SUMMARY

Technological identification of brass rod production based on simulation and probabilistic models

The dissertation was prepared in cooperation with "Walcownia Metali Dziedzice S.A." and was based on the analysis of the company's factual data. Within the framework of this study, close cooperation was established with the company's management and production staff.

Based on specific inquiries and the analysis of the production processes, an action plan aimed at eliminating production losses and random-location bottlenecks using appropriate tools was developed. In consultation with the management and the heads of respective production departments, an attempt was made to address specific problems through devising experiment plans and a research programme to tackle the issues of particular interest to the company. Thus, solutions known to the company as well as those adopted by other companies were sought. In the light of these considerations,a number of problems were encountered during the adaptation of new solutions to the existing tools and specific production features of "Walcownia Metali Dziedzice S.A.", where non-ferrous metal parts are manufactured.

The main research aim was to develop objective methods for improving productivity in the brass rod production line under industrial conditions. In order to carry out this task, the current condition of the company was analysed by means of a technological identification of workstations. Measures consisting in using appropriate tools to eliminate production losses and random-location bottlenecks were proposed. An experiment plan and a research programme were then formulated, on the basis of which histograms depicting the duration of given production steps were created. Subsequently, probabilistic models reflecting the actual duration of given production steps under industrial conditions were developed. An attempt was made to present the relationship between existing workstations and to merge them into a single production system. This was done using a simulation model. Within this approach, a computer simulation made it possible to identify a bottleneck in the production process in question.

A practical verification of the computer simulation and the use of Lean tools enabled the identification of different activities and the estimation of their impact on the occurrence of bottlenecks. Subsequently, Lean and TOC tools were used to eliminate bottlenecks, and appropriate technical and organisational changes to the workstations were put forward. The adopted approach made it possible to boost the productivity of the brass rod production line. Based on the simulations and Lean tools, i.e. Pareto-Lorenz analysis, Ishikawa diagram, the 5 Whys technique, the lengthiest activities were pinpointed during a production step causing a bottleneck, namely drawing wires below Ø 32. Within the framework of present research, technical and organizational improvements were implemented under industrial conditions. They consisted in designing the following: equipment for checking the wire diameter and length against the benchmark value "Sprawdzian do drutu" ("Wire check"); equipment reeling the wire off the coil when it passes through "Obrotnica" ("Swing device"); the arrangement of auxiliary equipment around the drawing die; work instructions for the worker performing the operation; diagram depicting the operator's movement pattern during the drawing phase. The proposed approach made it possible to increase the efficiency of the brass rod production line.

Technological identification, the probabilistic models developed, as well as the technical and organizational improvements in the brass rod production line have proven the thesis of the dissertation correct. They also made it possible to answer the research question: finding technical and organizational solutions for a specific production process based on existing support systems in the company using the Theory of Constraints combined with Lean will contribute to the reduction of bottlenecks.

The experiment plan and the implementation of the research programme made it possible to:

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1. Integrate existing support tools with the modern company management techniques.
2. Under industrial conditions, make a quantitative description of the phenomena occurring as a result of the technological identification of specific production steps. It was necessary to conduct an active experiment, interfering with the normal operating conditions of the object in question (machines). Therefore, a very important issue, especially under industrial conditions, was the proper planning of the experiment.
3. Assess the duration of a given production step using a working time regulation,
as well as statistical tools at selected workstations. The evaluation carried out showed that the duration of particular productions steps in compliance with regulations was random.
4. Development of probabilistic models, which gave a more complete picture of the occurring phenomena, as well as time characteristics of particular production steps. The main factors influencing the parameters of probability distribution are external, such as the wear of machine parts, machine handling and work organization during
a given brass rod production step.

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