

SIMAN Simulation of Assembly Operations in a Furniture Company

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There is an emerging need in many workshops in Hungary to change the traditional manual control to computer based control or - at least - supervisor system according to the newest results of mechatronics. The main problem of these projects is that the production information (including data and control rules) are not defined precisely. To evaluate such workshops the simulation is a useful tool in many cases. The paper gives a short overview of the SIMAN simulation tool and describes also a general method to model and code the assembly operations within the SIMAN. This method has the feature that there is no process plan information in the simulation model. Finally a case study closes the paper dealing with a real workshop in a Hungarian company (Zala Furniture Co.).

1. INTRODUCTION

The new production methods and the strong marketing conditions have caused in many companies severe problems also in Hungary and also in the near region. Those which have chances to solve these problems should change their management methods in all fields of the company. After implementing new financing and marketing strategies they realise that they should start the modernisation of the production itself. It requires more resources (financial and man-power also) and may cause a new view about their traditional working habits. The weak points of the production should be recovered while cheap and easy to implement solutions ought to be found.

Modelling with simulation has become an extremely important approach to analyse complex systems. It gives a tool to model the system and evaluate it with real or artificial situations. Animation became a minimal requirement for the present-day simulators. It must be mentioned that in recent years a great number of people using simulation together with artificial intelligence methods getting a good problem-solving aid [3].

As the automation of assembly operations was getting into the focus, its simulation should be managed as well. Many of the well known and world-wide accepted simulation tools have only limited resources when assembly operations are involved.

The users typically prefer a verified model with easy modification facilities of as many parameters as possible without changing the model itself. They need a clear separation of the model for a constant part and a variable data part.

2. SIMULATION USING SIMAN

SIMAN [1] is a world-wide accepted simulation tool for manufacturing problems. Conference proceedings (one of them [2]) show that nearly 30 percent of the manufacturing simulation projects are using SIMAN [2]. SIMAN is a traditional simulation environment with many built-in capabilities dedicated to the manufacturing processes. E.g. it has a very good tool for managing the different types of transport systems.

Working with SIMAN the user should generate different files about the problem, then compile and link them. Running the linked simulation program there are possibilities for the on-line communication of a C interface. Finally the SIMAN can run its output processor to postprocess the results of the simulation. If the user has any intentions for modification in the problem domain he/she should repeat those steps.

SIMAN has entities that represent workpieces. The simulation means that the entities are going from stations to stations according to their process plans. The steps they have to undergo within a given station are the main parts of the model built-up.

2.1 Definition of a problem in SIMAN

The description of the simulated problem in SIMAN can be given by the following three files:

- * The Model Frame describes the model of the simulated system, so it should be independent from the actual process plans and orders.

- * The Experimental Frame defines the environment of the simulation, plenty of statements of the model (layouts, stations, entity attributes, logical queues etc.).

* Graphical Layout with mappings to the special statements of the model to support on-line animation during the simulation run. (It is called Cinema, an extension of the SIMAN).

SIMAN can be divided also logically into two parts: one of them describes the general part of the simulated problem (the layout, the permanent experimental statements and the model itself); the other gives the actual problem domain of the simulated model (e.g. process plans, orders, quality and timing requirements).

