# REVITALIZING LIFECYCLE SUPPORT FOR HEAVY FORGING EQUIPMENT – MODERNIZATION AND UPGRADE STRATEGIES FOR EXISTING MANIPULATOR SYSTEMS

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Heavy forging equipment is designed for long operating periods and often remains in industrial use for several decades. During this time, however, the environment in which the equipment operates continuously changes. Production requirements evolve, automation and digitalization progress, safety requirements increase, sustainability becomes more important, and economic pressure demands the effective use of existing assets. The fundamental machine structure may still retain considerable technical value, while controls, components, production capabilities and support concepts may no longer fully meet current requirements.

For long-life equipment, lifecycle support must therefore go beyond spare parts, repairs and restoring functionality after failures. These activities remain essential, but they need to be complemented by systematic condition assessment, lifecycle planning, modernization, obsolescence management, digital connectivity, and consideration of energy and resource efficiency. The central question is not simply whether an existing machine is old, but which parts still create value, what its actual technical condition is, and how it can be adapted to future requirements.

**KEYWORDS: LIFECYCLE ENGINEERING – HEAVY FORGING EQUIPMENT – MACHINE HEALTH – MODERNIZATION – CONDITION ASSESSMENT – DIGITALIZATION – SUSTAINABILITY – LIFECYCLE EXTENSION**

## LIFECYCLE ENGINEERING APPROACH

For long-life forging manipulators, the same question repeatedly arises during operation: Which parts of the existing machine can continue to be used, where is action required, and which adaptations are necessary to meet future requirements? To answer this question, the OEM's original design and system knowledge, the actual technical condition of the machine, and the operator's operating experience and future requirements need to be considered together. This makes it possible to decide whether a machine should continue to operate, be repaired, modernized, or technically upgraded.

The lifecycle engineering approach describes this decision process in four steps. PRESERVE means continuing to use structures, components and functions that remain technically valuable. UNDERSTAND creates transparency regarding condition, wear and potential weaknesses through inspections, technical assessments and operational data. EVOLVE describes the targeted adaptation of the machine to changing production, performance, automation or safety requirements. MONITOR & LEARN uses recurring inspections, machine data and operating experience to identify changes and improve future decisions. The result is an individual lifecycle strategy based on the machine's condition, operating environment and expected future use.

## INTEGRATED LIFECYCLE SUPPORT

The traditional fundamentals of industrial service remain unchanged: reliability, availability, safety, maintainability and productivity. Today, however, additional requirements must be considered at the same time, including flexibility for new production tasks, obsolescence and lifecycle management, performance and capability upgrades, connectivity, system-level safety and resource efficiency. An integrated lifecycle service framework therefore combines wear and spare parts management, repairs, inspection and machine health, engineering and modernization, digital services, and lifecycle planning. These activities should not be regarded as isolated service products; together they form the basis for an individual lifecycle strategy for each machine.

## APPLICATION TO EXISTING FORGING EQUIPMENT

Practical examples from heavy forging equipment show how these principles can be applied. In the event of damage or wear, a repair can be more than the replacement of a single component. A structured damage and wear assessment can identify the underlying technical situation and support an engineered repair solution that restores reliable operation while also considering potential improvements.

A second field of application is the adaptation of existing equipment to new production requirements. Instead of replacing an entire machine, the existing structure can be investigated using engineering methods such as CAD-based redesign and structural assessment. Where technically feasible, selected components can be adapted to create new capabilities while preserving valuable parts of the original equipment. Such modifications require a system perspective because changes to controls, drives, capacity or mechanical components can influence mechanics, hydraulics, safety functions and conformity. The technical benefit of a modification must therefore be evaluated together with its system-wide effects and associated risks.

**MACHINE HEALTH AND DIGITALIZATION**

Modernization can also create the technical basis for connecting existing equipment to the digital environment. Control and automation upgrades can enable connectivity and access to operational data such as loads, pressures, temperatures, vibration, operating hours, energy consumption and faults. This information becomes particularly valuable when interpreted within the engineering context of the machine.

Combining expert assessment with operational data supports a more comprehensive understanding of machine health. Technical inspections can assess wear, clearances, structural condition, functionality and safety, while operational data can reveal trends and changes over time. Together, these information sources can support a gradual transition from predominantly reactive maintenance to preventive and condition-based strategies and, where data quality and operating conditions allow, to predictive approaches.

**SUSTAINABILITY AND LIFECYCLE EXTENSION**

Lifecycle engineering is also closely linked to sustainability. Heavy forging equipment represents a significant investment in materials, manufacturing effort and industrial infrastructure. Extending the useful life of technically valuable equipment can avoid premature replacement and keep existing resources productive for longer. Targeted modernization can additionally improve functionality, safety, efficiency and digital capabilities without necessarily replacing the complete machine.

In this context, sustainability is therefore not limited to reducing energy or resource consumption during operation. It also includes the responsible use of the technical value already embedded in existing equipment. Decisions between repair, modernization and replacement should therefore consider machine condition, future requirements, safety, resource use and economic feasibility together from a lifecycle perspective.

**CONCLUSION**

For long-life heavy forging equipment, lifecycle support becomes a continuous engineering task. Preserving valuable structures, understanding machine condition, developing equipment in a targeted manner and using machine data can extend useful life while maintaining safety, productivity and technical capability. In this way, the OEM becomes a lifecycle engineering partner throughout the equipment's entire operating life.


Fig. 1. Rail-Bound Forging Manipulator by DANGO & DIENENTHAL