Metaldyne: Plant-Wide Assessment at Royal Oak Finds Opportunities to Improve Manufacturing Efficiency, Reduce Energy Use, and Achieve Sigificant Cost Savings

Benefits

- Identified potential annual electricity savings of more than 11 million kWh
- Found opportunities to reduce energy and operating costs by $12.6 million annually
- Identified ways to incorporate lean manufacturing and energy management best practices to increase productivity, reduce inventory, and improve product quality

Application

Metaldyne's plant-wide assessment focused on improving overall plant efficiency and on reducing costs, inventory, and energy use. Best practices in energy management, lean manufacturing techniques, and emerging technologies were evaluated during the assessment.

Summary

Metaldyne recently completed a plant-wide energy assessment at its forging facility in Royal Oak, Michigan. The assessment addressed opportunities to increase energy efficiency, reduce waste and pollutants, and increase productivity by evaluating demand-side energy management, best practices, the use of emerging technologies, and potential supply-side improvements. Although the assessment focused on the plant's large energy-using systems and equipment, the assessment team also evaluated product inventory and the potential for reducing or even eliminating defects, which could also increase the plant's energy efficiency. Lean manufacturing techniques, best practices, and the use of emerging technologies that could improve plant efficiency were also considered. If all the projects identified during the Royal Oak plant-wide study were implemented, the assessment team estimated that total annual energy savings for electricity would be more than 11 million kWh. Total annual cost savings were estimated to be $12.6 million.

Public-Private Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. DOE promotes plant-wide energy-efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, while reducing waste and environmental emissions. In this case, DOE contributed $100,000 of the total $200,000 assessment cost.

Plant Description

Metaldyne, Incorporated, is the largest independent forging company in North America. Metaldyne's products include wheel hubs, spindles, rolled rings, and transmission and differential gears. Headquartered in the metropolitan Detroit area, Metaldyne operates more than 50 facilities throughout the world and has nearly 8,500 employees worldwide.

Metaldyne's Royal Oak, Michigan, operations can produce forged parts in several ways using hot-, warm-, and cold-forging processes. Hot-forging processes produce high-volume products that include transmission and transfer case components, such as gear blanks and bearing races, and wheel-end components, such as wheel hubs and spindles. The Royal Oak plant has the world's largest concentration of Hatebur hot-forging machines. These state-of-the-art machines forge concentric parts from a full range of carbon and alloy steels at rates from 70 to 120 pieces per minute.

The plant is also capable of warm-forging parts that require a greater degree of precision than can be achieved with hot-forging. Warm-forging is ideal for producing complex shapes with refined surface finishes, desirable grain flow, and tighter dimensional controls. Warm-forging eliminates the need for heat-treat normalizing and allows near-net and net-shaped components to be produced without causing structural changes in the raw material. In addition, Metaldyne is now one of the world's largest cold-forging companies. Heat-treating of parts is currently outsourced.

The annual cost of electricity for the Royal Oak plant is about $6 million. The plant spends another $40,000 annually for natural gas, plus $500,000 for water and sewer utilities. It operates eight Hatebur hot-forging machines, 14 cold-forging presses, a Kurimoto hot-forging press, a warm-forging press, three Wagner hot ring rolling machines, and several high-tonnage presses. The Hatebur forging machines utilize induction heating. High-power, high-pressure sodium lights provide the plant's primary illumination. Currently, six 150-horsepower (hp) air compressors and two 330-hp air compressors are in use.

Assessment Approach

Metaldyne and its team conducted a plant-wide energy assessment of the Royal Oak forging facility that addressed opportunities to increase energy efficiency, reduce waste and pollutants, and increase productivity. Electricity is the plant's main process-related energy source. Natural gas is used primarily for water heating and for heating, ventilation, and air-conditioning (HVAC) systems, and has a negligible role in process heating.

The assessment team evaluated demand-side energy management, best practices, opportunities for implementing emerging technologies, and potential supply-side changes. The assessment concentrated on the plant's large energy-using systems and equipment. This large equipment included the solid-state induction heaters for the Hatebur hot-forging machines, the warm-forging press, the hot-forging vertical press, the Wagner hot ring rollers, electric motors, material handling equipment, HVAC, and lighting. Product inventory and the potential for reducing or eliminating defects were also examined. Manufacturing processes were examined for potential lean manufacturing/best practices improvements. The assessment team also identified some emerging technologies that could improve manufacturing efficiency.

Results and Projects Identified

A team of energy and manufacturing process experts identified 21 assessment recommendations. Factoring in process improvements that would result in savings in water and waste production, the Royal Oak plant could save more than $12.6 million annually in overall plant energy and operating costs if all the assessment recommendations were implemented. The cost of implementing all the projects would be approximately $6.5 million. All the recommendations are listed in Table 1. More detailed discussions of certain proposed projects follow.

Install air saver nozzles on press machine blowoff lines (AR5)—Several of the presses use a continuous stream of compressed air blown through two 3/8-inch open pipes to detach parts from the dies. The assessment team recommended installing air-saver, high-thrust nozzles on the air lines to reduce compressed air usage. Air-saver nozzles work by entraining ambient air into the flow of compressed air.

Install radiation shields and improve insulation to reduce heat losses from induction heaters (AR9)—Eight multistage induction heaters are used to preheat the bar stock before forging. The air gaps between stages, which allow access for maintenance and temperature measurement, also permit excessive heat losses. The assessment team recommended installing an insulated, removable radiation shield to reduce heat losses through the air gaps. A quartz window could also be installed to allow the bar stock to be inspected visually.