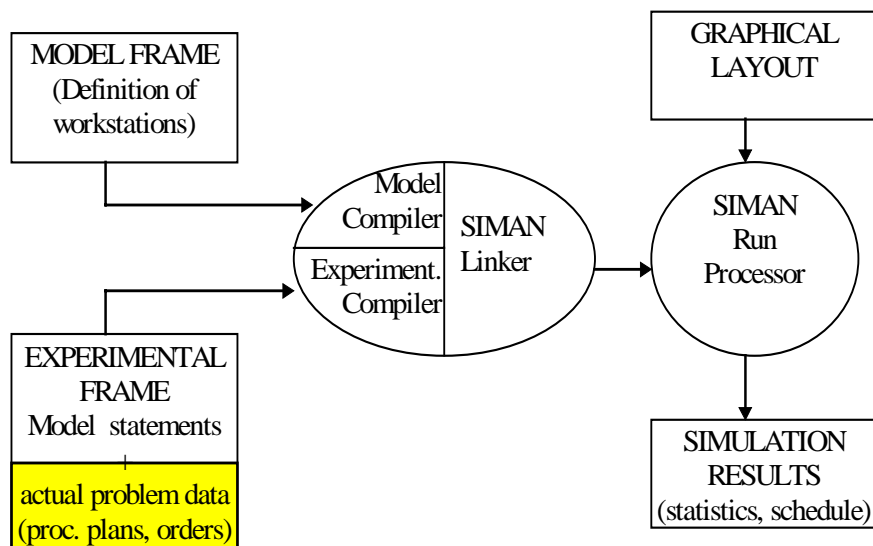


Figure 1. Structure of the SIMAN simulation tool

These actual data are special parts of the experimental frames. It can be organised to define them in independent files and just include them into the basic Experimental Frame. Two include files are suggested: process plans file (SEQUENCES statements in SIMAN) and orders file (ARRIVALS statement). It gives a clear structure about the constant and temporal parts of a given simulated problem. Using these features more user-friendly and automatic tools can be developed to define the temporal parts of the SIMAN frames [4].

3. SIMULATION OF ASSEMBLY OPERATIONS

SIMAN supports modelling of assembly operation with the MATCH and COMBINE statements of the Model Frame. The simulator builder should define as many queues as many different type of workpieces exist in the given assembly operation. The main disadvantage of this method is if more than one different assembly operations are in

a workstation, each of them should code independently in the model of the workstation. It causes a strongly process plan dependent model of the workstation. If any of the assembly operations have some changes or a new one must be included, then the model of the workstation should be modified defining new queues, COMBINE statements etc. The model of the workstation will be very complicated because of the plenty condition examinations and jumps and on the other hand, it hides the real behaviour of the workstation.

The suggested method lifts the process plan depending parts out of the Model Frame. Another file is defined whose syntax is also like the Model Frame, but the only aim of it is to describe the assembly operation independently from the model. Four additional attributes (Appendix A) belonging to the workpieces were introduced to be able to describe the assembly operations.

The method is the following:

1. If there are any assembly operation in a station than there is a jump out of the station model to the assembly manager model frame (Appendix C).

2. Then there is a big switch (BRANCH statement) to select identical queue for one workpiece of one assembly operation (Appendix D).

3. After that in the queue the workpieces are collected only if more than one is necessary in the given type in the given assembly operation (Appendix D). (e.g. if two doors are required for a wardrobe then the assembly operation can be started if both of them have arrived.)

4. Using a MATCH statement the different type of workpieces of a given assembly operation are collected (Appendix D).

5. If all of the pieces have arrived then returning back to the main Model Frame the assembly operation is performed (Appendix C).

The introduction of the independent description of the assembly operation allows the easy even automatic modification of the process plans of the workshop.

Appendixes give some more detailed information about the coding technique. Appendix A and B show parts of the Experimental frame, C and D are from the Model Frame. A and C are the constant parts, B and D are the part of the changing data (process plan and assembly functionality).

4. A CASE STUDY ON A WORKSHOP OF ZALA FURNITURE CO.

The previously described solution was applied in a project that was dealing with the simulation of a workshop of one of the biggest Hungarian furniture company (Zala Furniture Corporation). The whole production is managed in different workshops that are rather independent. Each workshop is responsible for special types of furniture, so the material flow is rather low among the workshops.

In our case study the so-called 'Body' Workshop was selected where different sets of wardrobes are produced. 3 different families (named Roland, Richard and Zala Prizma) of wardrobes were chosen from about 10 to built up the simulation environment. It did not cause a big error because they often work for days with limited number of wardrobe families, so the experts of the company were able to analyse the simulation results of the reduced set.

4.1 The resources of the workshop

The 'Body' Workshop consists of some workstations that are mainly logically separated manual workplaces with one or few dedicated functions. They are the following (Figure 2. shows a picture of the animation layout):

1. sheet cutting station (HOLZMA)
2. sheet manufacturing line (HOMAG)
3. mounting workplace (manual)
4. sheet cutting workplace (manual)
5. surface treatment station (ERNST EG2/L)
6. preparatory workplace (manual)
7. gluer, presser & equaliser (WEMHÖNER)
8. special manual machines (e.g. drills)
9. body preparatory workplace (manual)
10. front side assembly workplace (manual)
11. body presser
12. final assembly workplace (manual)
13. packing workplace (manual)

In the 'Body' Workshop there are also 14 different storage places (T1 -T14 in Fig. 2). They are just free places but the workers of the workshop generally use all of them for dedicated purposes, as pre- or post storage of certain operations. In the simulation model this feature was strongly used. E.g. T1 is the post-storage of the HOLZMA sheet cutting station. The capacity of the storage places are big enough so in the simulation model they can be calculated as infinite capacity.

