Proceedings of the 2000 Winter Simulation Conference
J. A. Joines, R. R. Barton, K. Kang, and P. A. Fishwick, eds.

SIMULATING THE FURNITURE INDUSTRY

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ABSTRACT

The furniture industry is operating on tighter margins and ever increasing competition. No longer are the days when one could develop a product and market it for years, if not decades. With more competition and ever changing consumer demands, manufacturers are frequently realizing the necessity to reengineer their facility to satisfy the needs of many product groups and styles. Designing facilities that recognize the need for flexibility to reduce costs requires a clear understanding of the interdependent relationships naturally occurring in complex cellular manufacturing environments. However, engineers are often left to their own inherent instincts during the design phase of a project without an analytical tool to help them assess if their assumptions are correct or not. One of the best tools available to provide correct evaluations of system interdependencies is discrete event simulation. With the use of simulation, manufacturers are able to quickly and accurately model future proposed modifications to their facilities without making costly guesses. Furthermore, if modeled correctly, the simulation model built to assess the significance of a proposed layout change can be evolved into an operational planning tool that can be utilized on a continued basis to evaluate issues such as scheduling sequences or batch sizes.

1 INTRODUCTION

There are six furniture manufacturers listed in the Fortune 500 with combined revenues approaching $14 billion in 1999. Dozens of manufacturers can be found in the small to medium sized markets with recognized brand names such as Bassett, Stanley, Broyhill, and Ethan Allan to just name a few. With a highly competitive market that extends into the billions, the strategic use of advanced technology is not an option; it's a must. Manufacturers are constantly under a directive to improve product quality while simultaneously reducing costs and increasing profit margins. Cost reduction equates to better process control, elimination of waste, and plant consolidations; which in turn yields improved profit margins. Therefore, it is no surprise that many of the common areas examined for improvement and cost reductions begin on the plant floor itself. However, the ease of determining where to begin is often a function of the overall system complexity. And in the furniture manufacturing industry the challenge presented can at times be substantial.

The complexity of interdependent relationships created by the sheer quantity of unique parts and machine operation sequences in furniture manufacturing causes the process of design and redesign of cellular facility layouts to be very challenging. Often engineers are assigned one of two major tasks: Either redesign an existing facility to meet current market demands, or design a new plant from scratch. The first task is difficult to perform with the plant already in production, and mistakes in the new alignment can be costly. Mistakes in designing a plant from the drawing board can be just as precarious, especially when considering the investment in new capital expenditures. Therefore, in either case it is crucial to build a model of the system to use in the engineer's analysis to minimize errors in layout design, system behavioral assumptions, and capital costs.

In the past, models have been created to serve and address a particular purpose at a particular stage in the reengineering process. After the problem has been addressed, the model is deemed useless having served it's primary purpose and quickly becomes one in a long list of shelve-ware models. Realizing that the actual model building can take months and cost a company thousands of dollars, it really is a shame to shelf what could be a very valuable tool if developed correctly. When built properly, a robust model will not only address the issue at hand, but can be adapted from a capital improvement evaluation tool into an actual operational planning tool.

In this paper, we are going to evaluate the proposed layout of a dining room tabletop plant. The plant consists of a machining cell where all of the legs and side apron pieces are cut and drilled, as well as a sanding operation where all of the tabletops come down a sanding line. After these operations, the tops and legs are joined together and placed on a conveyor system as they pass through the staining room. After the staining operations are performed, the table is sent through a finishing line before moving to final assembly, and then finally to shipping.

Sim X, Inc. of Woodbridge, VA is a simulation-consulting firm that focuses on delivering state-of- the-art multi-purpose simulation models. Utilizing the ProModel simulation engine from *ProModel Corporation* of Orem, UT, Sim X has built advanced models for a number of furniture manufacturers. The models being created not only address issues regarding facility layout, but also can be easily adapted to examine the effect on plant operations resulting from modifications in product styles and machine route changes as is often dictated by market demand.

