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INTRODUCTION TO SIMFACTORY II.5

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ABSTRACT

This paper provides a brief introduction to SIMFACTORY II.5 and explains how models can be developed without programming. The type of users who benefit most from SIMFACTORY II.5, the types of systems SIMFACTORY II.5 can model, and the various implementations of SIMFACTORY II.5 are also described.

1 INTRODUCTION

SIMFACTORY II.5 is a factory simulator written in SIMSCRIPT II.5 that provides its user with the ability to quickly model factories without programming. This capability is made possible with a mouse driven graphical user interface that enables the user to build a graphical representation of his factory. This paper describes who should use SIMFACTORY, the types of systems SIMFACTORY can model, and how a model is constructed.

2 WHO SHOULD USE SIMFACTORY II.5?

SIMFACTORY II.5 has been written for engineers whose other duties make it impossible for them to work on a simulation full time. Usually, this is because they have many other non- simulation tasks to perform and yet find a need for simulation in their work. In many cases these engineers will do without simulation altogether rather than use a programming language. However, there are often times when experienced simulation users require a model in less time than is possible with a language. In either case, ease of use and rapid production of working models are extremely important. That is what SIMFACTORY is designed to provide.

3 WHAT CAN SIMFACTORY MODEL?

As the name SIMFACTORY indicates, SIMFACTORY is used to model systems that act like factories. Most of the time this refers to manufacturing operations. However, many systems have been modeled with SIMFACTORY that are outside the manufacturing sector and yet have much in common with factories. For example, an insurance company wanting to know how many people were necessary to handle incoming phone calls modeled their operation with SIMFACTORY. This was possible because their operation was basically a factory that processed incoming calls. Others have used SIMFACTORY to model the flow of paperwork, viewing an office as a factory that processed paper.

4 HOW IS A MODEL DEVELOPED?

Modelling with SIMFACTORY is most successful when it is performed in an iterative manner, starting with a fairly simple and therefore manageable representation of the factory. After the initial model is developed and working it is saved and copied. The copy is then enhanced until it reaches the next milestone in the development of the model. Again the model is saved and a copy is made for further refinement. This process is repeated until the last milestone in the model is reached.

In SIMFACTORY we call the first simplified model of the factory the basic model. A basic SIMFACTORY model represents only the stations, queues and transportation paths that exist on the factory floor. Transporters and conveyors are ignored. Even though many products may be made in the factory only two or three are included in the model at this time. Any information about shifts, equipment failures, tooling, and transporters is not entered until later. The objective is to create a working model that can be progressively refined until the desired level of detail has been reached.

The basic model is built by first defining the factory layout, then the products produced by the factory, and finally, by setting the run options indicating the run length, number of replications and so on. The complete process is explained in the following paragraphs.

5 DEFINE THE LAYOUT

The layout consists of processing stations, buffers (queues), receiving areas, and transportation paths. It is created by selecting and positioning icons that represent these components. As each icon is positioned the data that describes its characteristics (name, capacity, setup time, etc.) are entered. Of course, editing capabilities such as copying, moving, or deleting icons are available for making changes at a later time. After the icons are positioned and described, the transportation paths that connect one icon to the next are drawn. Figure 1 show a layout of a simple gear finishing line.

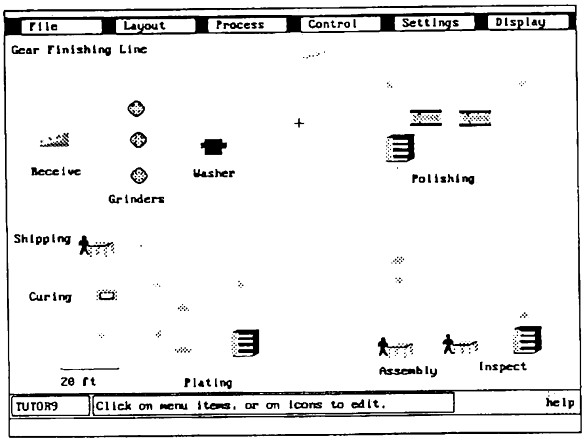

Figure 1: Layout of a Factory

6 PROCESSING STATIONS

Stations represent anything that processes or changes a part in some way. These could be machines such as lathes and mills or perhaps an inspection area where an inspector visually examines the parts. In SIMFACTORY stations are described in terms of the operations they perform. The part remains in the station for the amount of time called out in the Process Plans. (The plans are explained later in this article.) After processing, the part will be sent downstream for further work. However, if none of the downstream stations or queues are able to accept the part it will remain in the processing station until a station or queue becomes available. Three types of processing stations are available: Normal, Chamber and Batch.

