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MANAGEMENT OF THE FOUNDRY MACHINES OPERATION AIDED BY A MODELLING AND SIMULATION TECHNIQUE

This paper presents the possibility of applying a simulation technique in iron casting production management and takes into account the problems connected with servicing the foundry machines. Information and data records about assembly line and product failures were used to build a database which was used in the simulation process. Schedules of the actual work time of the assembly line equipment were used to estimate assembly line service schedules. A significance level α = 0,05 was used in the statistical analysis model.

ZARZĄDZANIE EKSPLOATACJĄ MASZYN ODLEWNICZYCH W OPARCIU O TECHNIKĘ MODELOWANIA I SYMULACJI

W artykule zaproponowano możliwość wykorzystania techniki symulacyjnej w zarządzaniu produkcji odlewów żeliwnych z uwzględnieniem zagadnień związanych z obsługą maszyn odlewniczych. Zbudowano bazę danych eksploatacyjnych służącą do zapisywania i przetwarzania danych o uszkodzeniach oraz innych postojach nieplanowanych linii. Wykorzystując narzędzia analizy statystycznej określono rozkłady czasu poprawnej pracy poszczególnych urządzeń linii na poziomie istotności α =0,05 i na tej podstawie zbudowano harmonogram obsługi linii.

1. INTRODUCTION

The model can be used to predict the sequence of physical service events including the products and the whole manufacturing processes. The use of computer technique in enterprise makes integration of production preparation processes and the production itself possible. Costly and sometimes even impossible to conduct industry tests are avoided this way. To manage the production efficiently, one can use a computer model of the real system to conduct many necessary experiments. One can simulate different decision situations to provide the basis for managing in real time. Taking into account the reports, which are the results of the conducted modelling experiments, one can compare the model results with actual decisions on the examined system operations and search for the best solution to assembly line service events [2,3].

2. DESCRIPTION OF THE GOAL AND THE RESULTS OF THE RESEARCH

The object of the research in the paper is a system of iron castings manufacturing on automated foundry lines to maximize assembly line structure. The lines are supplied with liquid cast iron prepared in electric arc or induction furnaces. Liquid cast iron is transported in ladles to the pouring stand of the foundry lines (fig.1).

