

Development Management in Food Industry

N. Y. Logunova¹, Y. A. Prokofyev²

Moscow State University of Food Production
Moscow, Russia

¹ Email: nlogunova@gmail.com

² Email: prokofyev@mgupp.ru

S. A. Amelkin

Program Systems Institute of the Russian Academy of
Sciences
Russia

Email amelkin@ist.education

Abstract— This paper examines the problem of determining the optimum service life for process equipment to ensure minimum average operating costs.

Keywords— process equipment replacements; production engineering; reliability assessment

Continuous, significant changes in technologies, markets and customer needs are ubiquitous in the modern economy. To survive and keep up with the competition, food industry businesses are forced to continually rethink their strategy and tactics. Improving all aspects of a business is integral to its continuous development, which is the foundation of any robust and competitive business. The need to constantly rethink the business model as a microeconomic system in order to respond to changes in macroeconomic factors, unpredictable competition and ever-changing market conditions is a challenging issue in business management. Business development models that use the fundamental concepts of profit and net cash flow need to be complemented with models that take into account external influences. A competitive business management model should treat a business as a microeconomic entity; and it should be designed as a function of its current state. A compelling set of business analysis tools should allow:

- Defining a sound business structure that would create the necessary development potential and ensure reliable operation under adverse external conditions, and
- Tracking the consequences of engineering or management decisions and external factors affecting the business.

Business development plans usually include the following activities:

1. Integrating new equipment without changing the product range
2. Replacing more expensive (imported) equipment, raw materials and/or consumables with cheaper alternatives of the same quality
3. Qualitative market expansion
4. Introducing new products
5. Lowering product costs
6. Sales promotion

7. Defining a sound fixed/current asset structure, and

8. Improving manufacturing process management.

When building an enterprise information system, you need to clearly define its business architecture, which should be based on the company's mission, development strategy and the prospects of achieving its long-term business goals. A rational decision would be to review and, if necessary, redefine the basic principles of the company's organizational structure and operations based on its end-to-end business processes instead of its department functions [1].

In this case, the system's business architecture should clearly define a list of the required business processes, material and information flows characteristic of the company's domain and organizational structure.

The basic key element of the developed system's business structure would be a business process.

The modern process-based approach to building information systems appears to be the most promising one, as it shifts the focus from managing individual structural elements to managing end-to-end business processes, with all structural elements linked together. A business process is defined as a set of activities designed to produce a specific output (product or service) that offers tangible value to customers [1]. The concept of the business process allows creating a business strategy, which answers the questions who does what, when, why and how. The modern business theory distinguishes between the following types of business processes:

- Primary processes (aimed at producing the primary product or providing the primary service, which is the primary goal in terms of generating income)
- Secondary processes (aimed at producing secondary products or providing secondary services as a result of activities associated with the primary production operations)
- Auxiliary processes (designed to support the specific features of the primary and/or secondary processes)
- Supporting processes (designed to support the universal features of the primary and/or secondary processes)

- Management processes (designed to implement all the necessary management functions at the business process level), and
- Development processes (aimed at improving the primary/secondary products or services, introducing innovations or upgrading the existing equipment and technologies).

Launching innovative products often requires food industry businesses to radically upgrade the existing equipment and technologies as “a way to improve the competitive performance of different manufacturing systems by upgrading the production facilities and replacing obsolete manufacturing equipment and technologies with modern, more efficient alternatives” [2, 4]. Technological modernization programs implemented at Russian food industry businesses often lack innovation due to the following reasons:

- Limited access to state-of-the-art technologies due to limited financial resources, which forces businesses to purchase outdated or used equipment
- Inability to implement the latest equipment and technologies, as it would require not just re-configuring the production lines, but completely overhauling all associated equipment and systems, or
- “Sluggish” modernization process (usually due to financial reasons), which results in equipment becoming obsolete before even being put into operation [2].

The renovation process involves decommissioning fixed assets that are worn out or obsolete and replacing them with new ones. And it is hard to predict whether renovation efforts will result in a business maintaining its competitive advantage or losing it. Business innovation and renovation are implemented through specific development-related business processes, which, among others, include processes of improving various aspects of a company’s operations, such as its products or services, business processes themselves, existing technologies, organizational structure or information system. In this case, development-related business processes are special internal processes that allow finding better ways of doing business in order to better meet the needs of both internal and external customers, use available resources more efficiently, and increase the competitive advantage. When considering the multitude of business processes that shape a company as a holistic business system, the ones that ensure continuous improvement, transformation or development of all aspects of its operations are of the most interest in terms of their transformative potential. The process of reorganizing an enterprise management system should start with developing the necessary business development processes that are based on “architectural” management and monitoring, as well as transitioning the enterprise architecture from the task-based approach to the process-based one. Business management processes are the business processes that connect all other business processes into a single system and thus shape the entire enterprise management system, including strategic management, planning, organization and monitoring [5].

Making a decision on replacing or upgrading equipment at a food enterprise is a critical and time-consuming process. The average age of process equipment operated by Russian food industry companies sometimes exceeds 20 years. Such equipment does not meet modern requirements and fails regularly, which leads to process interruptions or even shutdowns and results in lost profits.

In this situation, the maintenance manager of, let us say, a bread-baking plant faces the difficult challenge of finding new equipment that has a competitive price tag and, at the same time, meets current industry standards and requires minimum operating costs.

The process of selecting new process equipment involves:

- Developing an equipment layout plan that integrates both the existing and newly acquired equipment into a single process train
- Choosing equipment that is compatible with all aspects of the production technology that is currently in use, and
- Designing or choosing unique process equipment to facilitate the multi-purpose equipment upgrade process. According to some authors [6, 7], there are three possible approaches to solving this problem: a partial upgrade, an upgrade within the constraints of the currently used technology, or a complete replacement of the equipment and technology currently in use.