A Normal Station may perform any number of single operations on a part and then sends the part downstream. When the Normal Station is busy it will not accept any more work until it has finished processing and unloaded the current part(s).

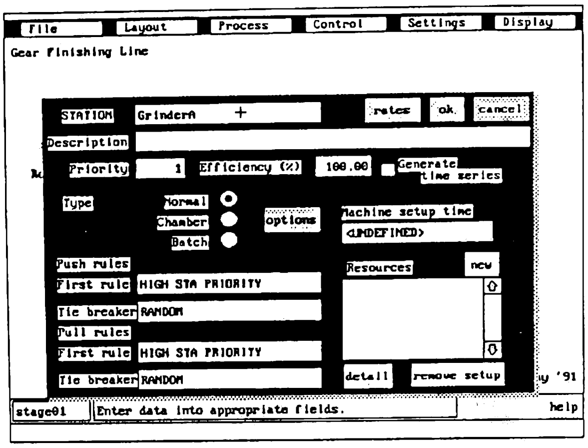

Figure 2: Editing a Station Description

Chamber Stations differ from Normal Stations in that they may accept additional parts even after they have already started working on other parts. The limiting factor on a Chamber Station is its capacity, which is the maximum number of parts that may be in the Chamber at one time.

6.1 Buffers

Buffers are simply areas where parts wait before the next operation is performed. Parts may accumulate in the queue until its capacity has been reached. At that time no more parts may enter the queue until it unloads some parts.

6.2 Receiving Areas

New work that is entering the factory enters in Receiving Areas. Work may be scheduled by assigning a quantity of parts to arrive periodically or by using a schedule to specify the exact time of arrival.

6.3 Transportation Paths

Another component of the factory layout is the transportation paths, which indicate the path from one station to the next and which buffer(s) feeds which station(s).

7 DEFINE THE PRODUCTS

In SIMFACTORY the steps necessary to make a product are defined in the Process Plans in terms of the operations necessary to produce the product. Process Plans determine what operations are performed on the part, the duration of each operation, and the order in which the operations are to be performed. Assemblies, disassemblies, and branching (such as occurs at an inspection station where the part passes part of the time and fails part of the time) are all shown in the Process Plans. This approach also makes it possible to show multiple products in production on the same production line. In fact, each product may have its own unique set of processing times. Rework loops are easily constructed even if different processing times are used on the second pass through the line.

A process plan consists of three lists: a list of input parts to the plan, a list of operations performed on the parts, and a list of output parts produced by the plan. The input parts may either be raw materials or work-in-process produced by another plan. The operations list references the operations performed by the stations on the factory floor. This list of operations combined with the information on the factory floor tells SIMFACTORY how to route the parts through the factory. The output parts may be finished goods, scrap, or work-in-process.

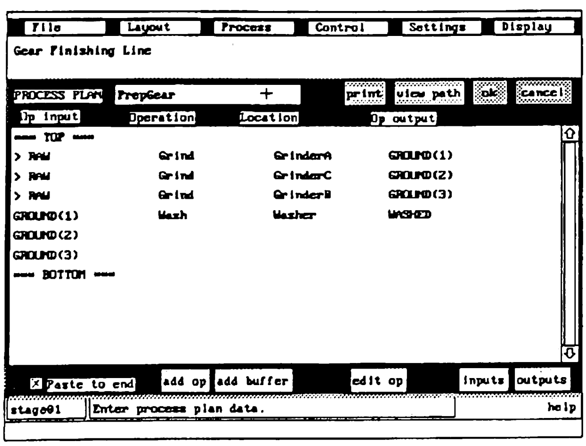

Figure 3: Editing a Process Plan

8 RUN THE BASIC MODEL

The last step in building the basic model is to set the length of the run, the number of runs to make, the length of the warm-up period, and the reports that will be generated by the model.

At this point the basic model is fully defined and should be run. Obviously the output is not yet what is needed for analysis and decision making, but the output should be checked to see if this version of the model seems to be working properly.

9 DEFINE ADDITIONAL PRODUCTS

After the basic model is working the first refinement that should be made is to define additional products. If a large number of products are being modeled then they should be defined two or three at a time. Then when the model works properly with the newly defined products move on and add more.