Some operations of the 3 selected wardrobe families are performed in an other workshop called 'TMW' (Timber Manufacturing Workshop). In the simulation model all the operations in 'TMW' are handled in common one as a 14th logical workstation. It causes a little but negligible error in the model. ('TMW' logical station can be seen in the layout (Fig. 2.) as a little triangle at the right bottom of the picture.)

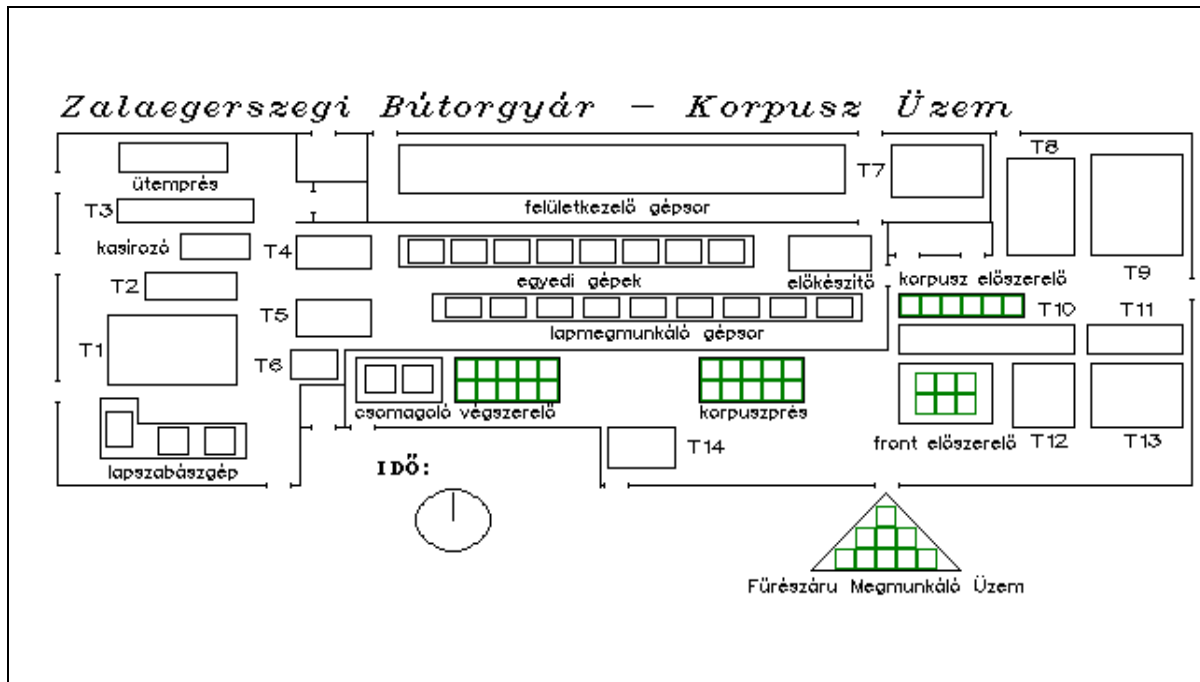


Figure 2: Layout of the simulation of the Body Workshop in the Zala Furniture

After special operations (e.g. 5, 7, 11) a waiting time is required. This case was handled within the simulation as a simple operation at a storage place with the necessary long operation time.

The transportation is solved by manual trolleys and the times for transportation could also be neglected. An average transporting time was used in the model. Its value can be set by the user to examine the effect of this parameter to the general behaviour of the workshop.

4.2 The products

The 3 selected furniture families mean 16 different types of pieces with more than 100 different parts and 6-10 parts belonging to each set. Some parts can be used in more

(typically 2) elements within one family. So they are not separated in advance but just before they are built into the body.

Roland furniture has five pieces:

- * 3/4 upper element with door,
- * deep wardrobe,
- * double doors element with bottom drawers,
- * half element for records,
- * glass doors element with bottom drawers.

Richard consists of four different pieces:

- * bottom commode,
- * double wardrobe,
- * bottom wardrobe with titled body,
- * upper wardrobe with titled body.

And Zala Prizma has seven elements:

- * 3/4 element with shelves,
- * bottom element with single door,
- * bottom deep element with single door,
- * bar commode,
- * half element for records,
- * shelf with pillar,
- * big wardrobe with titled body,
- * wardrobe with glass doors.

Each piece of the family was produced and offered together, but it was a requirement to handle them independently.

