SIMULATION AND PRODUCTION PLANNING, A SPECIAL CASE IN SHORT SERIES PRODUCTION

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Abstract

The idea of digital factory was created by automotive industry with the aim to be able for simulation, process analysis and cost reduction. The simulation must begin with model building, the processes of a production chain or a cell could be very complicated. Therefore while we make a model of an analysed system, we have to follow the rules of simulation and model building. In this paper are the steps of a research process on a short series press line highlighted. The difficulties of system modelling and differential case handling are detailed. This work introduces first the used modelling program, and the main points of simulation rules. Then we are going to learn more about the modelled physical system, how it works, which processes are used while production, which cases of runs has to be taken into account. After the structure of the machines is detailed, we will see how this functions could be modelled, which programming steps were needed. In the last part the difficulties of programming and methodology are described. The system works with set-up times, failures and parallel control, while object oriented programming and modelling was used. The paper shows an example for practical application in the field of digital factory - process simulation.

Keywords: digital factory, simulation, industrial production, automotive industry

Presenting Author's biography

Jósvai János, graduated in 2004 from Budapest University of Technology and Economics, specialisation for Industrial and Transport Logistics. Working at the Széchenyi István University since 2005, as phd student. Member of the University-based Regional Knowledge Centre for Vehicle Industry with simulation oriented research field.

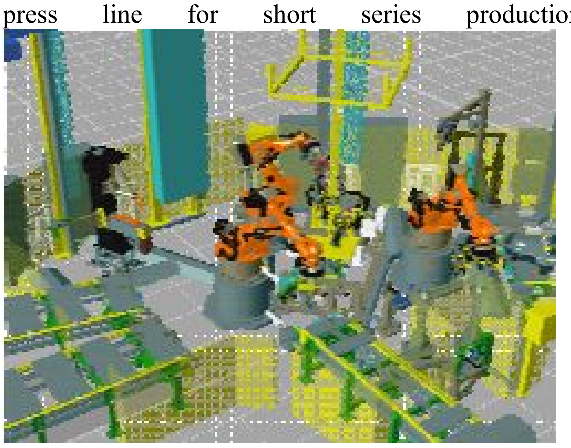
1 INTRODUCTION

VDI (Verein Deutscher Ingenieure, Society of German Engineers) guideline 3633 defines simulation as the emulation of a system, including its dynamic processes, in a model one can experiment with. It aims at achieving results that can be transferred to a real world installation. In addition, simulation defines the preparation, execution and evaluation of carefully directed experiments within a simulation model. [1]

As a general rule, there are few steps defined for simulation studies. First we have to check out the real-world installation we want to model and gather the data we need for creating our simulation model. Then we have to

abstract this real-world installation and create our simulation model according to the aims of the simulation studies. After this, we run experiments, i.e. execute simulation runs, within the simulation model. This will produce a number of results, such as how often machines fail, how often they are blocked, which set-up times accrue for the individual types of station, which utilization the machines have, etc. The next step will be to interpret the data the simulation runs produce.

For analyzing the press line processes the Tecomatix solution from UGS was used. This is a program group of several independent softwares. FactoryCAD is a solution for layout planning in a factory. RobCAD is a powerful tool for simulation and analysis of robot movements. Plantsimulation has been designed for modeling material flows in a production system,, this tool has been chosen to simulate the processes of a press line for short series production.



2 THE SHORT SERIES PRESS LINE

2.1 Material flow, technical elements, presses and robots

The concerned short series press line owns three presses and four robots. The presses can be mounted with one or two tools at one time in our case. The mounting of the tools and the setting up of the pressing parameters takes nearly one hour for every

