PROCESS EVALUATION OF MILK PRODUCT MANUFACTURING INDUSTRY FOR IMPROVING EFFICIENCY AND UTILIZATION OF PRODUCTION LINE

Mandlik Anil D.[1], Prof. Tajane R. S.[2], Prof. Borkar B.R.[3]

[1] *Production Engg., Amrutvahini College of Engineering, Maharashtra, India*
[2] *Professor, Production Engg., Amrutvahini College of Engineering, Maharashtra, India*
[3] *Professor, Production Engg., Amrutvahini College of Engineering, Maharashtra, India*

ABSTRACT

The globalization of the markets and the worldwide competition forces the SMEs to implement new technologies and organize themselves using new concepts order to maintain their competitively. This study is concerned with the simulation modeling of shop floor activities for milk product manufacturing industry. The simulation methodology for modeling shop floor activities was developed by using ARENA simulation tool in this thesis. A milk product manufacturing industry was selected for pilot application. Queue rules were applied to the developed model to optimize the system efficiency. By analyzing the output statistical results of ARENA which were obtained with the usage of the input variables (such as resource capacities, process times, setup and remove times of parts, variables w.r.t. to workers, etc.) best manufacturing policy was able to be found.

Keywords:- *Arena Software, Simulation, modeling, Simulation software, Utilization*

1. INTRODUCTION

Simulation is the imitation of the operation of a real world process or system over time. Whether done by hand or a computer, simulation involves the generation of an artificial history of a system, and the observation of that artificial history to draw inferences concerning the operating characteristics of the real system [1]. The behavior of a system as it evolves over time is studied by developing a simulation model. Once developed and validated, a model can be used to investigate a wide variety of "what-if" questions about the real-world system [1].

Simulation is used before an existing system is altered or a new system built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over-utilization of resources, and to optimize system performance. For instance, simulation can be used to answer questions like: What is the best design for a new telecommunications network? What are the associated resource requirements? How will telecommunications network performs when the traffic load increases by 50%? How will a new routing algorithm affect its performance? Which network protocol optimizes network performance? What will be the impact of a link failure? [2]

Implementing change can be a difficult task for any organization, big or small. For this purpose modeling of complex systems such as manufacturing systems is an arduous task. Simulation has gained importance in the past few years and allows designers imagine new systems and enabling them to both quantify and observe behavior. Whether the system is a production line, an operating room or an emergency response system, simulation can be used to study and compare alternative designs or to troubleshoot existing systems. With simulation models, how an existing system might perform if altered could explore, or how a new system might behave before the prototype is even completed, thus saving on costs and lead times. Modeling and simulation are emerging as key technologies to support manufacturing in the 21st century. However, there are differing views on how best to develop, validate and use simulation models in practice. Most development procedures tend to be linear and prescriptive by nature. Several researchers have

studied performance by using simulation techniques with the first uses dating back to at least the early 1960`s. Detailed discussions of simulation. In general, may be found in Banks, Carson, and Nelson [1] and Law and Kelton [3]. A practical discussion of the steps in a sound simulation study is given in Law and McComas [4].

2. PROBLEM DEFINITION

Nowadays product varieties are rapidly being introduced into the market. In this situation, the philosophy needed by a company to survive is by constantly changing from the old product to new one. Newly developed products need machines other production resources to process raw materials to become finished goods. Many times the order or demands in market are increased at that time the available resources not fulfills such type of market demands. It required the extra resource. On the other hand, the procurement of these machine & resources require the substantial amount of cost as well as time from design to production. Procurement, production will certainly lead to longer time to market thus affecting competitiveness of the company. It could be that the existing facilities are already in place for extra production within time but the problem is whether the utilization of the existing manufacturing or processing system is capable of producing a product. That is why it is very important to evaluate the utilization of an existing production facility in relation to product varieties produced in the company.

