



## **SIMULATION IN FURNITURE INDUSTRY I.** *Producing Components*

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### **Abstract**

*The goal of this simulation is to introduce and realize a part of materialflow of an international furniture manufacturing company. This simulation was made with a special process-simulation software, called SIMUL8. With SIMUL8 we could simulate the whole process under real circumstances, and gave live values of specific parameters that had interest to the company. This opportunity helped the company to create its strategy to maximalize the transmission and to search the possiblle bottle-necks without taking any investment, or rearrange the workcenters effectively. © University of West Hungary.*

**Key words:** *flow simulation*

### **1. DATA ACQUISITION**

In general, we can say that the considerable part of companies in Hungary don't spend enough time and effort to collect proper data. However, it should be, because if the essential conditions are not real, the result won't be real of course. On the other hand, we have to mention, that in many cases the data acquisition needs special knowledge, that companies don't have, or it takes much time to collect data, and companies don't have enough (human) resource to accomplish the collection of data.

#### **1.1 Sampling of timber**

In this specific case, the collection of data has been performed by us, because of the reasons mentioned above. We examined about 600 pieces of boards (about 100 per each sample) within the collection period which took 4 days, because we wanted to collect data on not subsequent days that.

It was necessary to get proper samples to measure. If we had collected data for example in 3 days following one another it could have happened that the sample wouldn't have reflected enough variousness, and calculation wouldn't have been correct. Some of the processed data is shown in *Table 1*.

Table 1: Average  $[x, \bar{x}]$  and standard deviation  $[\sigma]$  of timber length [mm], timber width [mm] and timber thickness [mm]

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
$x, \bar{x}_L$	3233	2918	2665	2645	3449	3298
$\sigma_L$	110	95	45	40	39	39
$x, \bar{x}_W$	332	320	390	354	397	329
$\sigma_W$	53	78	16	48	74	63
$x, \bar{x}_T$	30	40	40	40	40	40
$\sigma_T$	0	0	0	0	0	0

## 1.2 Mapping of plant and machinery

The examination of plant and machinery is at least so important as the collection of the data of the timber. We have to examine throughput, the (human) resource needs, etc. In this case the examined machines were the following:

- Undertable cross-cut saw for comminuting the timber (See: *Figure 1a*)
- Rip saw for shaping the cross section (See: *Figure 1b*)
- Four-head planer for setting up the cross sectional dimensions (See: *Figure 1c*)
- Longitudinal buzz saw for setting up the longitudinal dimensions

By the machines it is although an important thing to determine what kind of products are produced by a given machine. It is essential, because these are one of the pillars of the simulation. Because of that, we determined the produced products of the machines, and also determined the producing priority of the products. It is unavoidable if we want to handle woodwaste recycling which is the a marginal concept of the simulation. The dimension preferences are shown in *Table 2*.






Table 2: Dimension preferences

Four-head planer					
Rank		Length			
1.		33			
Undertable cross-cut saw					
Rank		Length			
1.		1170			
2.		770			
3.		540			
Rip saw					
Length		Width			
Rank		1.			
1170		50			
Rank		1.	2.	3.	4.
770		75	40	32	25
Rank		1.			
540		54			

## 2. BUILDING THE SIMULATION

### 2.1 About SIMUL8

SIMUL8 is an integrated environment for working with simulation models. It enables you to create accurate, flexible and robust simulations quickly. It is a very felxible solution: parametrizable and programmable and insensitive of different kinds of input and output formats. It provides all of the essential simulation building blocks, including:

- Work Entry Points 
- Storage Bins 
- Work Centers 
- Work Exits Points 
- Workpiece 

and other indispensable features, like:

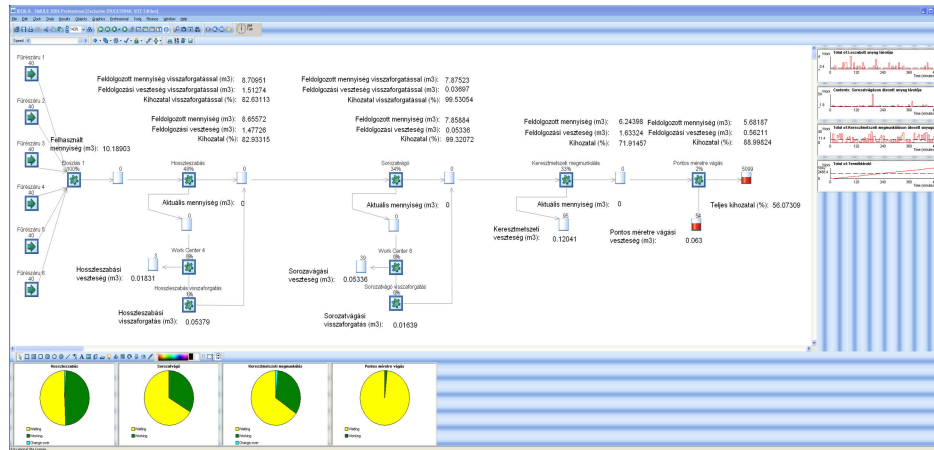
- Connectivity (SQL, XML, COM)
- OptQuest and Stat::Fit for optimization to low cost or high income
- Ability to share models with people who don't have SIMUL8 licenses
- Ability to merge simulations
- Virtual Reality, to represent the simulation in a realistic 3D environment
- Enhanced debugging tools, e.g. value hover tips in Visual Logic, Monitor spreadsheets at runtime.
- ABC Costing
- Speed Analyzers
- Additional objects

### 2.2 Applying sampled timber data

First step is applying sampled data on the simulation model. In this case, these values are in *Table 1*. On *Figure 2* the 'SIMUL8 creating distribution pop-up window' can be seen with the *Sample 1* values. This step guarantees, that SIMUL8 will generate boards, with dimensions specified in the distributions. (The generators of the boards are the Work Entry Points, which you can see on the left of *Figure 3*.)

