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Resource Productive Operations: Think lean

Part 2

Lean is a potent and proven method to understand how and where consumption of resources can be improved in production processes

by Markus Hammer and Ken Somers

This article is part of a series adapted from Markus Hammer and Ken Somers' book, Resource Productive Operations: Five core beliefs to increase profits through leaner and greener manufacturing operations (see

http://www.mckinsey.com/client_service/operations/latest_thinking).

A risky situation

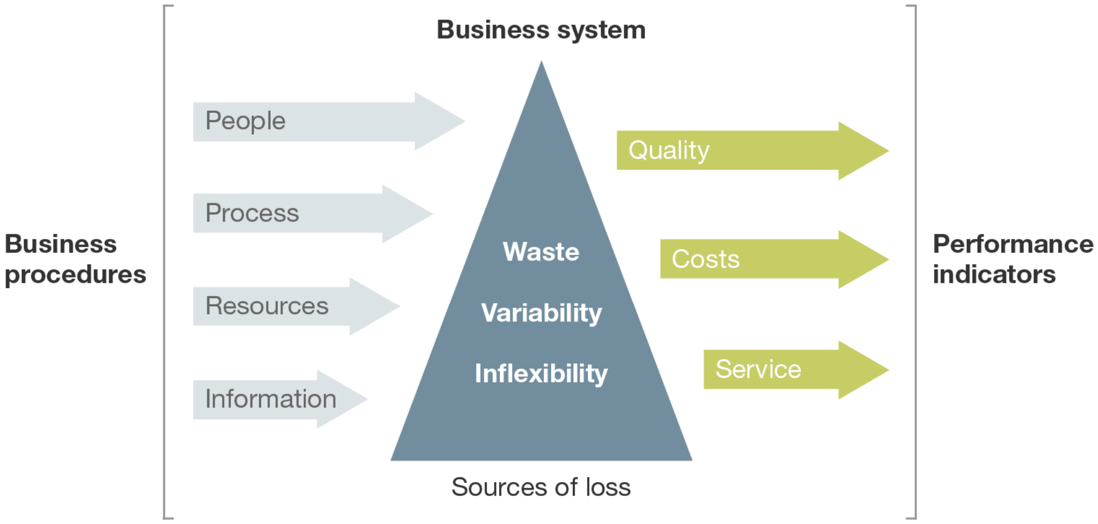
Resource productivity is a rapidly evolving discipline, and new technologies and approaches are emerging at every turn. If these new solutions are deployed without a comprehensive understanding of where the greatest opportunities lie, however, results often fall short of expectations.

Installation of variable frequency drives (VFDs) is a prime example. VFDs control the speed of an AC (alternating current) motor by varying the frequency of the power source. Attaching a VFD to a pump in order to vary its speed is a common practice. However, if the need is to slow the pump speed because too much water is moving through all points in the process, installing a VFD may be overkill. The device adds maximum value when different water flows are needed at varying points in the process. If the water flow need is static, a smaller pump may provide a much better return on investment. Lean thinking is a powerful tool for addressing this kind of problem.

A lean lens on resource losses

Applying lean principles to resource productivity is based on identifying the three primary sources of loss that erode operational and energy performance: inflexibility, variability, and waste (Exhibit 1). Each of these impinges on the system's ability to deliver the desired quality or service level at an optimal cost. By applying the three sources of loss from lean to resource productivity, companies can create a systemic view of what causes material, water, or energy loss; how and where. That understanding, in turn, helps pinpoint where solutions will have the greatest impact.

Exhibit 1: Inflexibility, variability, and waste erode operational and resource performance



Source: McKinsey Resource-Productive Operations service line

Resource-productivity loss: Inflexibility

Processes are inflexible when they can't respond easily to change. Oversize production batches are an example of inflexibility in its classic application to products. For instance, if batches in a chemical production process are determined by tank size, and the need to fill these tanks to a certain minimum level, rather than customer demand, the process will be unable to respond quickly to changes in market demand.

Lean can also pinpoint where inflexible production processes lead to resource loss. The following examples illustrate a wide range of potential sources of loss due to inflexibility across the entire value chain.

Customer

Customer specifications for a product will usually fall along a range. If process standards are always set to meet the highest customer needs, the company will waste resources because many customers don't require that standard. Water content in paper is an example of this. Some customers are able to tolerate more water than others. If the process produces only the lowest level of water content, the business wastes energy by drying paper more than it needs to. Additionally, an expensive resource, fiber, must be used to replace the water.

Inventory

Inflexibility can also lead to unnecessary inventory loss. For example, the production process at one petrochemical plant generates two by-products of different value. Although the reactors could be adjusted to maximize the higher-value by-product, the company lacks storage for the higher-value product. As a result, the organization is forced to produce an inordinate amount of the lower-value by-product.