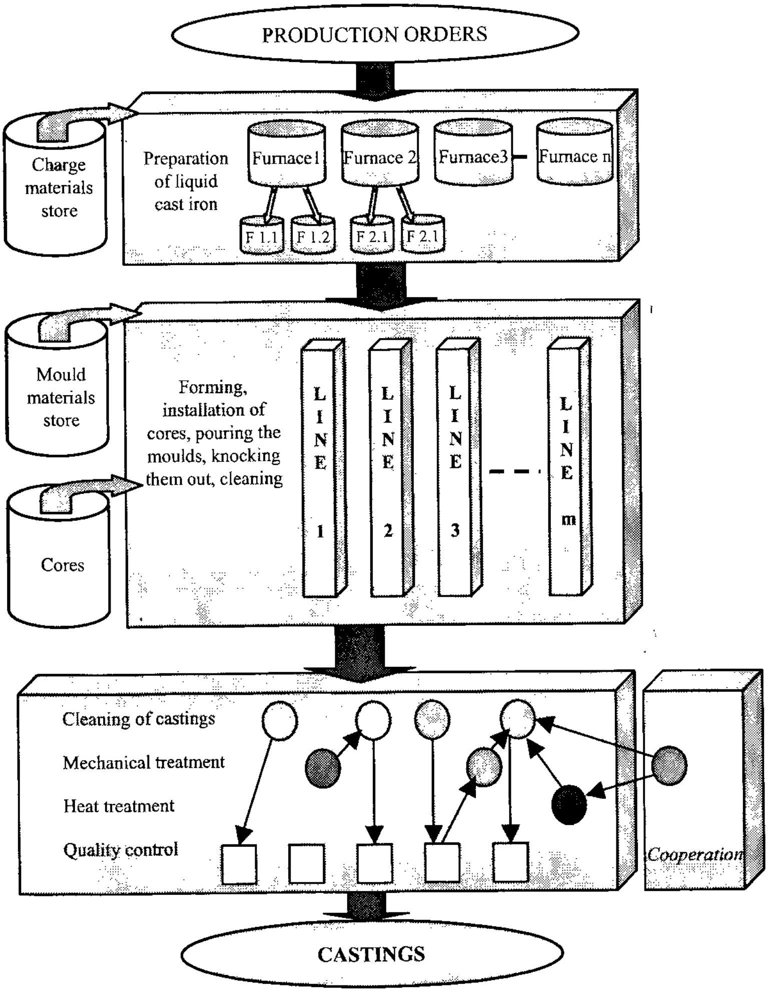


Fig. 1. Manufacturing system of iron castings on automatic foundry lines

Multi-batch production of iron castings on automated foundry lines is an example of repeated, rhythmic production with a wide range of the produced goods. Rhythmic behaviour of this kind allows us to use a statistical model to create schedules for periodic inspection, major repair as well as timely repair of minor disruptions in the assembly process. The analysis of the actual production service events helped create a scheme of the research objective. Figure 2 illustrates the process where output values are impacted by a combination of input values and assembly line failures.

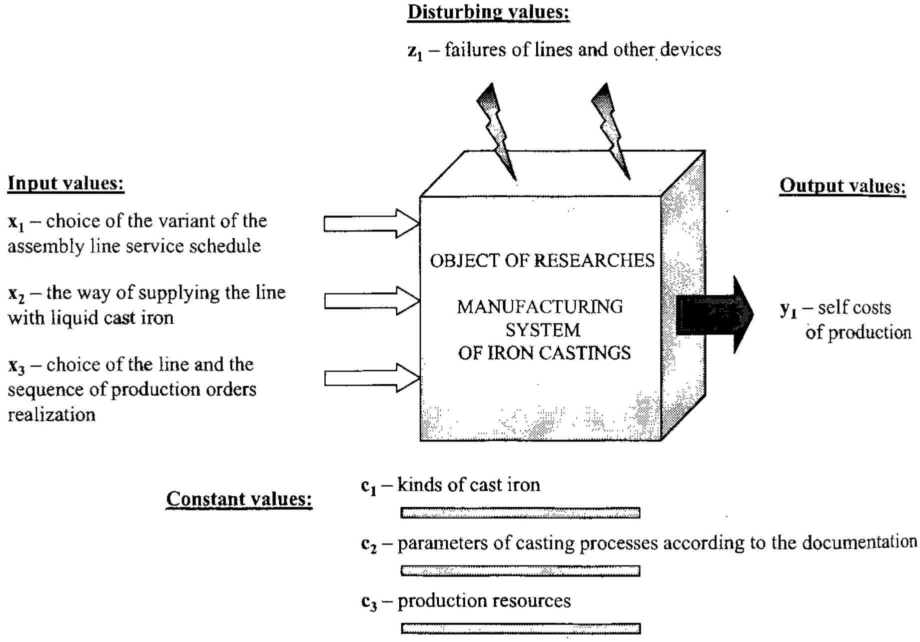
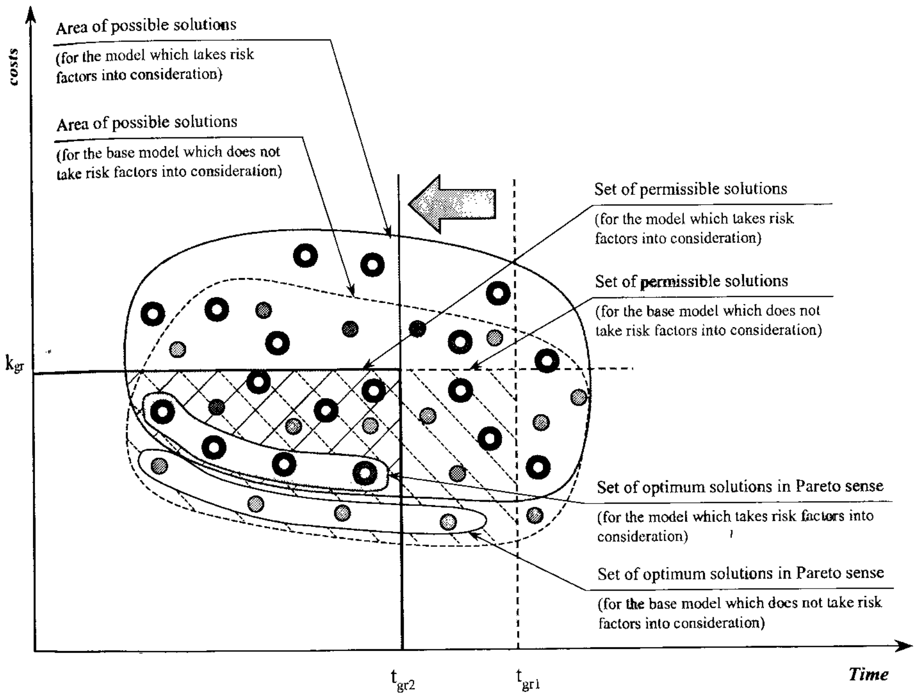