10 DEFINE RESOURCES

In SIMFACTORY the term resources refers to anything that is necessary to carry out an operation at a processing station. For example, a resource could be some tooling or a specially skilled operator.

Resources are added to the basic model in two steps. In the first step the resource is defined and the quantity available at the start of the run is set. In the second step each station requiring resources is defined. This is done by indicating what resource (or resources) is required by the station and the quantity required.

11 DEFINE THE TRANSPORTERS

SIMFACTORY transporters may either be batch transporters such as forklifts, or conveyors. To define a transporter you first position the transporter in the layout and then define the characteristics of the transporter. The important characteristics of a batch transporter are its pickup speed, delivery speed, load time, unload time, and capacity. A conveyor has a speed and capacity. In both cases the paths the transporter and conveyors must also be defined. This is done by indicating which paths comprise the transportation zone of the transporter and conveyor.

12 DEFINE THE INTERRUPTIONS

Interruptions are any activity that interferes with the operation of a station or transporter. The two most common examples are equipment failures and preventive maintenance. In SIMFACTORY we would say the failure is a priority interruption because it takes priority over anything else the station could be doing. Preventive maintenance will only occur when the station is between operations.

Other characteristics of interruptions that can be specified are the mean time between interruptions, the type of interruption clock, and the mean time to resume. The mean time between interruptions is the time from one interruption to the next. This can be calculated from the end of one interruption to the end of the next, or it could be the time between interruptions, or it can be based on the calendar time, or the operating time of the station or transporter being interrupted. The mean time to resume specifies the duration of the interruption.

13 WHAT REPORTS ARE AVAILABLE?

During the simulation traces and snapshot reports are available to track the progress of the simulation. Traces provide detailed information about each event as it occurs in the model. This will include events such as the arrival of raw materials, the start of an interruption, the completion of a final product and so on. Snapshots provide a picture of the model at specific point in time.

After the simulation, reports are available that summarize how the model performed. Information on such things as equipment utilization, throughput, product makespan and queue utilization is available. Each run (or replication) is summarized in a set of reports. A summary report of all the runs provides means, standard deviations and confidence intervals on the model output.

SFII 5 (v3.10) MAN1 Summary Part Status Report 19:29
(Data collected for 10000.0 MINUTES in 5 replications)
Degree of Confidence - 95.0%

Raw Material

Part Name	Statistic	Number Consumed
Raw	Mean	914 20
	Std. Dev.	24.14
	Lower C.I.	891 18
	Upper C.I.	937 22

Final Products

Part Name	Statistic	Number Made	--- Product Make Span ---- Minimum	Average	Maximum
GearSet	Mean	213.80	152 73	213 69	287 83
	Std Dev	6 42		1 98	
	Lower C.I	207 68		211 79	
	Upper C.I	219.92		215 58	

Work In Process

Part Name	Statistic	--- Status (%) -- Busy	Idle	Move	Number Completed
Cured	Mean	73.4	26 6	0 0	213 8
	Std Dev.	0 5	0 5	0 0	6 4
	Lower C.I	73 0	26 1	0 0	207 7
	Upper C I	73 9	27 0	0 0	219 9

Node/Operation/Part Flow

Name	Operation	Input Part	Count	Output Part	Count
Curing	Cure	Plated	36 40	Cured	37 40
Shipping	Ship	Cured	213 60	GearSet	213 80
Washer	Wash	Ground	460 60	Washd	460 40
PolishQ		Washd	914 00	Washd	914 00

Figure 4: Summary Report from a Simulation

14 HOW IS THE ANIMATION PREPARED?

The animation of the factory automatically follows from the description of the model. In other works, there are no extra steps to prepare the animation. However, animation can be improved by creating custom icons in the Icon Editor.

15 IMPLEMENTATION OF SIMFACTORY II.5

SIMFACTORY is available on the following computers: IBM PC AT's and compatibles (under DOS, Microsoft Windows and OS/2), IBM PS/2's, HP 9000 Series 300 and 800, the Sun 3 and the Sun 4. The look of SIMFACTORY on each of these machines is consistent, as are the data files. Users will have little trouble working on the different implementations and moving data from one machine to the other.

16 SUMMARY

SIMFACTORY's graphical representation of the factory together with sound modelling practices make SIMFACTORY the ideal tool for rapid model development. It should be seriously considered by anyone who is short on time but who requires a model for their analysis or presentation.

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AUTHOR BIOGRAPHY

JOHN GOBLE heads the SIMFACTORY II.5 development team. He has experience teaching and consulting with manufacturing engineers.