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Multi- objective Optimization and Decision Making Problems of Assembly Lines

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***Abstract*—This paper summarizes my recent work in the field of multi- objective optimization of assembly lines. Introduction to the topic is followed by tasks and results from previous years. Up-to- date research tasks are closely described in the main part, followed by the description of the future steps leading to finalization of my thesis, with focus on the engineering and scientific contribution of my dissertation.**

***Keywords*—assembly lines, modeling, criterion, multi- objective decision making, multi- objective optimization.**

I. Introduction

Both decision making and optimization are the subject of many research teams throughout the world, mainly because of the wide usage possibilities and wide range of decision making and optimization methods. Computational processing of these methods enables people to leave the decision making on the algorithms built on mathematical basis. This fact ensures the objectiveness of the decisions and strategies chosen by these methods.[1]

Main goal of my research is the definition of complex methodology for assembly line optimization with focus on finding the optimal assembly line configuration and optimal production process definition.

Means of multi- objective decision making (MODM) and multi- objective optimization (MOO) were chosen, because in most cases, more than one criterion has to be taken into account while solving decision making problem. Also, more than one main objective can be defined in optimization problems dealing with assembly lines (profit, time, efficiency, environmental effects, reliability, safety etc.).

Due to lack of the experimental data, my research also deals with the modeling of assembly line processes in order to realize experiments and raise the data for further processing and usage in MODM and MOO processes.

II. Previous tasks and results achieved in the research field

In order to define the complex methodology of assembly line optimization, tasks within my research can be split into 3 main categories:

- modelling of the assembly lines,
- multi- objective decision making,
- multi- objective optimization.

In modelling, models of assembly lines are developed using Stateflow diagrams within the Simulink library of the MATLAB environment. During previous years, model of the Flexible Manufacturing Company (assembly line in DCAI) was created. Its detailed description was published in [2].

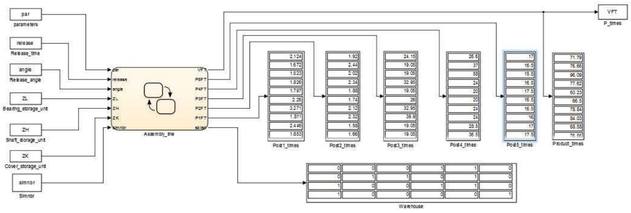

Fig. 1. Stateflow model of Flexible assembly line

During previous years of my postgraduate studies, I was working on many tasks dealing with MODM. Computational processing of many different MODM methods was realized (ELECTRE I – IV, AGREPREF, TOPSIS, AHP). Application use of these methods in solving optimal assembly line configuration task can be read in [3] and in my AEI article: *Solving optimal assembly line configuration task by multi-objective decision making methods,* which is now under review process. Theoretical background of these methods can be found in [4]. Another potential of use of the MODM methods can be found in [5].

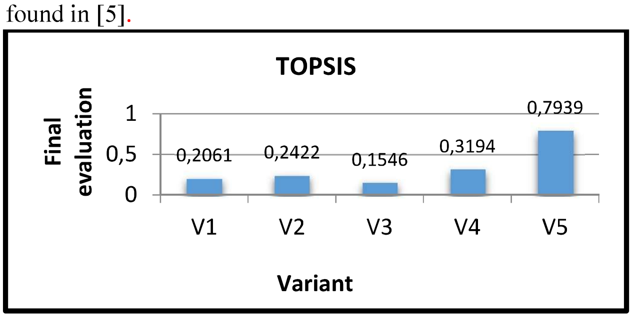

Fig. 2. Results of TOPSIS methods used for solving optimal assembly configuration problem

Dealing with the problem of optimal production plan of mixed – model assembly line, methods defining of the set of non- improving elements and compromising methods were implemented into the MATLAB environment in order to solve tasks of MOO of assembly lines. Closer description of the application solving these tasks can be found in [6].

III. Tasks and results solved in last year

Tasks described in this chapter are realized within our group in DCAI. Its other activities are the main topic of [7].

A. Stateflow models of assembly line and queueing system

Designing the model of assembly line is the necessary step in further MODM or MOO process, because outputs of the model are used for proper evaluation of the criteria. Furthermore, with the model it is easier to find the weak spots in production process and adopt the solutions before building an actual assembly line.

Parameters from both simulation models of assembly lines are transferred into another Stateflow model: model of queueing systems.

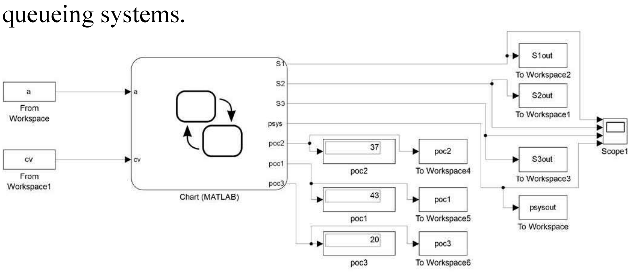

Fig. 3. Stateflow model of M/M/c queueing system

This model can simulate the situation, when there is more than one identical workplace in particular weak spot (place, where overlays take place and production process is not fluent) of the assembly line. Model can cope with various inputs both for the queue and for the service (exponential distribution, Gaussian distribution, continuous uniform distribution etc.).

Outputs of this model (number of products constructed on particular workplace, percentage of using of every workplace, number of used workplaces in particular time) will be used in evaluating possible alternatives in finding optimal configuration of assembly lines. Outputs of both model are exported into MS Excel, what makes the data available for further processing and analysis.

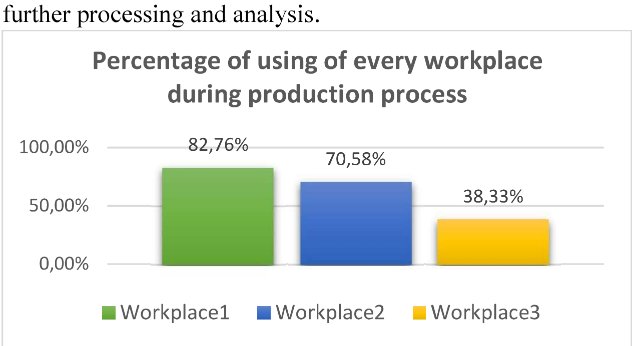

Fig. 4. Further analysis of simulation data

The other of part my recent research was focused on finding key parameters (likelihood of waiting in queue, inputs and service intensity, average waiting time, average service time, average time in queueing system etc.) of two types of queueing system (M/M/1, M/M/c), so queueing systems with 1 queue and 1 or c service places. Theoretical background of these methods can be found in [8] and [9]. Scripts with counting these parameters of the simulations were implemented in MATLAB environment and their outputs are used in MODM and MOO processes.

B. Information system AMANDA

Our research group is also working on Experiment ALICE on LHC in CERN: Study of strongly interacting matter at extreme energy densities. Within this project, I am the part of research team working on the upgrade of information system for off- line data access called AMANDA. This system provides users with the information about values of various elements, which can be downloaded from CERN server and subsequently used for further data analysis.

IV. Future Research Steps

In my future research, emphasis will be given to synthesis of various MODM methods in order to bring more objectivity into the decision making process.

Part of my future activities will be also dealing with finalization of complex methodology for decision making process, from choosing the objectives and criteria, through proper evaluation of their weights and relevance for particular criterion in order to find best solution for MODM problems.

In MOO, my research will be focused on combination of mathematical methods and methods of artificial intelligence, where goal is to find the best solution for various MOO tasks dealing with assembly lines. All these steps and goals should lead to finalization of my dissertation.

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