Production process

Inflexible production processes also drain resources unnecessarily. In an integrated steel plant, for instance, steel slabs are heated in a furnace before being fashioned into coils. When shutdowns and other issues slow the production process, many steel manufacturers don’t have furnace models that adjust the heat based on different production speeds. The temperature is often set high to accommodate the fastest production pace resulting in the generation of excess heat and energy, which goes into the exhaust and out of the stack.

Production-process support

Equipment such as motors attached to a pump can also make processes inflexible. Because motors move at a fixed rate, the pump will also operate at a fixed rate, even though the production work is far from static. Pumping water at a fixed rate often creates excess that must bypass the system. This uses energy, as does the need to pressurize the water again. VFD pumps address this source of loss very well.

Buildings and environment

In an assembly line, 50 to 60 percent of energy is used to control a building’s climate. Much of that is lost. Welding lines, for example, generate toxic fumes across the entire plant, even though they may account for as little as 10 percent of the space. Because the welding line often isn’t housed separately, the air in the entire building must be refreshed much more frequently than it would if the welders were in a separate structure.

Resource-productivity loss: Variability

Variability refers to changes within a repeating process that affect the output. In the classic product orientation of lean, companies focus their efforts on variability that affects product quality and production efficiency, such as machine breakdowns, changes in raw material quality, and inconsistent work processes. To improve resource productivity, it is often helpful to shift the focus to processes and the environment by addressing the “six M’s”:

- **M**an and management
- **M**ethod
- **M**aterial
- **M**achine
- **M**easurement
- **M**other Nature

In the paragraphs that follow, we illustrate these through examples from steel manufacturing.

Man and management

People often introduce variation into a process, either inadvertently or through the absence of standards. For example, after a short shutdown, furnace operators may believe they need to make up for lost time and boost temperatures beyond targets to increase production speeds. In addition, managers often change targets too frequently, fail to enforce standards, and provide inconsistent feedback.

Method

Poorly designed processes can also introduce significant variability in energy use. Furnace models that don't adjust for short stops and other delays, for example, can result in product that is manufactured faster than necessary and thus consumes more energy than needed. Production schedules should remain as constant as possible in order to maximize energy use.

Material

There is almost always variation in materials that enter a production process, such as steel slabs moving into a furnace at different temperatures. The colder the slab, the more energy is needed to heat it. Standardizing temperatures optimizes energy use.

Machine

Variation in the use of the same or similar equipment can increase energy costs. If a plant is operating two furnaces, loading one furnace more than the other can have an impact on performance. This is because one furnace may have a waste-heat exchanger to preheat incoming combustion air, and the other may not; the former is more efficient.

Measurement

The absence of disciplined measurement regimens is another source of resource loss. For example, equipment operators who are concerned that pyrometers on certain furnaces are inaccurate will often set furnace temperatures higher than needed.

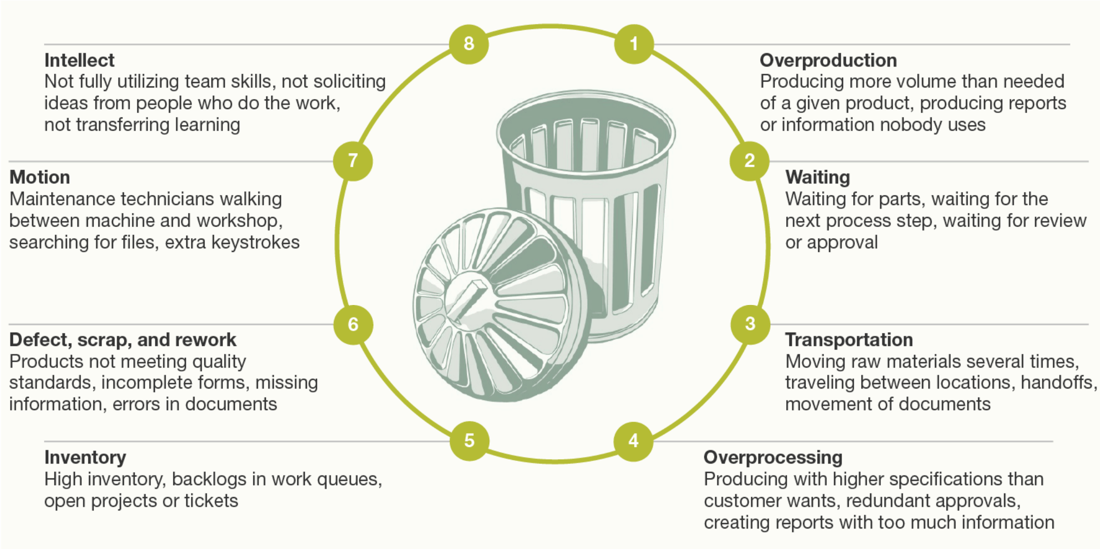
Mother Nature

Environmental conditions drive considerable variability. If a combustion air pre- heating heat exchanger is too small, for example, it will consume more energy when the outside temperature is low than if the exchangers were properly sized.

