset activity cycle and the elements of the supply chain cycle. Assets must be designed, maintained and operated to meet the expected lifespan, to meet the demands of the supply chain (customer perspective) and to comply with safety and environmental regulations.

The main processes in the asset activity cycle are:
- Asset acquisition/creation
- Asset utilization/exploitation/operation
- Asset care/maintenance
- Asset improvement
- Asset disposal

The various key processes and roles are illustrated in figure 8.
As described in the previous section, the concept and business case are linked to the portfolio and business unit asset management level. Why do we need assets from a corporate perspective, from an asset portfolio perspective and from a business unit perspective? The Asset Owner’s role is crucial here.

The concept and business case should already include the life cycle requirements of the asset, the requirements of the supply chain cycle, the requirements of intrinsic (built-in) and operational reliability, and regulation or compliance requirements. Supply-chain-related requirements relate to product portfolio, product quality, manufacturing strategy (e.g. Just in Time) and so on.

The Designer or Engineer is responsible for the execution of the design, purchase, construction, delivery and commissioning activities. These activities are part of the ‘project life cycle’ process. Operational requirements are also taken into account in this phase, as well as reliability, integrity and maintainability targets.

The ‘supply chain cycle’ describes the process from supplying and procuring raw materials, to the delivery of the end product to the customer. The requirements for the supply chain cycle are derived from other business functions, such as marketing, sales, product development, etc..

The organization of the supply chain cycle and its requirements has a huge impact on the function of the asset. The asset itself must be able to fulfill this function, and is ultimately at the service of this cycle to ensure that the right number of products is provided, at the highest quality, within the appropriate time and at minimum cost.

To manufacture or produce goods, assets need to be operated and maintained. How they are operated and maintained largely determines the asset’s operational reliability.

To adjust installations or assets to changing circumstances or needs, an improvement process must be in place to realize modifications. This process has characteristics similar to the asset creation process. The Engineer/Designer plays a central role. In most companies, the Maintenance Organization handles the process, at least for minor modifications (Operational Expenditures, or OPEX). The Engineering Organization usually carries out major modifications (Capital Expenditures, or CAPEX).

It is important to clarify all the processes that a company attributes to its asset management system, because ultimately, all the roles must be filled.
The timing of asset dismantling depends on several factors, including the lifespan of the product, the condition of the asset, the end-of-life of components (e.g. spare parts no longer available on the market), market trends, market opportunities, and more. The lifespan of an asset or installation has to be taken into account in the design phase. Insight into – and comprehension of – advanced technology and market trends can influence the lifespan.

Knowing the remaining lifespan of an asset is very important for optimizing the asset’s performance and cost. Risk measures to assure asset performance are different at the beginning of a asset’s lifetime than at the end (e.g. using up spare parts, other preventive maintenance needs).

All processes and activities related to creation/acquisition, operation, maintenance, improvement and dismantling of the asset are an integral part of asset management.

To manage these processes and carry out the activities, several roles are required:

- The **Designer/Engineer** is responsible for developing the design of new assets, or modifications to existing ones. The acquisition of new assets, and in many cases the dismantling, are also part of this role.
- The **Operator** is primarily responsible for the utilization/exploitation/operation of the assets. In this way, the asset is able to produce goods.
- The **Maintainer** maintains the equipment over its lifespan, to ensure the asset functions according to its designated purpose.
- The **Owner** integrates the activities of the Designer, Operator and Maintainer. The Owner is focused on longer-term issues. He is accountable for the realization of the Return on Capital Employed (ROCE).

From the perspective asset management, maintenance is not of secondary importance to operations. Both should contribute to the achievement of operational reliability. From this perspective, the traditional thinking in terms of customer/supplier (operations/maintenance) is no longer valid. Both functions are equivalent in ensuring asset performance. As such, both provide services to the Asset Owner.
4.3 Combined dimensions: Business Level and Life Cycle Activities

Visualizing the combination of the business level and life cycle activities dimensions will help to align and clarify the company’s asset management territory.

Figure 9 shows the combination of the two dimensions. The asset management scope for two different companies is illustrated. The complete and integrated scope of asset management covers the entire area.

The business scope is represented horizontally, and the asset life cycle activities vertically. Company B has limited its asset management system to the business level (in this case, all nuclear plants) and includes all asset life cycle activities. Company A stops at the plant level, and the acquire/create and disposal activities only reach the assembly level (e.g. new installation parts, not a complete new installation). That is because these activities are carried out at a global corporate level, and the local asset management has no direct authority over these processes (e.g. the decision-making process).