Fig. 2. Model of the research object

Simulation tools are proposed for use in analyzing the functioning of the production system [2,3]. The analysis in Pareto allows one to choose the best solution (fig.3.), where the criterion of optimization will be the cost of the produced castings determined on ZAR (enterprise account sheet) basis. In addition the criteria of quality and time will be regarded as an additional restrictions.

The model predicts assembly line disruptions in real time. This allows for improving quality requirements and better define production deadlines and output. The new modeling approach allows for consistent meeting of set time limits and projected production budgets.

If at least one product out of a certain number ends after the set time limit *(t_{gr2})* or self- costs exceed the set costs level *(k_{gr})*, the production schedule is not accepted.



Variant of production schedule for the base model which does not take risk factors into consideration

Variant of production schedule for the base model which takes risk factors on the significance level $\alpha = 0{,}05$ into consideration

Fig. 3. Optimization of the iron casting production processes on the basis of Pareto analysis

The aim function will represent the given below phrase which determines minimal self-costs of production.

$$f(k_{mb}, k_k, k_{st}^{st}, k_{st}^{z}) \to \min \tag{1}$$

where: k_{mb} – direct material costs,

k_k – cooperation costs,

k_{st}^{st} – fixed stand costs,

k_{st}^{z} – variable stand costs.

The rest of the cost components (k_{mp}- indirect material costs, k_{kp}-indirect cooperation costs, k_{pb}- direct work costs, k_{pp}- indirect processing costs) were omitted because they represent a constant variable in the process .

