1TH INTERNATIONAL WORKSHOP "ADVANCED METHODS AND TRENDS IN PRODUCTION ENGINEERING"

THE PRODUCTION SYSTEMS DESIGNING WITH SPECIAL TAKING INTO ACCOUNT OF WORKING CONDITIONS

Lucyna Brzozowska, Dariusz Plinta
Department of Industrial Engineering, University of Bielsko-Biala
2 Willowa Street, 43-309 Bielsko-Biała, Poland
lbrzozowska@ath.bielsko.pl, dplinta@ath.bielsko.pl

Abstract: *Designing of the production systems, it does not suffice determination how, what and when something should be executed. But it is important to determinate in which conditions it will be realized. We should remember here about different factors, such the requirements connected with working conditions, costs and lead time, which should be complexly optimizing. There is presented an example of modeling and simulation of the designed production system with taking into account the process of pollutants dispersion in the production room.*
Key words: *modeling and simulation, production system*

1. INTRODUCTION

Production of products and offering services are the target of all economic activities. Production is not, however realized in any method, but it is planned in detail, mostly with regard to effective utilization of resources. Production economy reflects the effects of all production activities and it is also a part of the integrated system of the company management.

Activity of the company in the free market economy conditions makes managers undertake more and more complex and complicated tasks. The consequence this is the necessity of synchronization of increasing quantities of the technological factors what brings looking for more effective methods of control of the production processes. Control of the production planning is one of the most important tasks of the company. The target of these activities is to manufacture the products at the planned time. Furthermore, they have to fulfill the qualitative requirements and their manufacture costs should be as low as possible. It is possible to understand production systems designing as creating of the conditions to appearing the smooth and effective manufacturing processes run.

New tendencies within the company organisational field, which have also an influence on the computer systems, have a meaningful influence on development of production planning and control. Furthermore, modelling and simulation becomes more and more essential method. Thanks to simulation it is possible to analyze not only the time and costs of realization of different production orders (the whole manufacturing process), but it is possible also to execute analyses of particular working operations. It is also possible to simulate the changing working conditions, for example the emission of harmful pollutants.

With designing of the production system there are realized activities leading to limitation of concentration of pollutants (dust or harmful compounds) especially from the point of view of the health and comfort of the work. There becomes very important the suitable (optimal) ventilation, allowing to transport the polluted air, faster and more effective, outside the object. Equally important, there is the question of expansion on impurities in the closed room (the industrial hall), which is forced by the way of ventilation and intensity of emission sources and their location.

2. MODELING AND SIMULATION OF PRODUCTION SYSTEMS

For set product and the planned size of production by the modeling and simulation it is possible to determine comparatively easily and quickly the parameters of the designed production system, for example the necessary machines, their duty, the necessary workers' quantity and means of transport. After warm-up period, if there are correctly chosen resources, it comes to stabilize of the production. System achieves the settled state. By choosing suitably resources there is created the model of production system, which approaches with one's parameters to optimum solution gradually [3, 4].

The optimization, which is achieved by the modeling and simulation of the designed production system, can for example concern:

- selection of workers,

– selection of machines,

– setting of workplaces,

– selection of transport means,

– location and size of buffers.