---

**Different level of identifying and managing assets**

<table>
<thead>
<tr>
<th>Equipment level</th>
<th>System level</th>
<th>Business unit level</th>
<th>Asset portfolio level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristics</strong></td>
<td><strong>Characteristics</strong></td>
<td><strong>Characteristics</strong></td>
<td><strong>Characteristics</strong></td>
</tr>
<tr>
<td>Individuals</td>
<td>Assemblies</td>
<td>Lines</td>
<td>Site</td>
</tr>
<tr>
<td>Example</td>
<td>Example</td>
<td>Example</td>
<td>Example</td>
</tr>
<tr>
<td>Pump</td>
<td>Generator</td>
<td>Steam generation</td>
<td>CHP plant</td>
</tr>
<tr>
<td>Asset concerns</td>
<td>Asset concerns</td>
<td>Asset concerns</td>
<td>Asset concerns</td>
</tr>
<tr>
<td>Optimized life cycle activities</td>
<td>Sustained performance</td>
<td>Integral, sustained and optimized planning and</td>
<td>Different investment opportunities, performance challenges and risks</td>
</tr>
<tr>
<td>Acquire / create</td>
<td>Operate</td>
<td>Maintain</td>
<td>Improve</td>
</tr>
<tr>
<td>Dispose</td>
<td></td>
<td>Disposal</td>
<td></td>
</tr>
</tbody>
</table>

---

**Example: company A, B**

Figure 9: Combined business and asset life cycle scope
4.4 Dimension 3: Organizational level

The main processes in the asset activity cycle are described in section 4.2. In figure 10, they are presented as:

- Engineering process for asset acquisition/creation
- Operating process for asset utilization/exploitation/operation
- Maintenance process for asset care/maintenance
- Improvement process for asset improvement

Note: The process of asset disposal can be included in the engineering process, due to similar characteristics.

The operational, maintenance and improvement processes are part of the manufacturing process.

Each main process can be further divided into the following sub-processes:

- Policy (The direction of the process)
- Concept (What to do - Effectiveness)
- Implementation (How to do - Efficiency)

Many companies have organized their asset management around the roles of Asset Owner, Asset Manager and Service Provider (see section 6.2).

The Asset Manager is focused on effectiveness (‘do the right thing’) and the role of Service Provider on efficiency (‘do the things right’). This division might suggest that asset management is limited to the content of the Asset Manager’s role. In some cases, companies have limited their asset management system to this content, even though service providing is an integral part of asset management. To manage assets properly, all levels (policy, concept and implementation) should be covered.

If only policy and concept are considered in the asset management system, all other sub-processes (e.g. workflow management) should be covered in another management system. These sub-processes need to be properly managed.
Conclusion on the three dimensions:
The full and complete realization of the three dimensions leads to well-managed assets. If the area covered by asset management is limited in one dimension, the omitted aspects should be considered and assured elsewhere in a management system.
ASSET MANAGEMENT MODEL

In cooperation with several industrial companies, Stork has developed an asset management model that is used to design the asset management system. The model refers to the requirements for an asset management system described in PAS 55 [6] and in the ISO 55001 [7].

The model contains 11 domains, and is refined later on in activities or elements. The 11 domains are presented in figure 11.
Asset management governance: The description and documentation of the system, methods/techniques, best practices and processes that must be followed throughout the company.

Risk management: Identifying, analyzing and evaluating risks and implementing the appropriate countermeasures. The risk management approach is the core methodology used to take measurements and decisions in the other asset management domains.

Asset management policy and strategy: A company should explicitly set out its asset management policy (direction) and strategy (long-term objectives and plans). This starts from the stakeholders’ values and overall company policy. Strategic analysis lies at the base of the asset management strategy. The company must establish asset management goals and objectives.

Asset concept management: Concepts describe what to do (the measures to reduce risks or seize opportunities), and why to do it (the reasons and justification for the 'what'). The reasons and justification are derived from the asset management policy and strategy, and based on a risk management approach.

Asset management plans: Asset management concepts will be integrated in long-term and medium-term plans, with the identification of all necessary resources. These plans will be used for budget planning. Investments, turnarounds and production schemes are integrated into these plans.

Asset service providing: Effectively, efficiently, qualitatively and safely implementing and executing the various concepts and plans.

Asset management performance: Besides the condition of the assets and their associated performances, expenditures and risks, the implementation and effectiveness of the plans needs to be monitored and controlled.