3. RELATED WORK

Production line consists of series of work stations. The workstations are arranged so that process completed from one workstation to the next. At each workstation certain process is carried out and production lines are balanced. Transfer of the prepasteurised milk to the culture tank by using suitable piping. Simultaneously transfer to the next workstation. Finally after packing completed the pouches are transfer to cold storage by manual tray handling. Production line associated with batch production. If the demand in the market is increased then uses the byproduct production line are used for further processing.

Simulation has been used to investigate a wide variety of problematic areas in processing. [1]. A simulation model is descriptive model of a process a system & usually includes parameter that allows the model to be configurable [1]. The model will then be used to estimate the effects of various actions. The idea behind simulation is to imitate a real world situation mathematically, then to fitly its properties and operating characteristics and finally to draw conclusions and make action decision based on the results of the simulation. In this way the real life system is not touched until the advantages and disadvantages of what may be major policy decision are first measured on the systems model.

Sending and receiving messages is a way for simulation model to interact with directly with a shop floor execution system. From external database that are updated by a process planning system and coordinated via an external business system, the process plans and master production order can be reads by control simulation model [29]. Using the Arena software as an analysis tools, the utilization and cycle time for production process can be simulated.

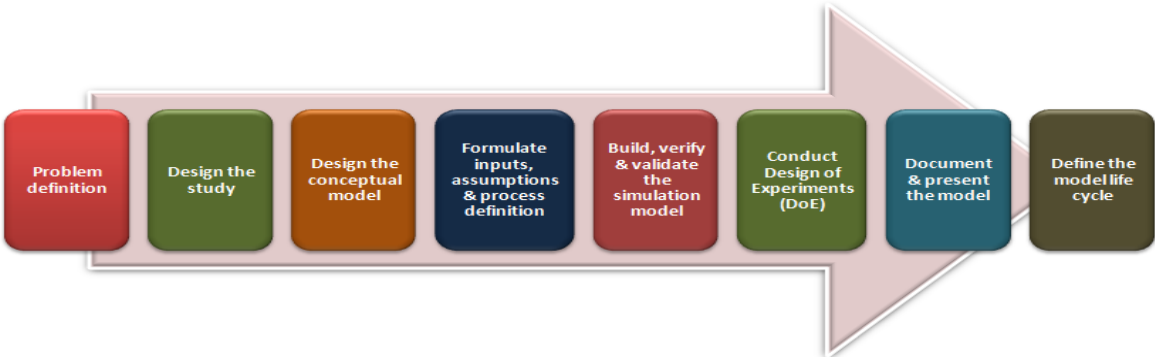
The efforts to improve performances of manufacturing system have never ended. And utilization is one of the performance parameters which need to be improved. Some of the previous studies to improve the resource utilization of manufacturing system have been conducted [17]-[20].

One of scenarios to improve productivity of production line in a food processing industry was by adjusting the number of resources (such as machine) and distance between workstations. And then Arena software was used to analyze the effects of that adjustment [17].

A few previous studies that related to resource utilization and Arena simulation have been discussed. Anyway, only a few of these studies have discussed directly on the effect of batch size and throughput parameters to improve resource utilization.

4. METHODOLOGY

The methodology for this study can be illustrated as shown in Fig. 1. The following paragraphs describe the individual element of the methodology flow chart.



A. Collecting General System (Company Properties) Data

The main issue for this study can be stated as finding the most appropriate firm(s) to fulfill a defined processesing task. To construct the model, steps which are explained below will be followed by the modeler. Before starting to collect real system data (process data), the identification tag of the company (name of the company), its location (address of the company), activity domain (activity field of the firm), its size and work hour should be defined by the modeler. To achieve this objective some essential data must be collected. These collected data will be used for either programming part or animation part of the model. Steps that modeler should follow for collecting data are;

- Determination of Simulation Parameters: Worker schedule
- Identification of Resource (labor and machine) Capabilities of the Firm: The resource list must be prepared. Specialization of the workers and machine types should be written in this list. In this country, because of economical disadvantages, SMEs occasionally prefer workers who are specialized in different machines. Because of this disadvantage modeler should pay attention while collecting the properties of workers. By collected data, entities should be seized according to related worker before machining.
- Examination of Machines and Machining Sequences of the Parts: The data about machines give information to the modeler about sequencing rule for machining.