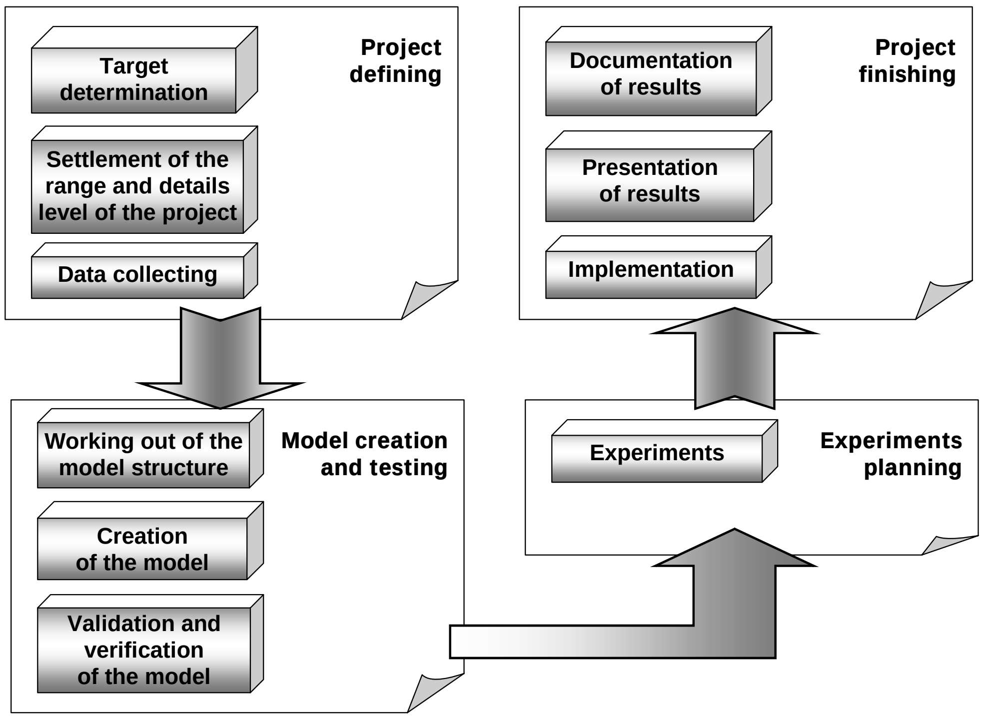

Fig.1. *The run of project realization using the modeling and simulation method*

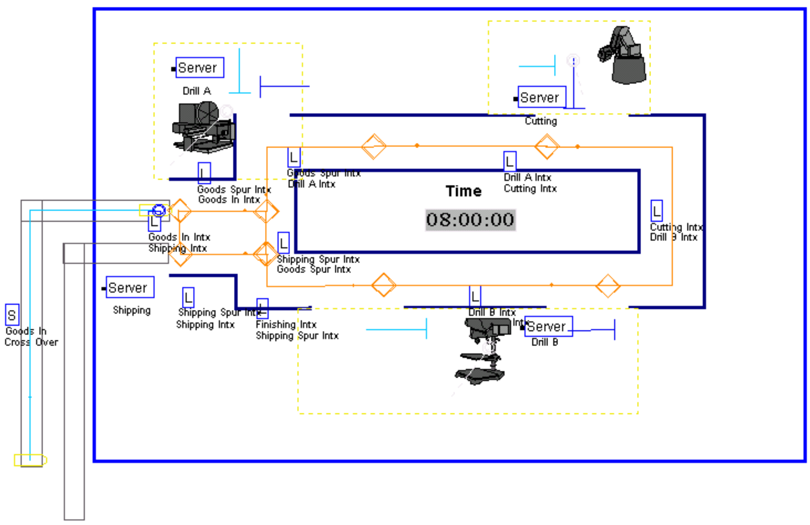

Fig.2. *Simulation model of the designed production department*

In next step it is possible to execute the analysis of working conditions in the designed production department.

3. MODELING AND SIMULATION OF EXPANSION OF IMPURITIES

The question of the dispersion modeling of impurities is the complex problem, exacting earlier defining of the position and intensity of emission sources and defining the kind of emitted substance (the dust, gas, gas reacting with air), and also the fields of air speed inside the modeled area. The source of a part of the input-data can be the simulation model of the designed production system - chosen workplaces being the source of impurities and their location.

The next stages of analyze are presented on the fig.3.

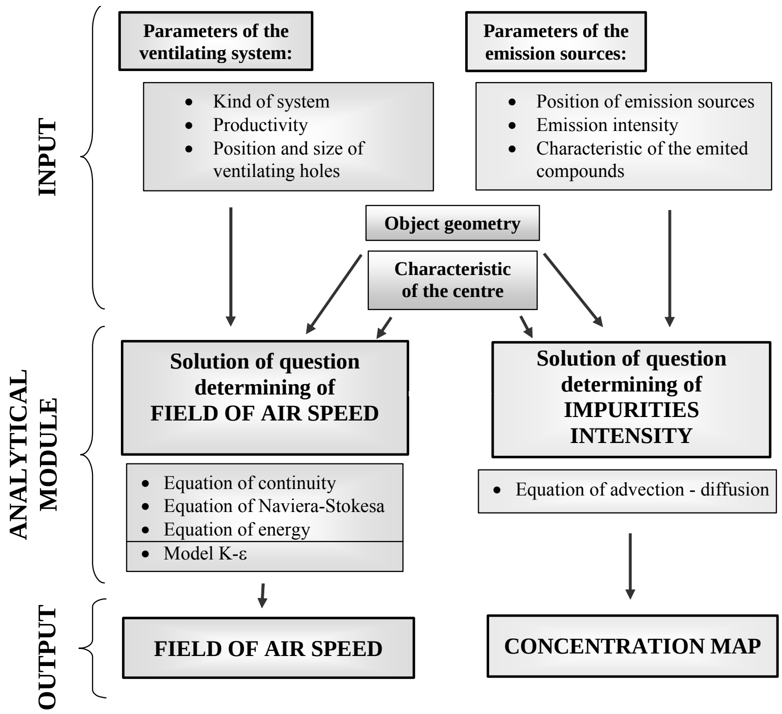

Fig.3. *Scheme of the computer model for determining the intensity of impurities emission*