Asset management analysis and improvements: Based upon the measurements and performance of the installations, check whether the asset management process is effective and efficient. Deviations from the stated objectives or potential opportunities are reason to conduct a critical analysis and prompt the necessary measures to correct and/or improve the process.

Asset Management Organization: An organization that is capable of carrying out asset management processes must be installed and maintained in a uniform, clearly structured and managed way.

Asset management people: People involved in asset management processes need to have the appropriate competencies, skills, leadership styles and attitude. Activities to assure this, such as training, communication and participation, belong to the domain of asset management.

Asset management infrastructure: The infrastructure and means necessary to support the implementation and execution of the asset management process (e.g. Computerized Maintenance Management System, or CMMS).

A further breakdown of these domains into elements or activities is shown in figure 12.

The asset management policy and strategy must be derived from – and be consistent with – the organizational strategic business plan and the expectations and requirements of the various stakeholders. Strategic analysis, such as life cycle analysis and scenario building, should be carried out. Asset management objectives and related targets are set in order to fulfill the policy and strategy.
The strategy and objectives are translated into concepts related to the risk profile, and summarized in a risk matrix, for example. Risk assessments and criticality studies will prioritize the risks and opportunities. Concepts – measures, reasons and justification – are created for engineering, operations and maintenance. So are concepts to guarantee asset integrity and compliance. Companies should also draw up concepts concerning spare parts (what to include or not to include in the store), data and documentation (which data and documentation to be acquired, maintained and used) and contingency concepts to recover from any unexpected incident and reassure safe operations and asset integrity.

These concepts are translated into plans. The project portfolio plan shows where investments and/or disinvestments are made. The long- and medium-term plans show which activities will be carried out on assets in the future. These plans must be set up in coherence with the production plans. The plans are refined into budget plans. Budget plans (activities and related costs) function as assignments for the Service Providers.

Figure 12: Asset management activities/elements
The concepts and plans need to be executed by service-providing process. That includes asset creation/acquisition, utilization/operation, care/maintenance, improvement, disposal and supportive processes. Quality, efficiency and safety are crucial.

The asset creation process must ensure that the project deliverables (described in the engineering concept) are delivered at the requisite quality level, within the time frame and budget.

The operation process must ensure that assets are utilized within the operating asset window, and that operational instructions (describing how to utilize the asset) are implemented. Both of these emerge from the operation concept. The operating process also needs to carry out the asset-related activities mentioned in the concepts and the plans (e.g. inspections, cleaning, etc.).

The maintenance process must execute the maintenance concept and plans by implementing and managing the work flow process (Request - Gatekeeping - Work preparation - Planning - Scheduling - Execution - Supervision - Feedback - Closing).

In addition, supporting activities, such as warehousing, purchasing, documenting and data management, need to be implemented in order to contribute to the asset management goals.

The condition and performance of the assets should be monitored. This also includes measuring the results for the defined objectives (e.g. cost versus budget). Relevant asset and asset management data is stored, and regular audits on the complete asset base are within the asset management domain.

Finally, various analyses, structural and incidental, contribute to the continuous improvement of asset management. Making results explicit through publications and reviews creates traceable and straightforward asset management.

The appropriate organization, employees and resources must realize the processes listed above.

The organizational context, responsibilities and authorities must be as clear as possible. The performance of outsourced activities is part of the Asset Management Organization’s responsibility. Outsourced or subcontracted activities must be managed appropriately.

Asset management must stimulate and empower people, in order to assure the required cultural and leadership styles (proactive, risk-based, continuous improvement, etc.). In addition, there is knowledge, know-how, skills and competencies, which are prerequisites for realizing the objectives and providing the foundation that assures a sustainable future.

Another basic requirement for effective and efficient implementation of asset management is having the right IT infrastructure (e.g. CMMS) and having the necessary tools, facilities and equipment (e.g. vibration analysis tools).

All activities are implemented and executed in line with the asset management governance rules and the risk management approach.

The completion of activities in the various domains may vary from company to company, depending on these activities’ contribution to achieving business goals. Therefore, each company should adapt this to its own specific objectives and organization.

The advantage to visualizing the various domains and activities of asset management is that it makes the overall asset management system and the different interactions between activities more explicit. This can be used as a basis for a more detailed description, to determine input and output needs and to relate roles to the different activities.
Once the asset management process is defined, it must be organized. The principle roles, as described in previous sections, must be embedded in the organization.

The roles become effective through jobs and positions in an organizational model.