Install a controlled cooling system for parts whose heat treating is currently outsourced (AR10)—The assessment team recommended that the plant consider options for in-house controlled cooling of

Table 1. Recommendations from the Metaldyne Royal Oak Plant-Wide Assessment			
Assessment Recommendation (AR)	**Annual Electricity Savings (kWh)**	**Annual Cost Savings**	**Capital Cost**
Eliminate excess lighting in warehouse areas (AR1)	115,000	$8,000	$500
Replace 400 W metal halide lamps with 360 W lamps at failure (AR2)	76,000	$5,000	$6,000
Replace standard V-belts with notched V-belts on belt-driven equipment (AR3)	32,000	$2,000	$0
Enhance motor management program by using MotorMaster+ software for repair/replace analysis (AR4)	40,000	$3,000	$14,000
Install air-saver nozzles on press machine blowoff lines (AR5)	953,000	$64,000	$400
Reconnect compressed air system supply via automation valves in primary presses to reduce compressed air use (AR6)	103,000	$7,000	$1,700
Implement maintenance program to identify and repair compressed air system leaks (AR7)	347,000	$23,000	$900
Upgrade compressed air system controls (AR8)	576,000	$39,000	$17,800
Install radiation shields and improve insulation to reduce heat losses from induction heaters (AR9)	2,678,000	$79,000	$117,000
Install a controlled cooling system for parts whose heat treating is currently outsourced (AR10)	NA	$6,598,000	$4,750,000
Provide additional baskets or use larger scale basket strainers in scale pits to improve mill scale trapping and reduce pit cleaning frequency (AR11)	NA	$99,000	$85,500
Install water meters on blowdown lines from cooling towers to document water loss from evaporation and apply for sewer charge exemption for water not sent to sewer (AR12)	NA	$116,000	$6,500
Install new groundwater supply system to reduce consumption of city water (AR13)	NA	$272,000	$180,000
Reduce change-over time for press retooling (AR14)	862,000	$43,000	$10,000
Reduce product inventory (AR15)	NA	$1,800,000*	$25,000
Establish a “pull scheduling” system (AR16)	NA	$720,000	$10,000
Improve product quality and reduce rework (AR17)	NA	$180,000	$20,000
Increase machine tool durability (AR18)	NA	$710,000	$60,000
Increase punch and die life by applying lubricating coatings (AR19)	4,478,000	$3,500,000	$1,200,000
Implement a “closed loop” procurement/disposal system to reduce cost of tool steel material (AR20)	NA	$27,000	$10,000
Employ alternative forging tool design and selection (AR21)	1,260,000	$84,000	$20,000
Totals	**11,520,000**	**$12,579,000**	**$6,535,300**

*One-time savings only; not included in total savings.

forged parts that are currently being outsourced for heat treating. The options were (1) to use a batch-type cooling system, in which parts are placed in bins and cooled under controlled temperature and time conditions immediately after being forged, and (2) to use a batch-type system to control the cooling of parts produced from the ring rolling machines, and two continuous (spiral) systems to handle single parts produced directly from the Hatebur presses. If cooling bins are used, the batch-type systems should feature high-convection recirculating air flow to ensure uniform cooling of all the parts.

Reduce change-over time for press retooling (AR14)—Current press change-over times for die replacement are longer than necessary; this results in increased machine downtime and wasted electricity because the induction heaters remain hot while the machine is idle. The assessment team recommended a list of actions to reduce change-over time, including improving personnel training and procedures, upgrading the tool kit, and using automatic locators for dies.

Reduce product inventory (AR15)—The current average stored inventory is one month's production of finished product, which the assessment team considered to be excessive. The team recommended that the plant reduce its product inventory by 50% by taking the following actions:

- Producing smaller lot sizes of product
- Using controlled supermarkets[1] for each product type
- Setting minimum and maximum inventory levels for each product type.

Savings would result from reductions in inventory carrying costs, i.e., those associated with keeping inventory. These include capital costs, taxes, insurance, handling costs, warehouse costs, and damaged inventory.

Establish a "pull scheduling" system (AR16)—The goal of lean manufacturing is to minimize or eliminate non-value-added steps in the process across the entire product supply, production, and customer delivery cycle. The "pull scheduling" approach ensures that upstream manufacturing activities are linked and controlled by the activities of the next downstream operation. The downstream operation physically sends distinct visual or electronic signals[2] to the last upstream operation, directing that operation to respond to its needs for a product or service. This approach is thus essentially process-driven.

Improve product quality and reduce rework (AR17)—Currently, product inventory is excessive and parts are stored longer than necessary. As a result, inventory stored outside can experience surface degradation caused by rain. The assessment team recommended reducing product inventory and improving material flow through the plant. These measures would reduce storage time and associated rework on degraded material.

Increase machine tool durability (AR18)—A new technology that can increase the life of stamping tools and improve the finish of stamped parts involves the application of hard coatings made of thin-film nitride or carbide-based ceramics. The assessment team recommended that Metaldyne consider using hard coatings on inserts, drills, bits, and other parts to increase the speed of machining operations as well as the life of tools. These measures would also reduce press downtime and costs associated with punch and die manufacturing.

Increase punch and die life by applying lubricating coatings (AR19)—
The team recommended that the life of the forging tools (punches and dies) be increased by maintaining cooler tool surfaces. This could be accomplished by reducing the cooling water temperature and by applying a lubricating coating to the tool surface. Longer tool life would increase the productivity of the forging presses, reduce press downtime, increase throughput, and reduce overall production costs.

These recommendations and others represent more than 20 opportunities for Metaldyne to save energy and money at the Royal Oak plant.

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[1] The "supermarket" concept involves pulling materials from the customers back to production to optimize product inventory based on customers' needs.

[2] This is known as a "kanban" system in the context of lean manufacturing.

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