Available online at www.sciencedirect.com
ScienceDirect
Procedia - Social and Behavioral Sciences 238 (2018) 424 – 431
Procedia
Social and Behavioral Sciences

SIM 2017 / 14th International Symposium in Management

New method to optimize the production functions in the system of safety in operation management

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Abstract

The Safety in Operation system represents the framework within which every technological process operates. Any technological parameter - production, quality, must be analyzed in terms of this system. Mathematical and/or empirical modeling, as the first stage in the determination of the technological processes optimum operation regimes, represents a “must” both in the phase of conception, but mainly in the operation analysis phase. From this standpoint, the introduction of the active optimization method based on scheduled experiment represents an efficient tool to relieve the extreme conditions and to get information for technological processes optimum management.
The work is focused on the mathematical modeling of the production function for an assembly of 13 drawing frames from two Romanian units, in terms of maintainability and reliability parameters. After determining the polynomial that characterizes the model, the work investigates the optimization of non-linear multi-variable polynomial function, and explains the context of getting the extreme values within the multi-factorial space.
The work defines in its structure the notions of the safety in operation system used in research, applies quantitative study on a system from textile spinning mill field (one notices reliable operation times, break-down times, number of failures and the production of the technical systems on a pre-established time horizon); it statistically validates and mathematically optimizes the results.
The theoretical approach consists in an algorithm in a unitary software application that can be used as a tool in the decision problems appeared during the technological process.

Peer-review under responsibility of SIM 2017 / 14th International Symposium in Management.

*Keywords:*textile technological process, statistic modeling, reliability, production, industrial processes optimization

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Peer-review under responsibility of SIM 2017 / 14th International Symposium in Management.
doi:10.1016/j.sbspro.2018.04.020

1. Introduction

Determination of wanted production values in terms of an established system of Safety in Function (SF) represents still a desiderate for all the technological processes (Pedro Moreu De Leon et al., 2012), (Damjan Maletic et al., 2014). The SF system is characterized by 4 parameters: Maintainability (M), Reliability (R), Security (S) and Disponibility (D) (Stapelberg, 2009). Because the disponibility is a linear function of maintainability and reliability, and security is a qualitative parameter, the problem reduces to optimizing the *production* parameter as function of M and R (Rachid et al., 2010). (Hincheeranan & Rivepiboon, 2012), (Stoica, 2010) and (Huang & Lai, 2003) propose new tools for measuring maintainability of system in the design phase that is a "must" to improves the maintainability of the system before to produce it, methods to whose results I have reported. In this paper I have referred to some of the metrics proposed in (Barabadi A, et. al. 2011) and (Babu & Bharathi (2013) and the proposed methods was based on the techniques described in (Reussner, 2003), and (Crowe & Feinberg, 2001).

The studied problem can be seen as a first order feed-back system (Fig.1.), where the input is given by the production P strategies, the output is given by the real values of production Pr, the maintenance parameters being computed (approximated) through the function *f*. The transfer function *f* can be modeled mathematically or with evolutional techniques (Vilcu, Verzea & Rachid Chaib, 2016), (Verzea & Luca, 2003). One compares the computed values with real values of the system (Mr, Rr) and computes the error e_r. The objective is to make this error tends to zero. In the second part of the system, one determines the computed values of P that are influenced by the two SF parameters, Mr, and Rr. One applies the reliability and maintenance values calculated in the technical process, and obtains the real values of production and quality. Based on the error $e_r = \|(Ps) - (Pr)\|$, one can adjust the parameters of the transfer function *f* such that the error is zero.

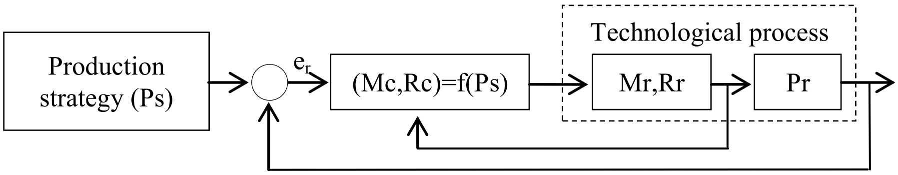

Fig.1. Production functions in the system of Safety in Operation Management.

The system to optimize is presented in the next figure (Fig.2).

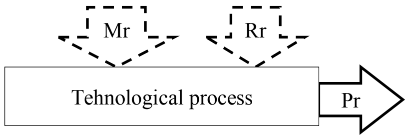

Fig.2. The system to optimize the objective function Pr.

2. Materials and method

The methods for technological processes optimization are meant to determine the extreme values of dependent parameters as function of independent parameter. If the relations between system parameters are linear or non-linear function, the optimization process reduces to finding the optimum coordinate in multi-factorial space and its value. (Catana, Safta & Panduru, 2004), (Rachid Chaib, et. al., 2010).

We shall realize in this work an unrestricted optimization through active experiment, which means that we shall determine the maximum level of production and quality for any values combination of the independent factors, combination resulted from processing the information supplied by the mathematical model.

The first stage of optimization through active experiment consists in **experiment programming** (Taloi, 1983) - establish the necessary number of experiments and the conditions to realize them. The technique of "passive optimization", also called empirico-statistical modeling, is characterized by assigning intuitive values for independent parameters, computing on their base the values of output experimental data for which the precision increases with the increase of the number of performed determinations. On the other side, the active experiment