Before start a computation of the impurities dispersion in a room, it should determine in whole modeled area the field of air speed. How it was already remembered to solution introduced questions, there were used numeric methods. The field of air speed was marked from equations: Naviera - Stokesa, continuity and energy, and equations describer turbulence according to model K-ε: the equation of kinetic energy of turbulence and dissipation turbulence [3,5,6]. For digitizing of the equations there was applied the method of complete volumes [1,2,3].

The production room, where is the designed production department (fig.4) was divided on 1155 rectangular prisms with dimensions 0,5 × 0,5 × 0,5 m.

There were assumed five intake ventilators, by which the air will be grouted inwards with speed 1,5 m/s (Inlets) and four openings of type Outlets, by which follows the free exchange of the air from and inwards the room. There were not taken into account such openings as doors and windows, because they the most often stay closed and the exchange of air is very small.

All elements of type inlet (the ventilations, fig.4) were situated symmetrically in relation to axis $0X^{(1)}$ and $0Y^{(2)}$ on ceiling, and their size was carried out 0,5 m × 0,5 m. On two parallel to axis $0X^{((1)}$ walls were situated the elements of type Outlets. The height of these elements carried out 0,5 m, and width 1 m.

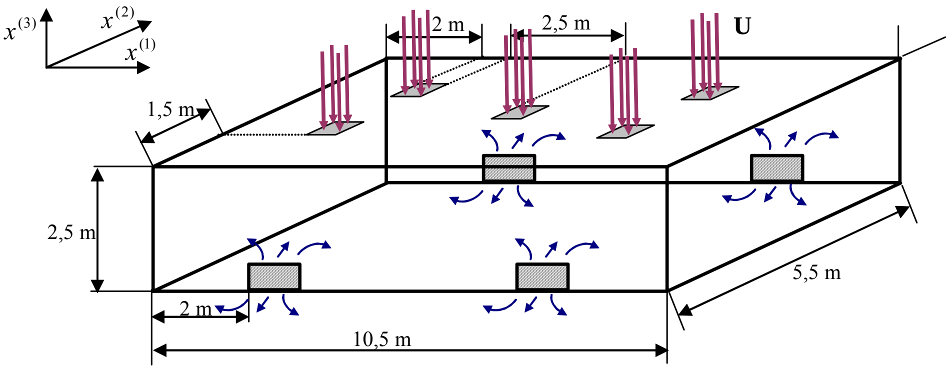

Fig.4. *Position of openings of type Inlets and Outlets in the modeled area*

In result of computer simulation there was obtained the values of all air velocity components $U^{(1)}, U^{(2)}, U^{(3)}$, in the whole area. The examples of results of calculations present figures 5 and 6.

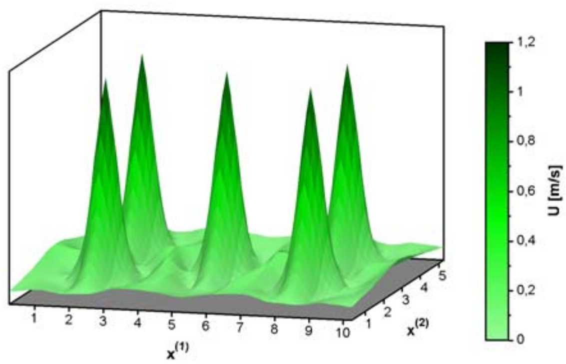

Fig.5. *Field of air speed on high $x^{(3)}$= 1,25 m*

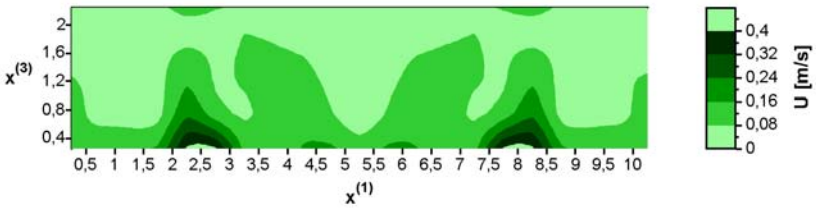

Fig.6. *Field of air speed for $x^{(2)} = 0,75$ m*

The acquaintance of the velocity component of air and the total speed U permits on adaptation in optimum way the workplaces and position of sources of emission according to the comfort of work, and not infrequently to the workers' health.

