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## Decanting Centrifuge Production Process Optimization using Plant Simulation

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### Abstract

This article deals with the problem of verification of production system optimization design for decanting centrifuge production process through the Digital factory tool - 2D simulation software Plant Simulation. The goal was use modern methods to replace estimation method (trial and error) and reduce investment risks before selecting optimizing steps for implementation.

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*Keywords:* optimization; production system; decanting centrifuge; simulation

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### 1. Introduction

Decanting centrifuges are rotational machines, Fig. 1., used for separating solids and suspended particles from liquids. These machines are used for wastewater treatment and sludge in food and chemical industry and agriculture. With their production is engaged industrial company PBS, which for cost projects of their products has no standardized methodology and uses the method of estimation. In cooperation with the Czech Technical University in Prague was designed project, which is to verify the possibility of modern optimization tool application - computer simulation.

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Fig. 1. Decanting centrifuge DO 250.

## 2. Technical and organizational conditions of production

The production hall is 110 meters long and 50 meters wide. It is a single-storey building. There is the technological production layout. In the production hall are grouped in close proximity machines with the same production focus (saws, lathes, drilling machines, milling machines, machining centers, heat treatment of metals, grinding) [1].

Existing material flows of selected manufacturing representatives are very complex. There is a large number of reversible movements and crossings. Some manufacturing representatives are transported unnecessarily long distances. In Tab. 1. are measured distances for each of individual manufacturing representatives around the hall between workplace.

The basic manipulation device is a classic hand pallet truck. There is also used diesel forklift Desta DV20AA. For the handling of smaller and lighter components, especially in the preparation of the material from the warehouse, is used electric platform truck. For heavier and bulkier products are used indoor cranes.

Table 1. Transport distances of manufacturing representatives.

Manufacturing representative nr.	Original cumulative transport distance [m]	New cumulative transport distance [m]	Difference [%]
1	880	510	-42
2	945	505	-47
3	945	505	-47
4	1095	525	-52
5	1610	830	-48
6	685	520	-24
7	710	385	-46
8	975	795	-18
<b>In sum</b>	<b>7.845</b>	<b>4.575</b>	<b>-41</b>

### 3. Creating a digital model

As a simulation tool we used software from Siemens - Plant Simulation.

For create a digital model is necessary to select a certain number of manufacturing representatives who meet predetermined criteria. In this case, because of the large number of diverse products and almost single-piece production, was the most important criteria choose frequency and complexity of the product. In sum, we selected 8 manufacturing representatives (Tab. 1).

As input data we used real data from the existing production system [2] - the layout of the hall (Fig. 2. shows the color-recorded material flows), using machines, shifts and handling equipment.