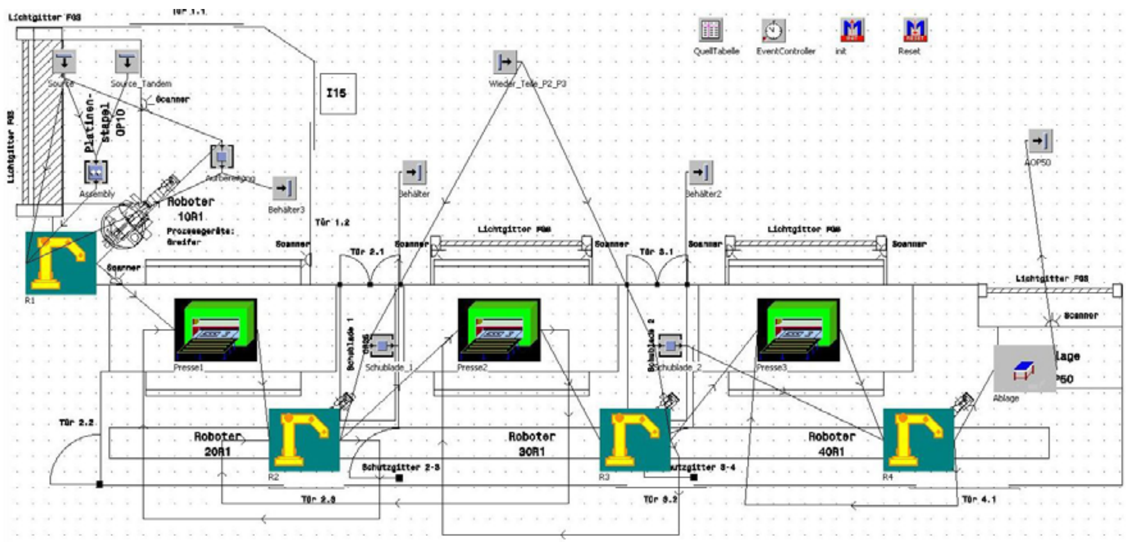


Fig. 1 Rough layout of a press line

kind of product. Sheets are moved by the robots, the first robot has to be trained for every new tool and new sheet bunch. The last robot puts the pieces on a table, the worker moves the ready components after quality check into the container. Figure 1 shows the rough layout of this system. The batch size of the production in our case moves between 150 and 400 pieces for each type, and there are 15 types of products under production. The scheduling of the product types is given, but follows no deterministic rule.

2.2 Cases of runs

After analysing the manufacturing process of the products, we made three main groups concerning the material flow. The first run type is the simplest, there is one tool in each press, the sheets are moving forward, Figure2.
P1 to P3 identifies the presses, R1 to R4 marks the robots.

In case of the second run type there are two tools in the third press, the other presses are working with only one tool. This means, that the fourth robot has to serve two operations, it is equipped with a special part holder for two parts at one time. This double manipulation had to be modelled in our case, Figure 3.
In case of the third run type there are two tools in each presses. This means a double operation for the last two robots, and a very complicated manipulation method for the second robot, which has in this matter four tools to serve. The material flow is shown by Figure 4.

3 STRUCTURE OF THE SIMULATION MODEL

3.1 Easy run

The elements of the simulation for the easy run process are single process elements from Plantsimulation. These working elements are bonded