But first: Should a company organize itself around assets? What is the importance of the asset and the employee in achieving the business goals? See also section 1, which explains the relative importance of assets for each industry type.

6.1.1 Resource-driven companies
If the employee has a very significant impact on achieving business goals, the company must be organized around people. This is known as a resource-driven company. Usually, the focus here lies more on human efficiency than on machine efficiency. If the employee works, there is output. For example, consider a shop floor with metalworking machinery.
core of their operating concept is not operating the installation or asset, but executing supply chain activities and/or increasing effective and efficient human activities and operations.

This does not mean that the assets should not be maintained. Maintenance still focuses on the reliability of the assets. In resource-driven companies with a strong employee focus, asset management is mainly limited to maintaining the assets. In this case, it is also important that maintenance provides answers to the ‘what’ question (concept-maintenance engineering) and the ‘how’ question (workflow processes) (see section 5.3).

6.1.2 Asset-driven companies
In contrast to this, there is the asset-driven company, in which assets are used intensively in the manufacture of products (e.g. power generation). In this case, the focus is definitely on the asset, and machine efficiency is very clearly essential. If the asset works correctly, there is output.

Each company will have to determine its own focus. An orientation in one direction or the other will have a major impact on the operating and organizational model in use.
6.2 Organizing asset management for asset-driven companies

If the company is more asset-driven, it should formalize and incorporate the integrated approach to assets into the operating and organizational model.

These companies design their processes and organization around the asset. They choose to give the Asset Manager an integration role. All current and future decisions related to the assets come together in the Asset Manager's role. He monitors the integrated, unified and consistent approach to asset management, in order to achieve asset objectives. He is directly accountable to the Asset Owner, who delegated those responsibilities to him.

The Service Provider must ensure that resources are used efficiently within the scope of the contract, and conform to the assignments received from the Asset Manager. Figure 14 shows an operating model. The engineering and manufacturing processes are presented, in combination with asset management roles.

The Asset Owner is responsible for the asset management policy and strategy. He also imposes or validates the business values, and the risk and performance framework.

The Asset Manager defines and monitors the engineering, operations, maintenance and improvement concepts and plans. He translates the policy into 'what' must be done in asset management to reduce risks and realize objectives. Note: for instance, a Maintenance Engineer can create the concepts, but the Asset Manager is responsible for validating and integrating them into the whole framework of measures and plans.

By agreement, the Service Provider translates the 'what' question into the 'how' question (efficiency). Service Providers receive assignments from the Asset Manager.

The advantage of organizing asset management in this way is that assets are managed with an integrated approach. By doing so, potential conflicts of interest are avoided, such as short-term versus long-term conflicts. Asset management does not have to be organized as described, but the interactions between, and the integrated approach of, the individual processes (asset creation, operation, maintenance, improvement) have to be guaranteed in order to make the best (optimal) decisions.

**Figure 14: Operating model**

- **Asset owner**
  - Assesses requirements of stakeholders
  - Defines business values, KPI, risk and performance framework for the management of the assets

- **Asset manager**
  - Values the asset risks and check these with the framework of AO
  - Defines measures to reduce risks and put them in SLAs

- **Service provider**
  - Executes the SLA effectively
  - Is responsible for the efficiency of the execution
6.3 Asset management or maintenance management?

Before asset management was introduced, maintenance management was responsible for the whole maintenance process. That includes the maintenance policy, concepts and plans, workflow and execution.

When companies are organized so that the Asset Manager is responsible for the asset concept and plans (see section 6.2), then the role of Service Provider – the execution of asset care/maintenance – is often called ‘maintenance’.

The interaction between both operating models is shown in figure 15.

The Asset Manager provides an assignment (task and plan) and budget to Maintenance. Maintenance translates this assignment into ‘how’, within the budget. Maintenance delivers a service to Asset Management.

In the absence of an explicit integrated Asset Management Organization, the Maintenance Organization determines the policy (related to asset care), what to do and how to do it. The goal and target for maintenance management is to manage the asset (care) properly.
6.4 Global approach to asset management
Companies operating globally, with several sites and plants, must manage their assets with a global asset portfolio perspective. The advantage of managing assets globally, across the various plants, is presented in figure 16.

There are several advantages to a global approach to asset management:

- Companies identify, share and deploy best practices in maintenance and operations.
- One language, one set of tools
  - Easy communication between Asset Management Organizations
  - Easy access to local knowledge and improvements
  - Creation of a learning organization
- Transparency between different sites; benchmarking
  - Global industry ‘peer’ group
  - Coordination among the different plants
- Faster accumulation of historical data to support engineering, maintenance and operations
- Integrated stock management
  - Sharing critical spare parts between sites
  - Standardized purchase contracts
  - Enforced purchase departments

Organizing a global asset management approach requires a different operating and organizational model. Where is the responsibility and related authority situated, locally versus globally? Figure 17 illustrates an example of a global asset management organization.