2 PROBLEM DEFINITION

2.1 Objectives

The first step in modeling a furniture facility is to determine the objectives. To generalize, assume that the first objective is to determine staffing levels in a machining cell. The second objective is to determine batch sizes and perform a line-balancing act between multiple machine cells. The third objective is to determine buffer sizes at the major staging areas.

The first objective is a typical problem which simulation is adept at handling. Determining proper staffing level in the studied machining cell should improve the throughput of the plant, but a bottleneck may exist further upstream or downstream in the manufacturing process. The second objective of determining batch sizes and line balancing is a major task to undertake. The complex interdependencies that exist between multiple machine cells can be mind-boggling, thus having a good model of the whole system can significantly aid in the analysis. The third objective is important because this will determine space requirements for key staging areas in the plant.

2.2 Model Scope

Often the scope of a facility study is focused in a specific region of the plant, but for the purposes of this paper the model scope will cover all major operations of the plant. The model begins with receipt of raw materials into the plant. The first operation is the cutting at the CNC machine for the tabletops. At the same time, the legs and apron pieces are released into a machining cell. (The idea here is to have batches of tops and legs pieces to finish simultaneously such that the parts can advance to the staining operations in tandem.) Once the pieces are finished in the machining cell or sanding operations, the parts are stored in a buffer area and are matched with the appropriate tabletop. After being matched, the parts proceed to the staining conveyor system and are stained. (See Figure 1) After the staining room, the legs and aprons are removed from the tables so that the tabletops can go through a finishing line. After the finishing line, the legs and tops are reattached in final assembly and then the product advances to shipping (See Figure 2).