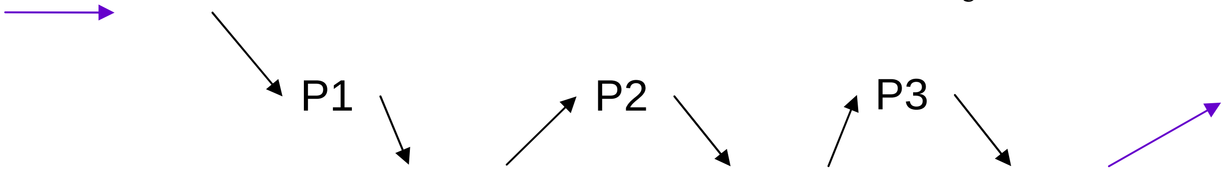


Fig. 2 Easy run

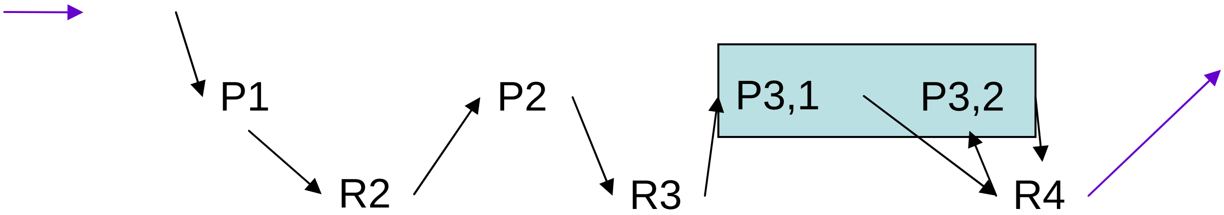


Fig. 3 Double flow

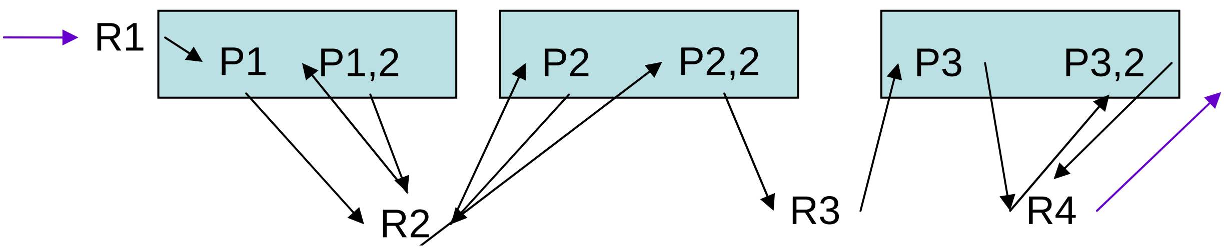


Fig. 4 Quattro flow

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in series, just like the elements on Figure 2.

3.2 Double handling on the last press

The double handling method of the last robot is shown in Figure 5 and 6. Figure 5 shows the second level of the modelling structure of Robot 4. The R2For4OP box serves the processing of the concerned moving unit types. The other way is for the simple processing.

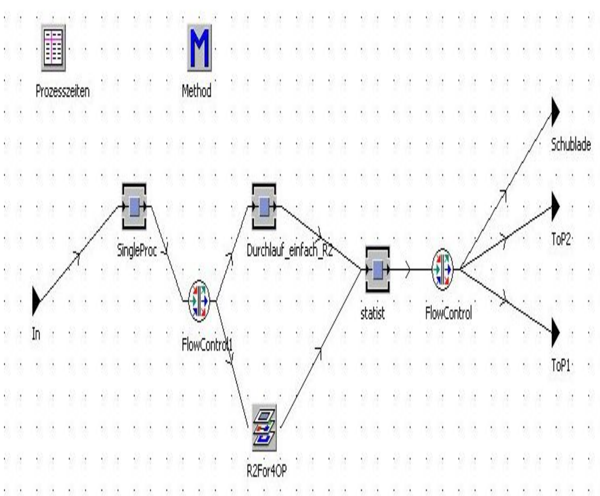

Fig. 5 R4 third level

Figure 6 shows the structure of the third level, where the double processing of the parts happens. The two single processes From30 and From40 are taking the parts from press 3, and after a processing time they forward them to press 3 or to the final table. The processing times and the forwarding routes are controlled by methods – programmed rules, the way of programming is shown in the next section.

3.3 Double handling on each press – special P1 P2 and R2

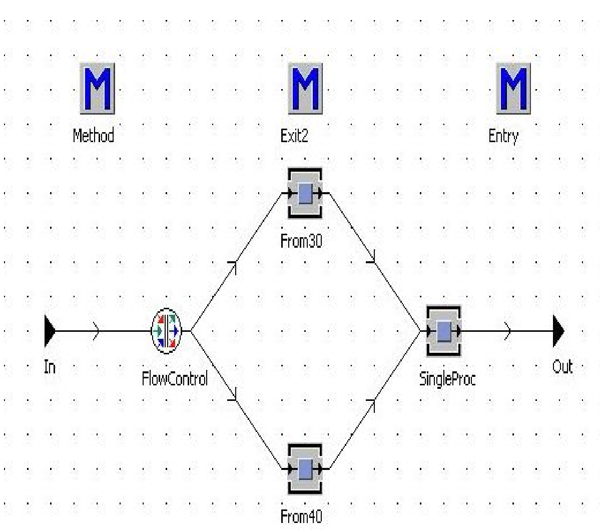

Fig. 6 R4 second level

The double handling on each press is a complicated material flow, because the robot 2 between P1 and P2 serves four tools. The movement of the parts is shown in Figure 4, but the simulation model had to be completed for the filling up of the line, which means different rules for the single processing. The presses are manufacturing two pieces at one time, so this had to be modelled. Figure 9 shows the structure of this material flow process on P1.

4 USED METHODS AND PROGRAMMING DIFFICULTIES

After the building the material flow structure, we had to make sure, that the processing of the parts follows the rules of the reality. This needed programming work. The programmed functions are handling the routing of the moving parts, delay, setting up, and failure rates. The programming enables to make simulation runs and evaluate them while running, and after running as well for different aims. Store handling is going with methods, and the lot size setting as well. The programming enables to pause the simulation run to observe the status of parameters at a given time or after a number of manufactured parts. The difficulty of the programming is, that the parameters of the fix elements has to be modified from different places. In case of the double processing in P1 and P2, the elements of P2 are changing the status of the elements of R2 and P1, and P1 has to modify the parameters of P2 and R2 as well. In the following a few example will be shown.