Asset management organization for a multi-site company
An example of a company with multiple plants, which directs asset management from the corporate level, is shown in figure 17.

At the corporate level, the board acts as Asset Owner, and decides on the business unit and the asset portfolio policy and strategies (production load of the plants, investment/disinvestment). The Asset Owner at the corporate level is accountable for the investment and manufacturing policy and strategy across the different plants.

Plant Management is primarily responsible for implementing and executing the manufacturing policy and strategy. Within this framework, the operation, improvement and maintenance policy must be set up.

The design/creation (engineering) process is carried out by a corporate organization, cooperating with local plant management, to realize an investment project.
The Asset Manager’s main objectives at the corporate level include:

- Integrating best practices and standardization requirements into the engineering concepts
- Monitoring integrity and reliability over the long term, to avoid the risk that plant management acts on the short term in function of supply chain requirements
- Defining and ensuring uniformity of asset concepts across the different plants for (critical) assets, and to look after the exchange of plant experiences in terms of asset performance, failure behavior, improvement proposals, etc.

Asset management governance ensures that all plants apply uniform processes and best practices (e.g. KPIs, benchmarking, etc.).

The plants have their own Operations and Maintenance departments. Within the conditions imposed by the Asset Manager and governance, they are responsible for efficient, outstanding realization of the plant goals.
Implementing an asset management model or system involves bundling, writing, adapting and combining a lot of existing processes, initiatives and organizational models.

We advise organizations to first carefully consider the framework, also called the architecture, of their future asset management system.

This framework encompasses all the aspects we have discussed:

- Scope
- Relationship to company policy
- Vision and mission
- Goals
- Interactions with other business processes
- The process
  - Domains
  - Activities
  - Activity descriptions and inputs/outputs
- Organization, authorities and responsibilities

This framework should be further developed into and described in business models, operational procedures and instructions.

The full set of all these descriptions is referred to as the Asset Management Reference Model (also called the Asset Management System).

This model is the basis for asset management direction, implementation, execution and subsequent reviews, audits and improvements. This is also presented in figure 19 as the management and control loop, consisting of: Direct, Design, Do and Measure and Adjust.

![Figure 18: Asset management Reference Model](image-url)
Companies face challenges every day. The world is evolving rapidly. A high Return on Capital Employed (ROCE) is necessary to realize added value for the shareholders. Excellent safety and environmental performance are required to obtain and maintain the License to Operate.

Especially in asset-driven industries, professional asset management is a necessity for companies that want to perform at a world-class level.

This document provides Stork Asset Management Solutions’ field-proven vision on asset management in different industries.

In most companies, many of the required asset management processes, tasks and roles are already present. To really integrate the different functions and make them work together towards the same goal, it is necessary to build a clear structure, covering all aspects of asset management.

Stork is omnipresent in the field of asset management – from generic and specialized services to asset management consulting. Every day, we help our customers realize their asset management objectives. This document is intended to provide ideas, models and structures to our customers and to asset-driven companies, in order to help them become – or continue to be – outstanding, world-class enterprises, now and in the future.

Jos Van der Aelst
Principal Consultant, Asset Management
Stork
REFERENCES

[4] Economic Value Added or EVA, registered trademark of Stern Stewart & Co
[6] PAS 55 2008, PART 1, figure 6
[7] ISO 55000, 55001, 55002

Maynard International Management Consultants, Breda, various texts related to Maintenance Management
Figure 1: Asset management in different company types
Figure 2: Evolution from maintenance execution into asset management
Figure 3: Asset activity cycle and supply chain cycle
Figure 4: Asset management influencing financial indicators
Figure 5: Asset management goals
Figure 6: The asset management 3D scope
Figure 7: Business dimension of asset management
Figure 8: Main processes and roles in asset management
Figure 9: Combined business and asset life cycle scope
Figure 10: The engineering and manufacturing process
Figure 11: Asset management domains
Figure 12: Asset management activities/elements
Figure 13: Resource- or asset-driven
Figure 14: Operating model
Figure 15: Asset management & maintenance management
Figure 16: Global asset management
Figure 17: Asset management organization at the corporate level
Figure 18: Asset Management Reference Model