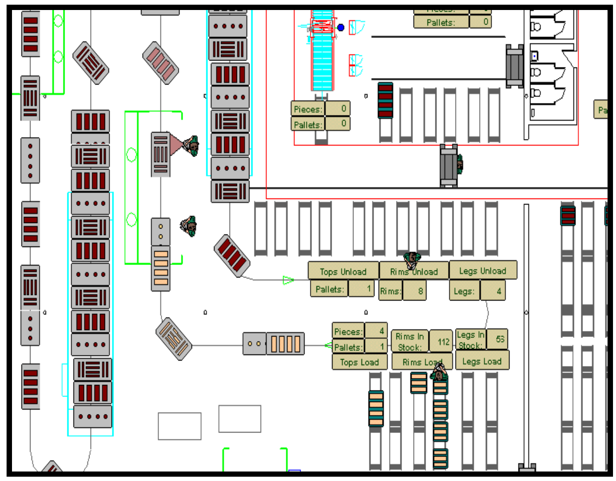


Figure 1: Staining Operations

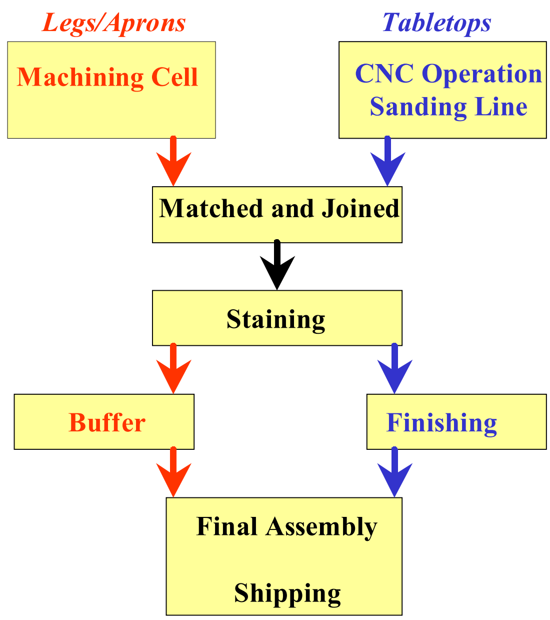


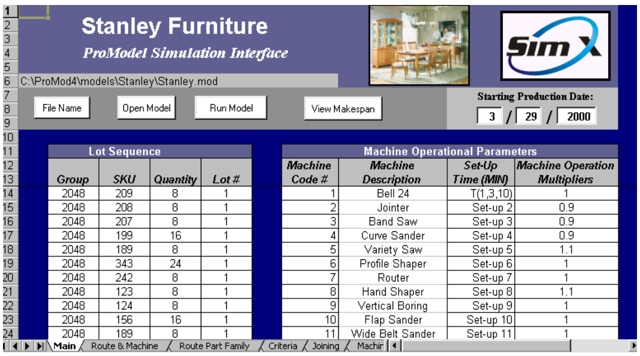
Figure 2: Sample Operation

3 MODEL DEVELOPMENT

Sim X uses the ProModel simulation engine as the modeling language to address the problem. After developing the model in ProModel, Sim X increases the usability of the tool by creating a custom front-end user interface utilizing the latest Visual Basic features of

Microsoft Excel and the Active X capability of ProModel. This Excel/VB interface is what the final user will use to develop operational scenarios for system performance analysis. The user simply manipulates the input data on a spreadsheet and the input parameters transfer automatically into the simulation model when executed. Preformatted and customized output sheets are then populated with the relevant statistics from the actual simulation run.

With the interface a user manipulates fields controlling basic input parameters such as run length, data, number of machines, and shifts. However, Sim X has taken the level of available detail one step further by integrating access to complete bill of material lists and product routings regarding thousands of parts assigned to the facility for production. The availability of options provided through the custom interfaces transforms the model from a facility-planning tool to an operational planning tool (see Figure 3).



Lot Sequence

Group	SKU	Quantity	Lot #
2048	209	8	1
2048	208	8	1
2048	207	8	1
2048	199	16	1
2048	189	8	1
2048	343	24	1
2048	242	8	1
2048	123	8	1
2048	124	8	1
2048	156	16	1
2048	189	8	1

Machine Operational Parameters

Machine Code #	Machine Description	Set-Up Time (MIN)	Machine Operation Multipliers
1	Bell 24	T(1,3,10)	1
2	Jointer	Set-up 2	0.9
3	Band Saw	Set-up 3	0.9
4	Curve Sander	Set-up 4	0.9
5	Variety Saw	Set-up 5	1.1
6	Profile Shaper	Set-up 6	1
7	Router	Set-up 7	1
8	Hand Shaper	Set-up 8	1.1
9	Vertical Boring	Set-up 9	1
10	Flap Sander	Set-up 10	1
11	Wide Belt Sander	Set-up 11	1

Figure 3: Front-end Interface (User inputs)

4 MODEL DESCRIPTION

4.1 Model Inputs

The model has been developed to be as flexible as possible. The Microsoft Excel front-end interface takes into account specific input parameters by categorizing issues utilizing a series of worksheets in the Excel workbook.

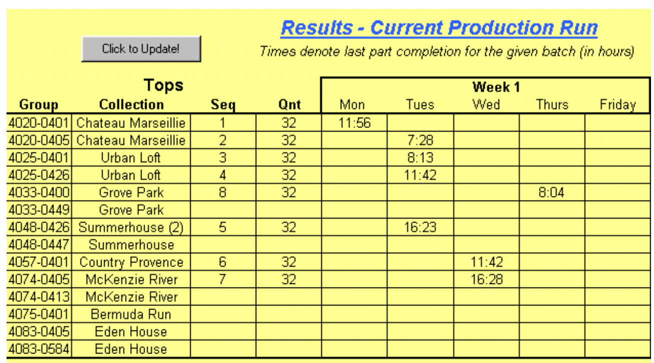
The first set of inputs includes lot sequences and batch quantity sizes. The lot sequence is the cutting order for particular suits scheduled for the production run. Parameters of the lot sequence can include group number, SKU number and quantity. The interface furthermore recognizes the user's need to have access to the machine's behavior. How machines are set-up and maintained often determines optimal batch sizes for a production run. Also, as all engineers know, rarely are the process times retrieved from large database MRP or ERP systems 100% correct. Often the standards for one machine type are known to be over or under rated. Therefore, the interface allows for easy modification, by machine, of these performance standards even if the data retrieved concerning process times was provided on a part-by-part basis. Supplement categories and worksheets provide the option to aggregate similar part routings and process times to increase the ease of setting up the input data for the bill of material. The bill of material list is then used to determine where each bill of material will be routed to and in what sequence. Users also have the ability to input key part characteristics that may effect the behavior of that part in the system; such as the part's physical dimensions or the quantity of this part class which can fit on a specific type of material handling equipment. Finally, the input sheet recognizes that in a machining cell assembly operations will sometimes occur. The spreadsheet design is able to convey to the model where assembly in the plant will transpire and the specific criteria necessary for that assembly to occur; such as all part types needed for assembly are available in a particular assembly queue for that machine cell.