4.1 Failures

The failure handling needs statistical parameter settings or availability rates. For example on Figure 7 the statistical failure handling is shown, where the parameters are depending on the part type.

```
x:=@.name;
inspect @.name
   when "        " then
      .models.v5.presse1.durchlauf_einfach.failinterval.type:="Gamma";
      .models.v5.presse1.durchlauf_einfach.failinterval.stream:=2.63;
      .models.v5.presse1.durchlauf_einfach.failinterval.alpha:=2.6;
      .models.v5.presse1.durchlauf_einfach.failinterval.beta:=19.1;
      .models.v5.presse1.durchlauf_einfach.failstart := 20.00;
      .models.v5.presse1.durchlauf_einfach.failstop:=0.0;
      .models.v5.presse1.durchlauf_einfach.failduration:=380.0;
```

Fig. 7 Method for failure

4.2 Statistics

The simulation program collects several information while running. These statistical numbers can be shown while the simulation, and can be analysed after the run. For example the capacity of the line can be calculated after the system has been simulated on a long time distance with settings for the individual elements. Figure 8 shows the statistical table of a single element, the working, waiting, blocked and failed rates can be analysed detailed too. Several other parameter can be collected in a simulation, and calculated together. Methods must be used to reach the collected data, which is not contained by the statistical table.

Portions of the States of the Statistics Collection Period

Object	Working	Waiting	Blocked	Failed
Durchlauf_einfach_P3	38.25%	49.88%	11.87%	0.00%

Working Time Statistics

Object	Portion	Frequency	Sum	Mean Value
Durchlauf_einfach_P3	38.25%	11	5:19.0000	29.0000

Blocked Time Statistics

Object	Portion	Frequency	Sum	Mean Value	Standard Deviation
Durchlauf_einfach_P3	11.87%	11	1:39.0000	9.0000	14.2408

Fig 8. Statistical example

5 SUMMARY AND CONCLUSIONS

In this work the simulation of a material flow has been concerned. The introduction gave a short picture of the rules of simulation. The Tecnomatix software group was presented, and the used Plantsimulation software has been detailed. The low batch size press line layout and the production system was shown. After presenting the real manufacturing system, the modelled structures were detailed, the difficulties of the material flow controlling has been shown.