B. Collecting and Processing Real System Data

The items that should be done step by step while collecting data are the following in sequence;

- Type of entity and its process cycle should be described.
- Parts of entity and their process sequences should be determined.
- Part List Table should be prepared.
- Process Plan should be analyzed. (Prepared by Flowchart)
- Machining times and input distributions should be determined: There are different kinds of statistical distribution types which are used by Arena. General usage of statistical distribution can be summarized

There are also five technicians working in this company. Each of them is specialized on a different machine

	Culture tank filling	Pasteurisation	Packing machine	Cold storage	Cleaning
Worker 1	•				•
Worker 2	•				•
Worker 3		•			•
Worker 4			•	•	•
Worker 5			•	•	•
Worker 6					•

Table 1: Workers process table

EXAMINATION OF THE FIRM		
RESOURCE CAPACITY (MACHINE)	MACHINE TYPE	PROPERTIES
	Pasteurisation	5000 lit/hrs
	Culture unit	1000 lit
	Fill Packing Machine	5000 lit/hrs
	Cold Storage	10000 lit (05 racks) with $+4^0$C to 7^0C
	Boiler	Pressure 14 kg

Table 2: machine Capabilities

The triangular distribution is commonly used in situations in which the exact form of the distribution is not known, but estimates (or guesses) for the minimum, maximum, and most likely are available. Operators could give maximum and minimum process times. By using this distribution, ARENA® could calculate average values for operation times. For this pilot application, base time unit was selected as minute.

C. Process Sequence (in minutes)

CULTURE	TRIA(300, 365, 420)
PASTEURISATION	TRIA(55,58,60)

PACKING	TRIA(83,85,90)
COLD STORAGE	TRIA(4, 4.5, 5)

Table 3: Process Sequence

D. DATA ANALYSIS

The first step is to model the existing line by using ARENA software. This step was done by utilizing the build function in the software. There were 4 types of processes were studied. The data collected from the each processes of production line is entered in the model. After the developed model has got verification, the validation of model is done by comparing the result resulted from the model to the results based on the real situation. The product production processes plans is shown in Table 3

E. RESULT AND DISCUSSION

Product In, Product Out, and Utilization

Figs. show the numbers of 'products in' (product quantities coming into a certain workstation), the numbers of 'products out' (product quantities coming out from a certain workstation), and utilizations percentages for each processes.