A partial equipment upgrade involves the following activities:

- Identifying failure-prone process sections
- Assessing the reliability of the existing equipment
- Identifying the nature of equipment failures and how they affect the entire production process
- Assessing losses due to equipment failures, and
- Comparing the estimated cost of the partial upgrade to its projected benefits.

Making a decision on an upgrade within the current production technology involves the following activities:

- Identifying the bottlenecks of the currently used technology
- Determining how those bottlenecks affect the performance of the adjacent process sections, and their impact on the environment
- Developing “material flow performance” charts indicating process steps that require improvement or replacement, and
- Comparing the projected benefits and the estimated cost of upgrading or replacing equipment within the constraints of the currently used technology and forecasting the company’s potential economic performance over the next five years.

If the market offers a new production technology, a company may consider completely replacing its old process equipment. Deciding on the feasibility of such a radical change involves:

- Assessing the operability of the existing equipment
- Drafting and approving an equipment inspection report that confirms the necessity to decommission the existing equipment due to it being worn out and/or obsolete
- Projecting the future demand and the financial benefits of the equipment replacement project, and
- Making the final decision on dismantling the obsolete items and installing new alternatives.

Making informed decisions and achieving the best possible results in solving this complex problem requires an adequate information and software system (Fig. 1).

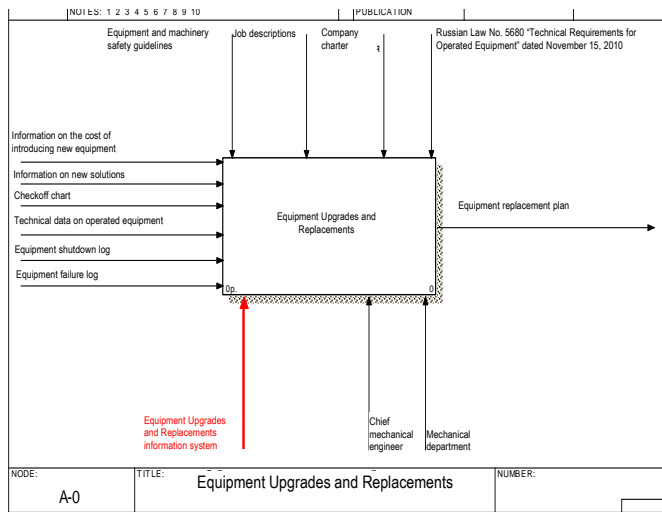


Fig. 1. Overview of the manufacturing equipment replacement and upgrade process

The ultimate goal of developing such an information system is to increase production efficiency by reducing operating costs. Operating costs include all costs associated with production engineering, product manufacturing and sales. Solving the problem of manufacturing equipment upgrades requires considering the following cost items:

- Fixed costs C_1 , which do not change over time. These include one-off costs of purchasing, installing and dismantling equipment. They are evenly distributed over equipment lifetime. These costs may vary depending on the total operating time τ of equipment, so that average costs $\bar{C}_1 = C_1/\tau$ decrease as τ increases.
- Variable costs $c_2(t)$, which depend on the operating time of equipment. These include operating costs, such as repair costs, spare parts storage costs, implicit costs associated with equipment obsolescence, costs of unplanned outages, etc. With old equipment wearing

out and new equipment of better quality being introduced, costs $c_2(t)$ increase over time, i.e. average variable costs increase as equipment's total operating time τ increases:

$$C_2 = \frac{1}{\tau} \int_0^{\tau} c_2(t) dt \quad (1)$$

The problem of determining the optimum replacement age can be expressed using the following equation:

$$\bar{C}(\tau) = \frac{1}{\tau} \int_0^{\tau} c_2(t) dt + \frac{C_1}{\tau} \rightarrow \min_{\tau} \quad (2)$$

According to the above classification of business processes, replacing or upgrading equipment at a bread-baking plant is a development-related business process, as it leads to improved, higher-quality products and lower production costs as a result of modifying or replacing the existing manufacturing equipment and ensuring its high availability.

Let us consider the process of upgrading and replacing manufacturing equipment (Fig. 2), which involves the following activities:

- Calculating replacement age (mechanical department)
- Analyzing the equipment market (marketing department)
- Reviewing purchase orders (purchasing department)
- Negotiating supply contracts (purchasing department)
- Tracking order status (purchasing department)
- Tracking delivery (warehouse)
- Inspecting equipment (mechanical department), and
- Replacing equipment (maintenance department).

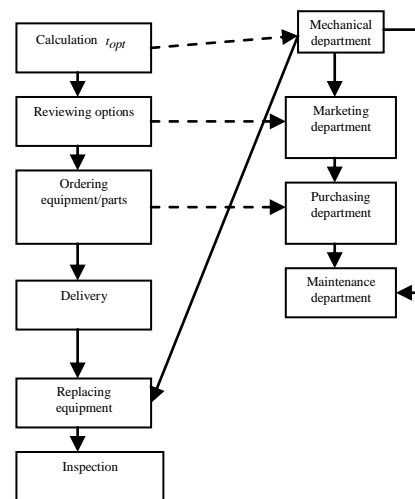


Fig. 2. Equipment replacement/upgrade flow chart

In today's market, a wide range of e-business or e-commerce solutions and online services (online trading

platforms, online advertising, online stores, electronic payment systems, web portals and services, etc.) can help food industry businesses tackle the challenge of replacing or upgrading manufacturing equipment. For example, an equipment manufacturer can provide a form on its site that helps potential customers calculate the optimum replacement age for their process equipment and choose the right option, which would definitely increase customer engagement and bring more revenues.

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