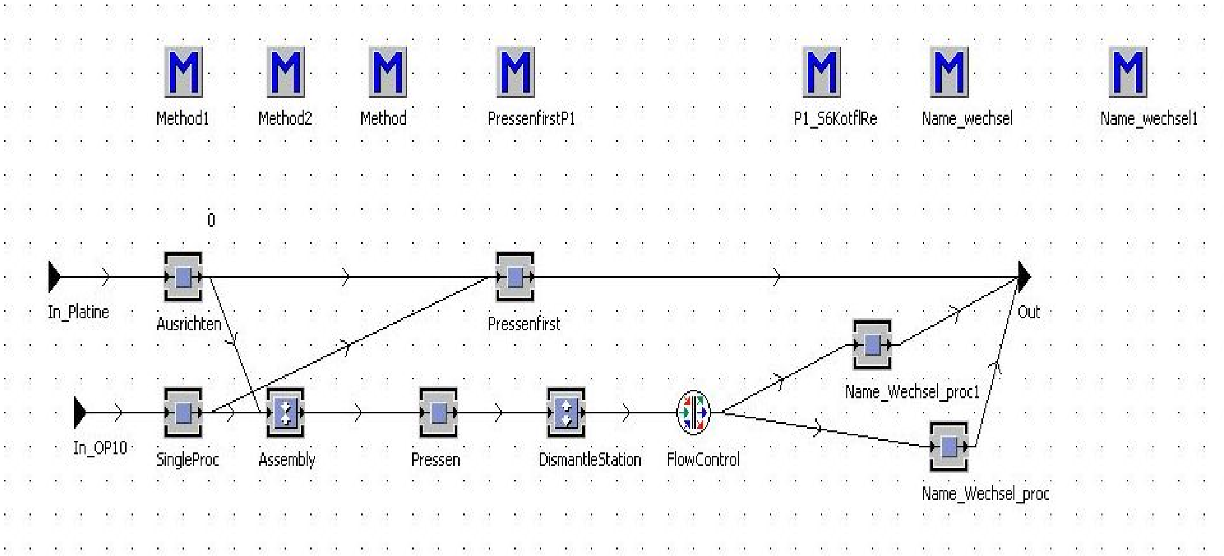

Fig. 9 P1 double processing system

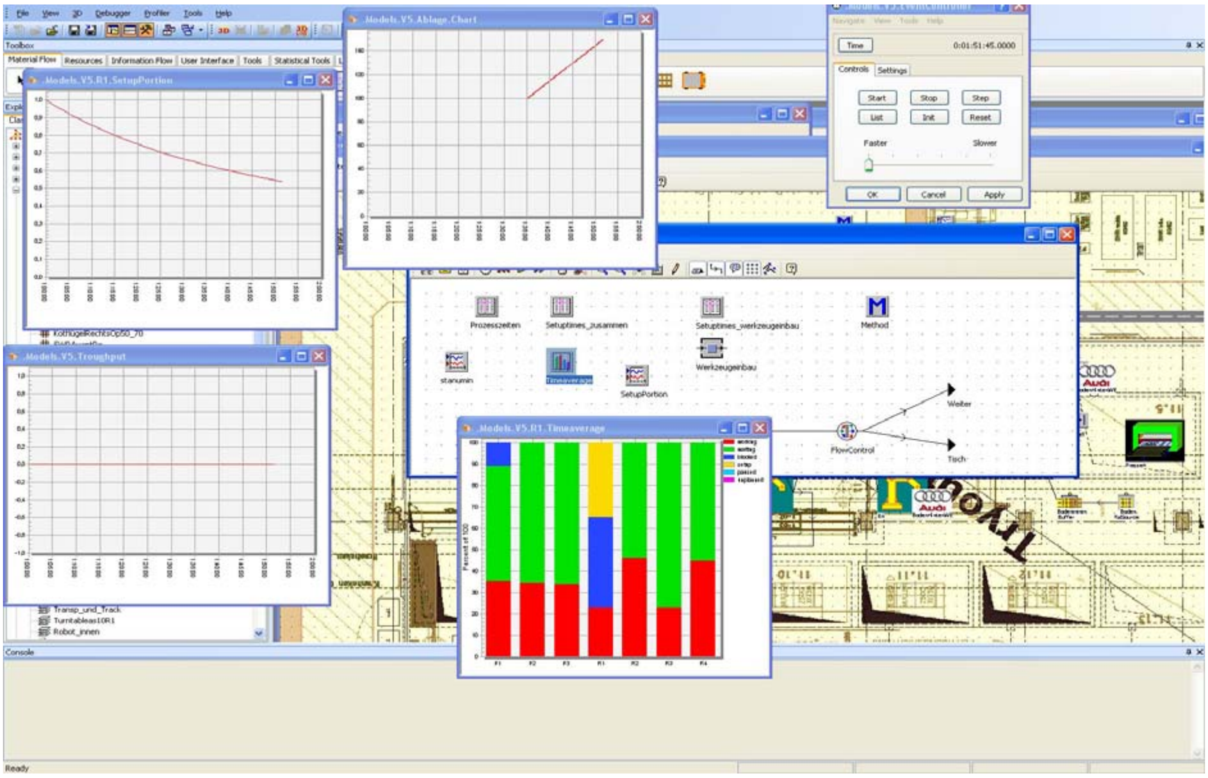

Fig. 10 Model and runs

The paper gave a possible solving possibility to handle such difficulties in sheet metal handling during the pressing processes. The structure of the production system has been reproduced. The movement of the workpieces in the simulation follows the reality, this needed the programming of the structure. The aim of the simulation was to analyse the behaviour of the system. For analysing there are statistical methods these were shown in this paper. There is a possibility to increase the number of presses by adding plus one press to the line. The simulation shows, that the capacity of the line could be increased by nearly 25 Percent.

There is a possibility to automatise the analysis, and make several simulation runs after each other without a need of manual resetting the simulation model. This could be a further step, to enable the model to modify it's parameters after one run, and rerun the simulation again.

6 References

[1] Wolfgang Kühn: Digitale Fabrik, Fabriksimulation für Produktionsplaner. *Carl Hanser Verlag München Wien, 2006.*

[2] UGS: Plant Simulation, Step-by-Step Help, *UGS Corp. Tecnomatix Technologies Ltd., 2006.*

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