

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

---

Industrial and Management Systems Engineering --  
Instructional Materials

Industrial and Management Systems Engineering

---

Fall 1999

# Introduction to Industrial Engineering: Simulation Analysis

Paul Savory

University of Nebraska at Lincoln, psavory2@gmail.com

Follow this and additional works at: <http://digitalcommons.unl.edu/imseteach>



Part of the [Operations Research, Systems Engineering and Industrial Engineering Commons](#)

---

Savory, Paul, "Introduction to Industrial Engineering: Simulation Analysis" (1999). *Industrial and Management Systems Engineering -- Instructional Materials*. 15.

<http://digitalcommons.unl.edu/imseteach/15>

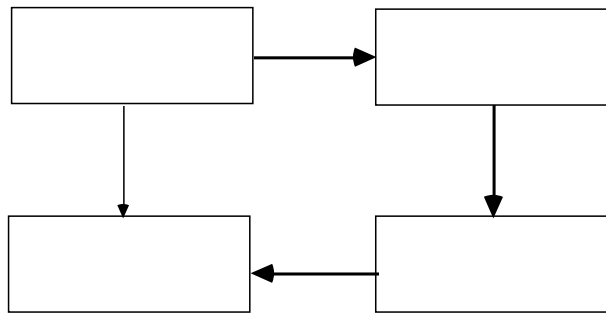
This Article is brought to you for free and open access by the Industrial and Management Systems Engineering at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Industrial and Management Systems Engineering -- Instructional Materials by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

## Class Exercise 21: Simulation Analysis

Simulation is one of industry's most used operations research. Its uses range from answering questions about work-in-process and production feasibility to comparing alternative plans for system routing and scheduling.

### How a Model is Used?

Consider the following uses of a model:



### What is Computer Simulation?

Computer simulation is:

### Why Use Computer Simulation?

- 
- 
- 
- 

WHAT WILL THEY DO? ARE THEY GOING TO INTERROGATE ME AND BEAT ME UP?? ARE THEY GOING TO BREAK MY KNEES?? WILL I HAVE TO SIGN SOME CONFESSION???



**What are Some Simulation Disadvantages?**

- 
- 
- 



**Simulation Example: Bank vs. Grocery Store**

Consider the following results for each of the bank models:

	1 Teller	2 Tellers	3 Tellers	4 Tellers
<b>Time in System</b>				
<b>Waiting Time</b>				
<b>Teller Utilization</b>				
<b>Customers Processed</b>				

Consider the following results for the grocery model with 3 checkout systems:

	Cashier 1	Cashier 2	Cashier 3
<b>Time in System</b>			
<b>Waiting Time</b>			
<b>Cashier Utilization</b>			

**Simulation Example: Work In Process**

This is a demonstration of a manufacturing line in which the focus is to reduce line imbalance by controlling tote size of pallets between operations.

**Simulation Example: Assembly Flow Line**

The model demonstrates the simulation and animation of a circuit board assembly flow line. each server has a buffer of specified capacity. If no space is available in a buffer, the machine in blacked and cannot process. In addition, machines experience failures.

## Simulation Example: Penny Game

Let's consider a variation of the penny game you played. Let's assume that a part arrives to station 1 every 1 to 6 minutes (uniformly distributed). The time to process a part for each station is 1 to 6 minutes (uniformly distributed – that is, any value between 1 and 6 is equally likely). Hence, the average processing time for a station is 3.5 minutes. If we model 1400 minutes of continuous operations, we would expect  $1400/3.5 = 400$  parts to be produced.

**Penny 1** – Average of 3.5 and ALL stations have same variability (1 to 6)

	Results
Number Produce	
Final WIP Station 1	
Final WIP Station 2	
Final WIP Station 3	
Final WIP Station 4	
Final WIP Station 5	

Let's modify the system such that arrivals and all processing time are UNIF(3,4). Note, has the same mean but a smaller variability.

**Penny 2** – Average of 3.5 and ALL stations have same variability (3 to 4)

	Results
Number Produce	
Final WIP Station 1	
Final WIP Station 2	
Final WIP Station 3	
Final WIP Station 4	
Final WIP Station 5	



Let's add a bottleneck to the system. Let's make Station 1 slower (UNIF(1,8) – hence, has an average of 4.5 minutes of processing time) and more variable.

**Penny 3** – Average of 3.5 and Station 1 slower and more variable

	Results
Number Produce	
Final WIP Station 1	
Final WIP Station 2	
Final WIP Station 3	
Final WIP Station 4	
Final WIP Station 5	

Rather than have the bottleneck be Station 1, let's make it Station 4. Let's make Station 4 slower (UNIF(1,8) – hence, has an average of 4.5 minutes of processing time) and more variable.

**Penny 3** – Average of 3.5 and Station 1 slower and more variable

	Results
Number Produce	
Final WIP Station 1	
Final WIP Station 2	
Final WIP Station 3	
Final WIP Station 4	
Final WIP Station 5	

Notice that with the bottleneck towards the end of the line, the intermediate WIP levels went way up! Too much WIP is bad!!!

**MONEY! HA HA HA!  
I'M RICH! I'M RICH!  
I CAN BUY OFF ANYONE!  
THE WORLD IS MINE!**