4.2 Model Outputs

Many performance measures are collected in multiple reports. The default statistics being collected by the ProModel Output database include:

- Buffer levels over time
- Operator utilization
- Cycle times for each suit

The customized back-end has preformatted output specific to the performance measures necessary to evaluate detailed behavior of the particular system being studied. In the example of the tabletop versus apron manufacturing line, one of these detailed system behaviors the model would report is the start and end time (for their respective machining cells) of dependent pieces that needed to be matched for the staining operation (see Figure 4). When dealing with thousands of parts that are elements of hundreds of items, it is often appropriate to examine the start and end times of each part in a more formal format for the entire system. Therefore, Sim X developed a method to integrate the back-end into Microsoft Project to examine the implications of scheduling practices on the production time for a given cutting.



Group	Tops Collection	Seq	Qnt	Week 1 Mon	Tues	Wed	Thurs	Friday
4020-0401	Chateau Marseillie	1	32	11:56				
4020-0405	Chateau Marseillie	2	32		7:28			
4025-0401	Urban Loft	3	32		8:13			
4025-0426	Urban Loft	4	32		11:42			
4033-0400	Grove Park	8	32				8:04	
4033-0449	Grove Park							
4048-0426	Summerhouse (2)	5	32		16:23			
4048-0447	Summerhouse							
4057-0401	Country Provence	6	32			11:42		
4074-0405	McKenzie River	7	32			16:28		
4074-0413	McKenzie River							
4075-0401	Bermuda Run							
4083-0405	Eden House							
4083-0584	Eden House							

Figure 4: Finish Times of Table Top Suits

5 RESULTS

The results of the models have been overwhelmingly positive. "The operational planning model Sim X developed has become vital to testing out our weekly production schedules," says Tom Der Tatevision, Director of Industrial Engineering at Bassett Furniture Industries. The models being created not only serve the initial purpose of determining buffer space and resource levels, but they are being used on a regular basis to evaluate new cuttings. This multi-functionality feature has turned the simulation models into operational planning tools.

6 CONCLUSION

The furniture industry has begun to utilize the latest in simulation technology. With a Microsoft Excel front-end interface, simulation is being brought directly to the plant floor where the everyday engineer can evaluate changes quickly and accurately. The multi-purpose plant model is now becoming the norm rather than a far-fetched dream when evaluating new product flows on the plant floor. With companies like Bassett, Stanley, and Rowe utilizing this technology, others are soon to follow or be left behind.

AUTHOR BIOGRAPHIES

ROBERT G. KYLE, JR. is president and founder of *Sim X (SIMulation eXperts)*. He founded *Sim X* in 1996, which is located in Woodbridge, Virginia, and has dozens of clients in the United States. He is a licensed agent for *ProModel Corporation*. Activities in his business include selling ProModel products, consulting, and customized training classes. He is a 1997 graduate of Virginia Tech where he received his Bachelors Degree in Industrial & Systems Engineering. Prior to *Sim X*, he worked with the Central Intelligence Agency and International Business Machines. His email and web addresses are `<bob.kyle@simxinc.com>` and `<www.simxinc.com>`.

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