Resource-productivity loss: Waste

Lean targets eight sources of waste—everything in a process that does not add to the value that customers are willing to pay for (Exhibit 2).

Exhibit 2: A lean process targets eight types of waste



Source: McKinsey Operations Practice

Consider overproduction. This can happen when a company produces more inventory than it can sell at a given time. Overproduction is considered the most costly source of waste. It ties up capital and incurs unnecessary transportation and warehousing costs to move and store excess inventory. In terms of resource productivity, overproduction is the creation of more utility (such as compressed air) than a company can use at a given time. For example, if a compressor is set to produce a fixed amount of compressed air over a given period of time, it will inevitably produce more than is needed at certain points. The unused air is often vented into the atmosphere; the cost to compress it is similarly lost.

Transportation is another example. From a classic lean perspective, transportation waste stems from challenges such as the need to move finished goods offsite for packing. Applying an energy lens, transportation waste comes from excess energy used to move a utility through the plant. Steam, for example, must travel from the boiler to different process points that use it. If the piping has leaks or its design includes unneeded turns, the steam dissipates without ever being used.

In addition to lean's eight categories, we have identified two specific resource-productivity sources of waste. We have added them to round out the lean application to resource productivity.

Inefficient equipment is the first. Many production facilities have machinery that hails from eras when energy was much less expensive or use legacy machinery that's still around from previous build-outs and hasn't been upgraded. For example, factories may be using pumps that are much less efficient than similar equipment designed more recently.

System integration is second source of waste unique to resource productivity. Often, energy is put into a product only to be taken out again later in the process. For example, a product is heated with steam during production and then chilled with cooling water for storage. Each is a separate process with its own costs. To reduce waste, the finished hot product can be used to heat the cold raw material, and vice versa—provided the production processes are sufficiently integrated. Similarly, pressure residing in liquid or gas can be used through expansion turbines among other options. (See the sidebar for additional examples of both classic and resource-specific sources of waste that can be targeted by lean.)

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Because resource-productivity improvements can involve a great deal of leading-edge technology, it can be tempting to define resource productivity as primarily a technical challenge. However, such an approach often misses the bigger picture of where the greatest resource-productivity opportunities lie. Applying lean principles to resource productivity reveals that bigger picture. Because many companies already use these principles, adding resource productivity to the mix can give a strong impetus to improvement efforts by leveraging well-known approaches understood by a broad base of people in the company■

Our series continues with detailed discussions of how resource-productive operations look in practice, and why they are important.

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SIDEBAR: Classic and resource-specific sources of waste can be targeted by lean

Waste categories and examples	Result	Operations examples
Classic		
Overproduction Producing more volume than needed of a given product or generating unnecessary reports	Producing utilities that aren't used	Excess cooling water is sent to the plant, bypasses the heat exchanger, and is sent back to the tower
Waiting Waiting for approvals, reviews, or parts needed to perform the next step of the process	Energy is consumed even during production stops	During a production stop or shutdown, conveyor belts, pumps, and fans still operate even though no product is flowing through the process
Transportation Moving raw materials repeatedly, traveling between locations and handoffs	Energy is lost during transportation	Multiple air compressors are linked to pipes that have extensive leakage or large pressure drops occur in pipe networks
Overprocessing Producing a higher-quality product than the customer is willing to pay for	Energy consumption is deliberately set higher than the process needs	Operators add a safety margin to ideal settings of furnace temperatures, production speeds, and compressed air pressure
Inventory Accumulating excess stock, work-queue backlogs, open projects and tickets	Energy is lost in stored inventory and energy required to store products	Hot steel slabs cool too much prior to production or operators must heat or cool inventory in warehouses because of overproduction
Rework and scrap Producing products that don't meet quality standards or incomplete, error-filled documents	Resources are consumed by rework or scrap production	Improperly sized sinter is sent back to the beginning of the sintering process
Motion Walking between machines and workshops or searching for needed items such as files	Processes or pieces of equipment use resources inefficiently, although the equipment is efficient	Company uses high-quality, efficient boilers, exchangers, and VFDs but sets the oxygen level too high, which reduces boiler efficiency
Employee potential Failing to fully utilize employee skills or elicit ideas from the people who do the work	Company fails to capture employee knowledge to identify and reduce energy waste	Employees are not directly involved in developing energy-saving initiatives
Resource-specific		
Efficiency Operating inefficient equipment	Higher energy use due to inefficient equipment (eg, motors, compressors)	A boiler set to run at optimal levels loses energy because the stack lacks an economizer
Integration Failing to take advantage of available energies across different processes	Available energies (heat, cold, work, pressure) are being wasted	When products are heated for processing and cooled for storage, not using the hot product to heat nor using the cool product to chill