The application, enabling realization of calculations, which results became partly introduced above, permits on making for different variants of efficiency and position of openings computational experiments. It is possible to conduct quickly testing calculations and their results can be used in the project.

In the modeled closed room are three independent, stationary sources of emission, which intensity carries out 0,8 mg/s. The kind and his degree of toxicity were not analyzed. It was considered the concentrations in the modeled area of impurities with special regard on the workplaces. There were assumed, that emitted substance is a gas and there has not heat radiation during emission. The positions of sources of emission and control points are introduced on the figure 7.

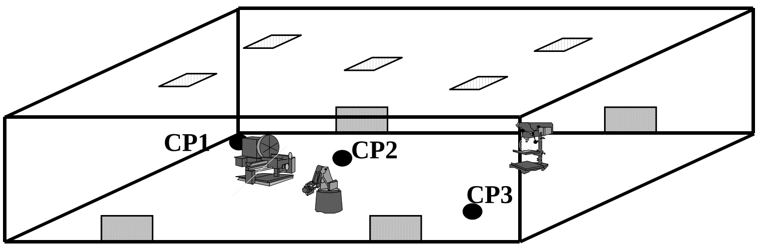

Fig.7. *Positions of emission sources and control points*

Table 1. Coordinates of centers of sources emission and control points

Object	$x^{(1)}$ **[m]**	$x^{(2)}$ **[m]**	$x^{(3)}$ **[m]**
Source 1	2,25	3,25	0,5
Source 2	5,25	1,25	0,5
Source 3	7,75	3,75	0,5
Control point 1	1,25	4,25	1,25
Control point 2	5,25	2,75	1,25
Control point 3	8,75	0,75	1,25

It is proper to notice that source 1 is below one of openings intake ventilator (coordinates of the centre: $x^{(1)}$=2,25m, $x^{(2)}$=3,75, $x^{(3)}$=2,5), and the second control point is below central intake ventilator. In these points "deflation" will be the most perceptible. Equally important how the position of emission sources, or looking with different perspective, from control points, in relation to openings intake ventilator is their distance from openings of type Outlet and the position regard the emission sources and control points.

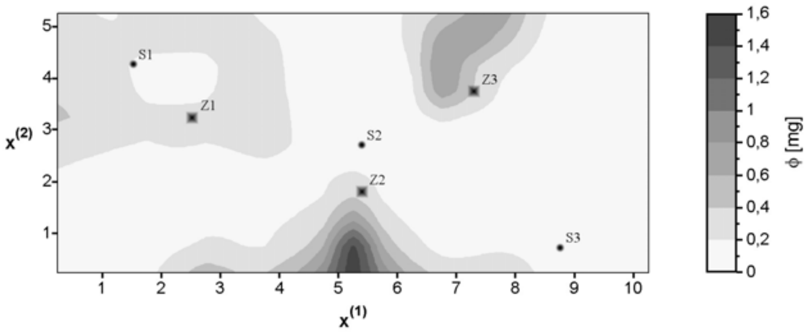

Fig.8. *The layout of average impurities concentrations on high 1,25m; S1, S2, S3 mark the next control points; Z1, Z2, Z3 - the source of emission*

The simulation was carried out in time t = 300 s. On the figure 8 is introduced the average concentrations of impurities in the modeled area on high 1,25m. It is possible to notice influence of both "outlets " and "inlets" on the layout of impurities concentrations.

How it results from introduced data, the smallest values of concentrations, it is possible to observe in near of point S3. This control point is the best situated under regard of risk on working of emitted compounds. It is particularly important, in case, when impurities are harmful substances, influencing toxically on worker.

4. CONCLUSIONS

The modeling and simulation of production processes becomes more and more important helping technique for designing of a new manufacturing system. It makes possible tracing of the production functioning and detection the weak points yet before actuation of the production. It exists series of simulating programs enabling the analysis of different aspects of the production systems functioning (e.g. ARENA, Quest, Simple++ - applications for modeling and simulation of manufacturing processes; Star CD, Fluent or own program FVMod - applications for the air quality modeling). On the basis of simulation results it is possible to draw conclusions about designed system, to propose improvements, which can be basis for generating next variants. Simulation makes possible to trace effects of the proposed changes. It facilitates the choice of the best variant of solution.

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