So-called technological plans were used in the workshop that described the operations and their parameters (e.g. where to drill a hole). They were developed manually with many undefined phases for a non-expert reader. From this raw data source one had to build up the real process plans during the model building. The validation of such process plans required two repeated checks with the technology experts of the company.

There were serious problems with the timing of the operations. The company had no information about them earlier. Some timing data could be calculated (e.g. HOMAG, WEMHÖNER), while had to be estimated.

4.3 The control of the workshop

There were only 'soft control rules' in the workshop. They had a plan for a month ahead what to produce and in which quantity. One day there was allocated for one operation in this plan. It means that if an operation was finished, the next operation of the given part should be done the following day. It is a very bad algorithm in the sense of the

throughput time. So the deadlines were kept with a backward calculation: 'As many operations a given part must have, that as many days earlier it should be started'.

This method was working rather good in the past, when they could plan the production for a year and schedule according this without disturbances. Because of the new marketing conditions they had less and less fixed orders for months or a year ahead and more and more unexpected orders within 1-2 weeks to fulfil.

Two versions of the simulation were developed. One was working as the real production, and the other with a simple FIFO scheduling strategy without unnecessary waiting times. Via the simulation the effects of the unexpected orders can be analysed rather well.

5. CONCLUSIONS

In the paper a special solution was presented to manage assembly operations in SIMAN simulation. The method allows to separate the constant and temporal parts of the simulated model. It causes a little redundancy in the SIMAN Model Frame, but it has extremely importance when the simulation is embedded and an automatic creation of orders and process plans are required.

In the case study the main experience was to get minimal information about the production flow if it is being controlled by such 'soft rules' with plenty of hidden knowledge of technologists and workshop workers. Building up a 'relatively' real simulation model of the workshop was difficult job. The result of the simulation proved clearly for the management of the company that simple, but well designed shop-floor control would increase the robustness and decrease the throughput time very much. Unfortunately the financial resources are still missing to enable the company to invest in this direction..

6. ACKNOWLEDGEMENTS

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7. REFERENCES

nase:	IF,assem_cd==0,X_fi	SZERE_VE	ELSE,NOSZE_VE; QUEUE, finalassem_Q3; COMBINE: all_num,FIRST; BRANCH, 1:
X_finase	ELSE,X_szere; QUEUE, finalassem_Q1; GROUP: n_all_type,FIRST; DELAY: transport_time; QUEUE, finalassem_Q2; SEIZE: finalassem_R; ASSIGN: all_num=SAG(6); BRANCH, 1	,NEUJ_VE: UJTIP_VE	IF,wp_type==nxt_typ ELSE,UJTIP_VE; ASSIGN: wp_type=nxt_typ: NS=wp_type: IS=0:
BRNCH_VE	IF,NG>1,SPLIT_VE:	NEUJ_VE	MARK(living_tim); ASSIGN: assem_cd=0: n_all_type=1: n_pieces=1:
SPLIT_VE	ELSE,NOSPL_VE; SPLIT: op_time,all_num: NEXT(BRNCH_VE)		all_num=1; DELAY: op_time/2,finalassem
; NOSPL_VE	DELAY: op_time/2,finalassem	NOSZE_VE	RELEASE: finalassem_R; ROUTE: atl_szall;
_CS;	BRANCH, 1:	_CS;	
E_VE:	IF,all_num>1,SZER		

APPENDIX D

Some parts of the model frame are shown where the process plan dependent parts are coded because of the assembly operation. First there is a selection among the workpieces (BRANCH), then the given one goes to its queue belonging to the given assembly (BRANCH, QUEUE, GROUP) and finally the different types are waiting for each other (MATCH):

BEGIN;			
X_szere	BRANCH, 1:		DISPOSE; no
	IF,assem_cd==8,le8:	good assem_cd le8	BRANCH, 1:
	IF,assem_cd==9,le9:		IF,n_pieces>1,lg8:
	ELSE,le0;		ELSE,lng8;
;-----		lg8	QUEUE, 308;
le0	DELAY: :		

	GROUP:	lng9	QUEUE,
	n_pieces,FIRST;		109:
lng8	QUEUE,		DETACH;
	108:	;-----	
	DETACH;	MATCH:	lng8,X_finase:
le9	BRANCH, 1:		lng9,X_finase;
	IF,n_pieces>1,lg9:	MATCH:	lng10,X_bodymk:
	ELSE,lng9;		lng11,X_bodymk:
lg9	QUEUE,		lng12,X_bodymk:
	309;		lng13,X_bodymk:
	GROUP:		lng14,X_bodymk;
	n_pieces,FIRST;	;-----	
		END;	