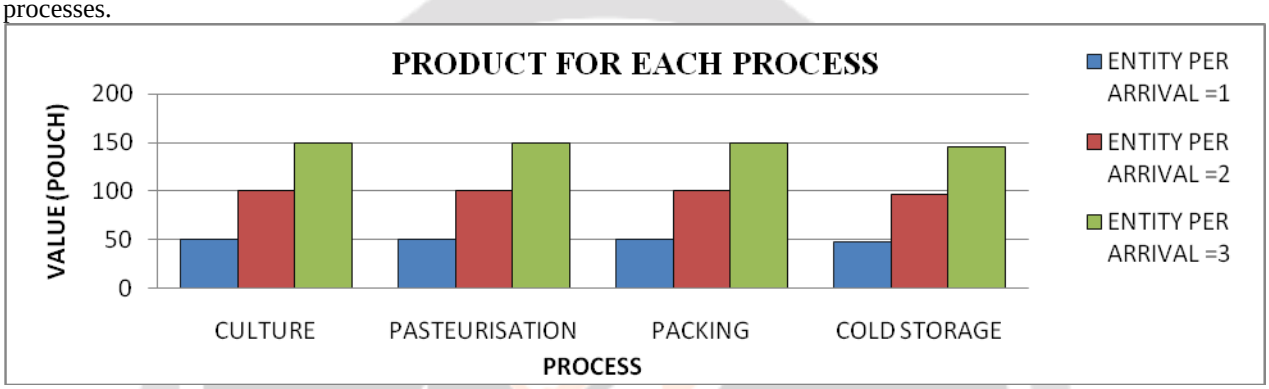


Fig.: Result for number of 'product in' for each process

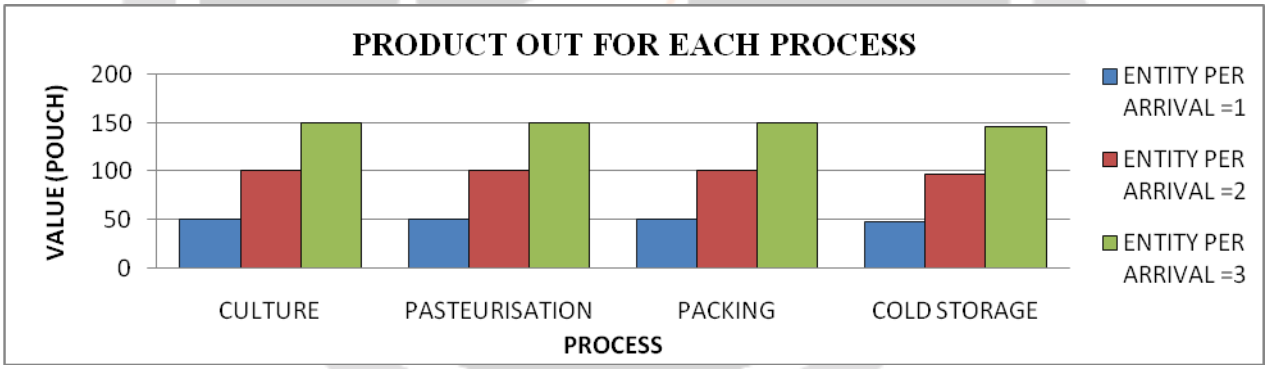


Fig.: Result for number of 'product out' for each process

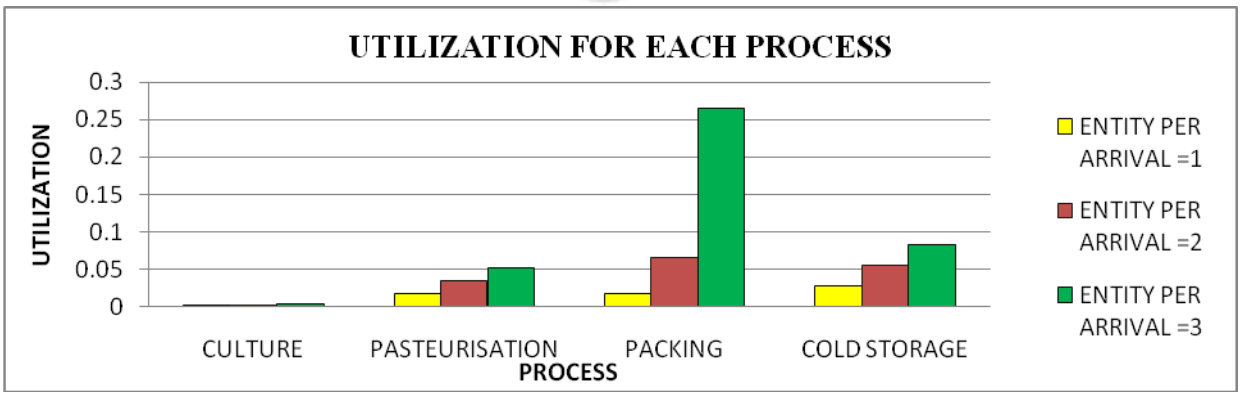
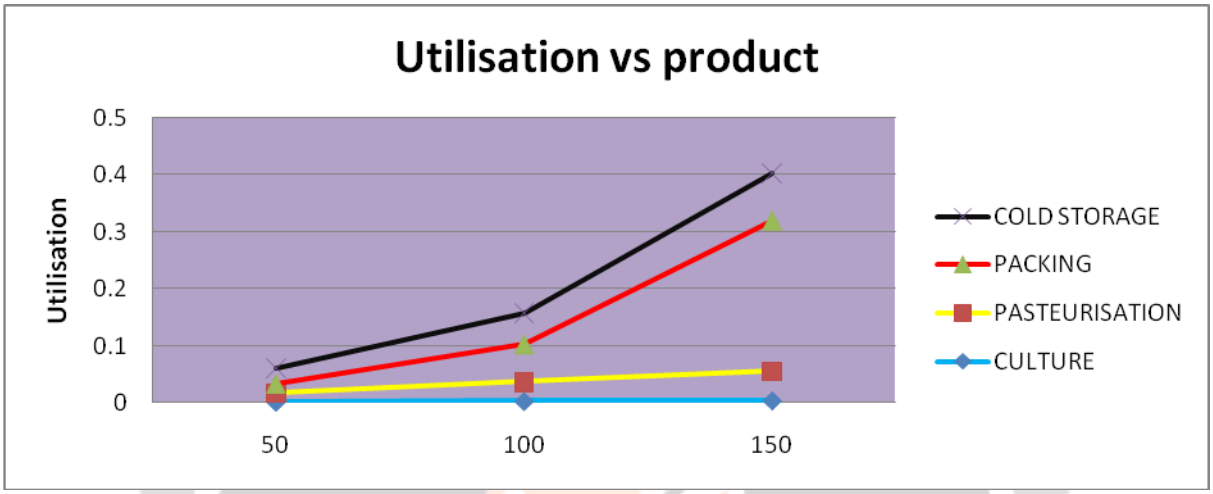


Fig.: Result for 'Utilization' for each process

Utilization versus product out & Wait Time

Fig. shows the utilization versus number of product in, out and wait time for each process with different entity per arrival



Based on the graphs plotted on these figures, numbers of products out, numbers of products in and wait times for each processes increased when entities per arrivals increased. This clearly showed that a utilization percentage is linear with products out, products in and wait times.

CONCLUSION AND RECOMMENDATION

Based on the results of this study, it can be concluded that the parameters of 'product in', 'product out', and 'utilization' have positive relationship to processing time at each workstation. By increasing batch size, higher quantity of products will be processed at any workstation, and this causes more time to process them. As a result, 'product in', 'product out', 'utilization' parameters will also increase.

For further study, it is recommended to investigate the effect of changes in production line at the constant condition of batch size.