Length	Width	Thickness
<p>Named distribution</p> <p>Sample 1 Length</p> <p>Sample Value: ?</p> <p>Average: 323.3</p> <p>Std Dev: 11</p> <p>Distribution: Normal</p> <p>Buttons: OK, Cancel, Help, Memo, New, Detail</p> <p>IF Pre-Sample Visual Logic</p>	<p>Named distribution</p> <p>Sample 1 Width</p> <p>Sample Value: ?</p> <p>Average: 33.2</p> <p>Std Dev: 5.3</p> <p>Distribution: Normal</p> <p>Buttons: OK, Cancel, Help, Memo, New, Detail</p> <p>IF Pre-Sample Visual Logic</p>	<p>Named distribution</p> <p>Sample 1 Thickness</p> <p>Sample Value: ?</p> <p>Fixed Value: 30</p> <p>Distribution: Fixed</p> <p>Buttons: OK, Cancel, Help, Memo, New, Detail</p> <p>IF Pre-Sample Visual Logic</p>

Figure 2: Applying *Sample 1* timber data on the simulation model

Figure 3: Simulation in the 8<sup>th</sup> hour

### 2.3 Creating specialized simulation objects

SIMUL8 has just a few types of objects to build a simulation, but it offers the opportunity to specialize any of them. It can be done by a simple, but powerful script language called *VisualLogic*. This assures, that every object can operate so, just like in reality.

For the least part of simulations, you just don't have to specialize objects, but as the job gets more complicated, it is unavoidable. SIMUL8 reckons everything in the simulation as an object. The objects can have different kinds of attributes of course and some of them (e.g. Work Centers) can handle events, too. It is very practical, because if you want to represent an attribute –like length, width, thickness– in the simulation, you just add these attributes as *Labels* to the Workpiece. From the time you've added these attributes, you can handle the workpiece through these attributes of course.

Table 3: Manageable events at Work Centers

Route In	Route Out	Attributes		
Before Selecting	After Loading Work	On Work Complete	Before Exit On Exit	If VisualLogic

Let's see the application of these on this concrete Rip saw example:

There is a 3 fork IF condition that examines the *length* label of the incoming workpiece, and depending on its length it completes the adequate job in 4 steps:

1. Gets a new width value, according to the set distribution (See: Table 2b)
2. Divide the incoming board, to the number of slat that the given width will reach
3. Set the outgoing number of slat on the work center
4. Set the new width label value on the newly created slat

```
VL SECTION: Width Route In After Logic
IF Length = 1170
  SET NewWidth = Width distribution 1
  SET Rip saw BatchOut = TRUNC[(Width*10)/NewWidth]
  SET Rip saw.Batching Out Size = Rip saw BatchOut
  SET Width = NewWidth
```



```

ELSE IF Length = 770
    SET NewWidth = Width distribution 2
    SET Rip saw BatchOut = TRUNC[(Width*10)/NewWidth]
    SET Rip saw.Batching Out Size = Rip saw BatchOut
    SET Width = NewWidth
ELSE IF Length = 540
    SET NewWidth = Width distribution 3
    SET Rip saw BatchOut = TRUNC[(Width*10)/NewWidth]
    SET Rip saw.Batching Out Size = Rip saw BatchOut
    SET Width = NewWidth

```

The recycling routine is also simple. If the incoming workpiece has dimension or quality defects normally it would be dropped. But in order to decrease the loss, you have to examine what happens, if you cut these workpieces not to its nominal dimension but to a smaller dimension. In case of smaller dimensions they will be faultless so, it is worth to cut them to the smaller dimension. Choosing the proper dimension is simple: you have to choose the greatest dimension among the smaller than the nominal dimension. If it fits, the workpiece can be used for further processing. If it doesn't fit, you have to try with a smaller dimension. If the smallest dimension doesn't fit, then the workpiece should be really dropped.

```

VL SECTION: Recycling Route In After Logic
IF Length = 770
    IF Width = 80
        SET Width = 46
    ELSE IF Width = 46
        SET Width = 40
    ELSE IF Width = 40
        SET Width = 33

```

### 3. RESULTS, EVALUTION

As we mentioned before, base data are always one of the most important parts of a simulation. If the base data aren't accurate the result won't be accurate either. In spite of that, simulations give the ability to take examinations without having to take any investment, or rearrange the technology. With SIMUL8 it is possible to create very detailed customized reports. *Table 4.* shows the report of this simulation. It consists of 3 cases, the *worst case*, the *actual case*, and the *ideal case*. In worst case we supposed that the company buys relatively bad quality timber. This indicates that the utilization of the machines is high, but the yield is low because of the high loss of timber. In the actual case we applied the actual state in what we used the values we sampled. In ideal case we supposed that the company buys good quality timber. It can be seen clearly from the results, that the yield is very high, while the loss of wood is very low.

Now, having the results of the 3 cases (worst, optimal, ideal), the company has the opportunity to decide what type of buying policy should be followed.

### REFERENCES

Ma.Sc. Jaret W. Hauge –Ph.D. Kerrie N. Paige: Learning SIMUL8: *The Complete Guide*. 2<sup>nd</sup> edition. 2004, Plain Vu Publishers.