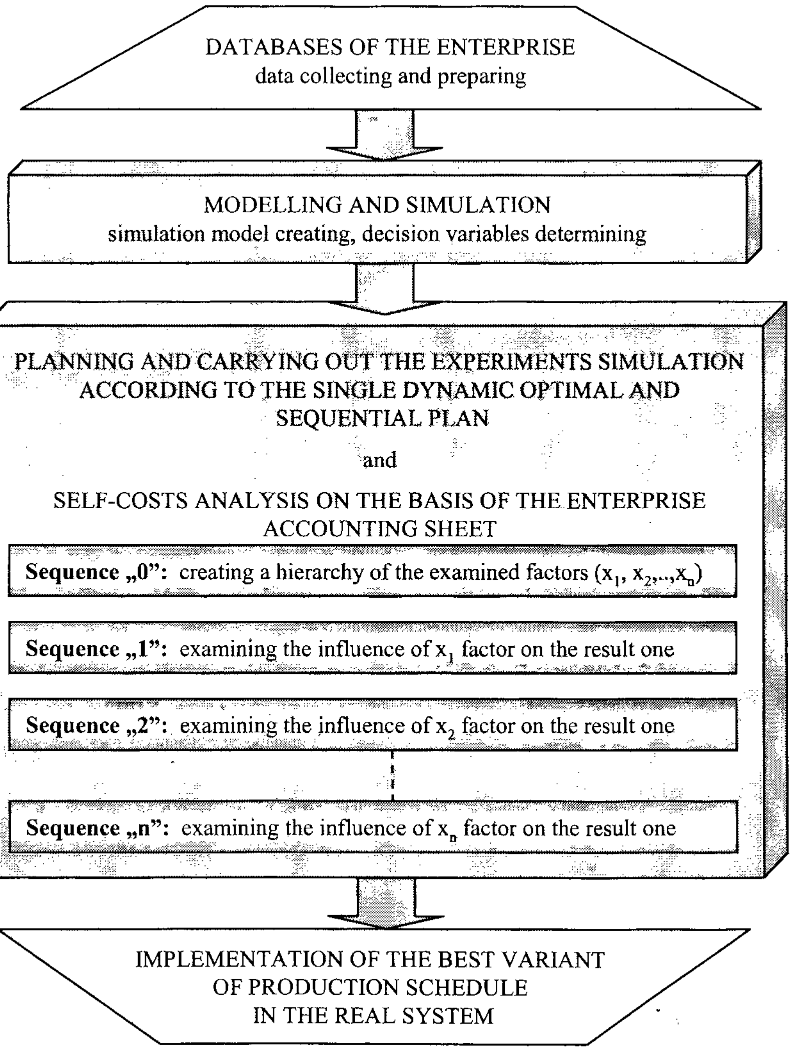


Fig. 4. Modelling and simulation – efficient tool aiding management of castings production

The simulation experiments derived from the model were created on the basis of single, dynamic, optimal, and sequential plan (fig. 4) [4,5]. The hierarchy of the examined factors are described according to their influence on the output value. The sequence of examined factors is as follow:

X_1 – choice of the variant of service schedule of the planned assembly line,

X_2 – the way of supplying the assembly line with liquid metal from arc and induction furnaces,

X_3 – choice of the assembly line and the sequence of production orders realization.

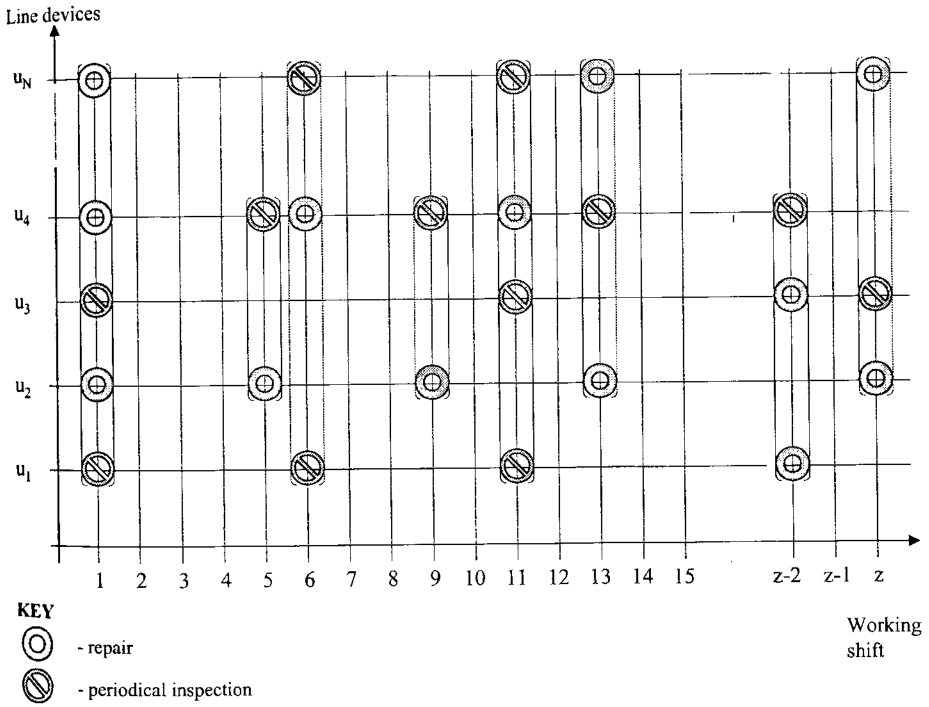


Fig. 5. Timework run of the foundry line with infallible row structure

Regarding the low level of use of automated foundry lines, which represents the weakest link of castings production system, one should consider maximizing their usage. Positive effects within this range can be achieved through the properly managed preventive maintenance activities as well as better organization of the assembly line usage.

3. CONCLUSION

To solve the problem of optimal usage of foundry lines a model of line service should be created. It should consider the organizational possibilities of the enterprise [1] on the basis of the prepared exploration database. Creating proper service schedules (fig.5) should improve efficiency from the organizational and technical aspects of managing the automated line and decrease the loses because of disruptions. With the help of the simulation technique the influence of the proposed schedules of automatic foundry lines service on the functioning of the system of iron castings manufacturing can be estimated.

Literature

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