REFERENCES

[1]. Banks J., Carson J.S.II and Nelson B.L. (1996). "Discrete Event System Simulation". Prentice-Hall, Inc., New Jersey.
[2]. Anu Maria, (1997), "Introduction to manufacturing process" Winter Simulation conference, University of New York at Binghamton., Department of Systems Science and Industrial Engineering., Binghamton, NY 13902-6000, U.S.A.
[3]. Law, A. M., & Kelton (2000). "Simulation Modeling and Analysis" (3rd). McGraw-Hill.
[4]. Law A. M., McComas M.G., " Simulation Modeling Analysis" IInd Ed. New Yark, McGraw Hills
[5]. Hosseinpour F. and Hajihosseini H., (2009), "Importance of Simulation in Manufacturing", World Academy of Science, Engineering and Technology Vol.51.
[6]. Onur M. Ülgen., (April 3, 2002), "Simulation Methodology, Tools, and Applications", University of Michigan-Dearborn and Production Modeling Corporation, Dearborn, Michigan.
[7]. Yücel, Necati Deniz, (September 2005), "Simulation of a Flexible Manufacturing System" M. Sc., Department of Mechanical Engineering.
[8]. Mustafa Bahtiyar, (June 2005), "Simulation Modeling of Shop Floor Activities for SME in VE" Middle East Technical University.
[9]. Pedgen C.D., R.E. Shannon and R.P. Sadowski, (1995). "Introduction to Simulation Using Siman" 2nd edition, New York: McGraw-Hill.