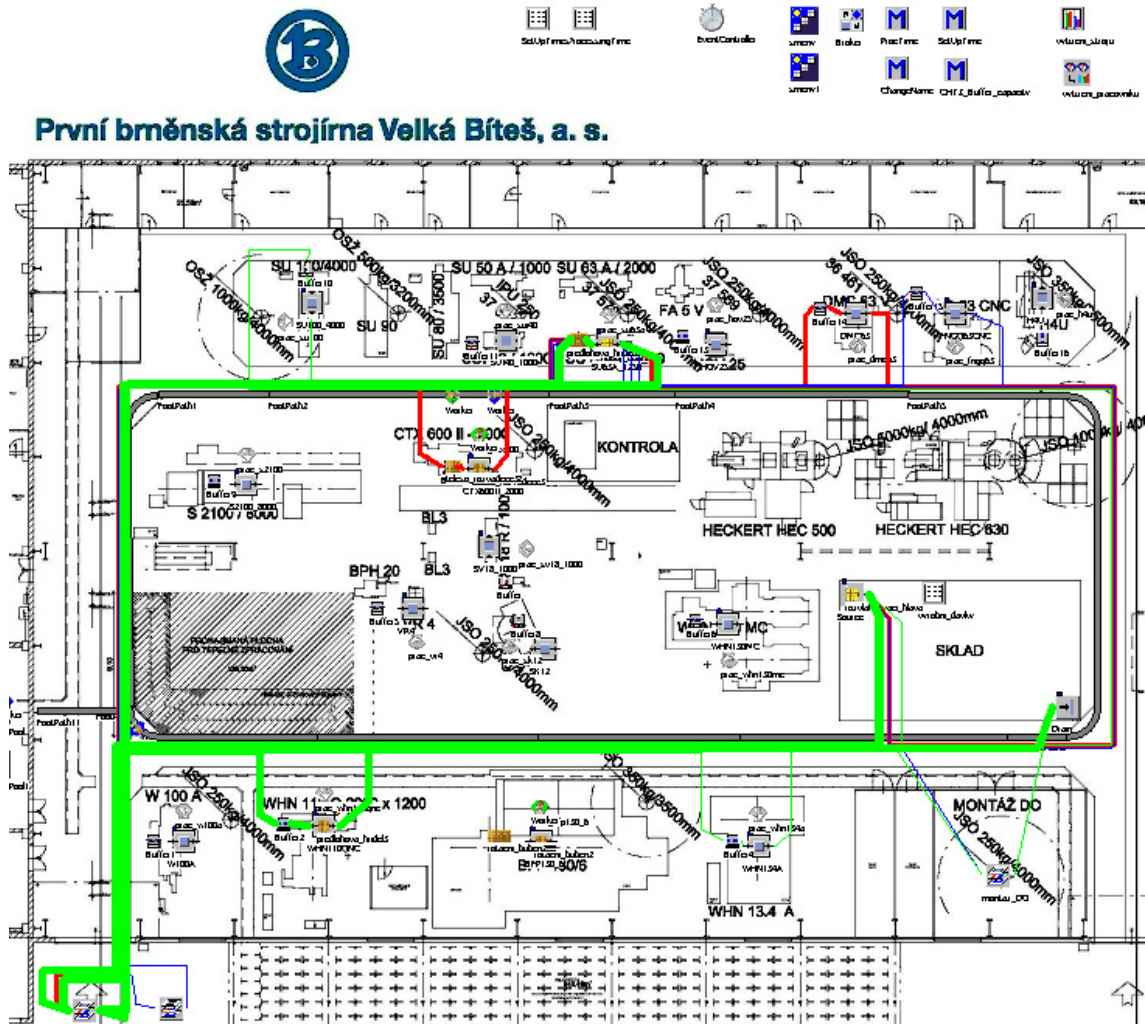


Fig. 2. Digital model of production system.

## 4. Optimization proposal

### 4.1. Additional work shift at selected workplaces

The first optimization proposal is to remove bottlenecks in the form of workplaces, we have set by capacity calculations [3]. These bottlenecks can be eliminated by adding the second shift. This solution is the simplest and also the increased cost of wages and energy does no large investment costs.

### 4.2. Layout change

The goal is to reduce the overall length of the transport paths. As a first step, we have compiled a checkered table of carriage between sending and receiving workplace for manufacturing representatives. Source data is annual quantity produced in pieces. Based on the performances of the table has been compiled their significance and using the triangle method, we can design the layout modifications of the production hall [1].

The biggest change is the creation of new path in the middle of the hall, which should reduce transport distances between workplaces. Input warehouse we moved closer to the entrance gate and move exit the warehouse assembly decanting centrifuge. In addition to the input warehouse we have placed the most widely used lathes and beside them less boring.

The final material flows are shorter and more direct, without long reverse movements. The cost of modifying the layout was set at 25,000, - €.

### 4.3. New machinery buying

To replace morally and technically obsolete machines we proposed purchase of two new machines worth 258,000, - €. This adjustment related to change in layout and machine time savings is estimated at 22%.

## 5. Simulation results

Through implementation of optimization proposals from section 4. to the digital model of the current situation was mainly verified reduction in lead time of production in average of 34%.

Table 2. Simulation results – lead time.

Manufacturing representative nr.	Original lead time [d:h:m:s]	New lead time [d:h:m:s]	Difference [%]
1	743:05:38:52	362:07:03:08	-51
2	708:08:28:51	252:00:41:22	-64
3	722:05:29:21	114:07:07:23	-84
4	211:06:21:30	354:01:33:56	+67
5	673:08:16:48	326:05:41:45	-51
6	745:00:30:08	338:14:45:03	-54
7	60:00:54:51	64:06:05:00	+7
8	71:04:02:54	52:03:30:38	-27

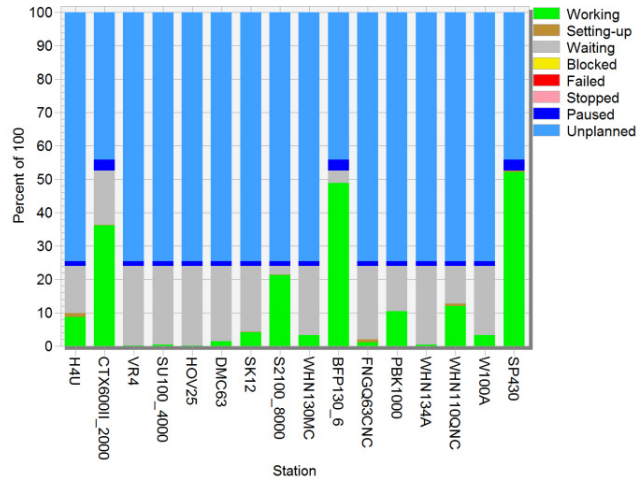


Fig. 3. Visualization of workplace utilization.

## 6. Conclusion

In small batch production of decanting centrifuges were innovative use of modern methods of simulation through the Digital factory tool - 2D simulation software Plant Simulation as a substitute estimation methods, and to reduce the investment risk associated with the implementation of optimization. Concrete results in a reduction of production lead times by an average of 34%, followed by quantification of the economic returns to all optimization suggestions for 3,6 years, which can be clearly evaluated positively and recommended for wider implementation.

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