[10].Kelton, W. D., Sadowski, R. P., & Swets, N. B. (2010). "Simulation with Arena". (5th ed.). New York, NY: McGraw-Hill.
[11].Idoia Echave, "Simulation of manufacturing systems", Dept. Ingeniería de Producción Fundación Tekniker., Avd. Otaola 20, 20600 Eibar, Spain., Bernd Noche., Department of Mechanical Engineering Transport Systems and Logistics, University of Duisburg - Essen. Lotharstraße 1-21., 47057 Duisburg, Germany b.noche@uni-duisburg.de
[12].Edward J. Williams., "How Simulation Gains Acceptance as a Manufacturing Productivity Improvement Tool", 206-2 Engineering Computer Center, Mail Drop 3., Ford Motor Company Dearborn, Michigan 48121-2053 U.S.A., williame@umdsun2.umd.umich.edu.
[13].Bronislav Chramcov, Petr Beran, Ladislav Daníček, and Roman Jašek., "A Simulation Approach to Achieving More Efficient Production Systems", International Journal of mathematics and computers in simulation.
[14].Montazer, M. A., Ece, K., & Alp, H. (April, 2003). "Simulation modeling in operations management: a sampling of applications". Paper presented at 14th annual conference of the production and operations management society, Savannah, GA.
[15].Kelton W. David, Sadowski Randall P., Sadowski Deborah A., (2002) "Simulation with Arena", McGraw-HILL International Editions,
[16].Laguna, M. & Marklund, J. (2004), "Business process modelling, simulation and design". New Jersey. Prentice Hall.
[17].Allen –Bradley, (2010), "ARENA: User's Guide", Rockwell Automation, USA.
[18].Andradóttir S., Healy K. J., Withers D. H., and. Nelson B. L,(1997) "Introduction to Modeling and Simulation", Proceedings of the 1997 Winter Simulation Conference ed., Binghamton, NY 13902-6000, U.S.A, pp.7-12.
[19].Arena Packaging Edition, Rockwell Automation, USA.
[20].Takus David A, Profozich David M., (1997) "Arena® Software Tutorial", Proceedings of the 1997 Winter Simulation Conference, Sewickley, Pennsylvania, USA, pp 541-543.
[21].Balci O., Ormsby W.F., Carr J.T.III, and Saadi S.D. (2000). "Planning for verification, validation, and accreditation of modeling and simulation applications". Proceedings of the 2000 Winter Simulation Conference
[22].ARENA of Rockwell Software, http://www.arenasimulation.com/
[23].Ekren, B.Y., & Ornek, A.M. (2008). A simulation based experimental design to analyse factor affecting production flow line. "Simulation Modeling Practice and Theory", pp. 278-293.
[24]. Improving Production Line Performance: A Case Study, www.scientific.net/
[25].Christopher A. Chung, (2003), "Simulation Modeling Handbook: A Practical Approach", pp. 17-23.
[26].Jerry Bank, (1998), "Handbook of Simulation: Principles, Methodology, Advances, Application & Practice,
[27].Pam Laney Markt et al., (2010), "Witness Simulation Software a Flexible Suite of Simulation Tools", Winter Simulation Conference
[28].Averill M. Law., (1997), "Simulation of Manufacturing Systems", Winter Simulation Conference, Inc. P.O. Box 40996 Tucson, Arizona 85717, U.S.A.
[29]. K. V. Nagarajan, P. Vial, and G.(2003) "The use of Arena simulation software to illustrate network operations in an educational setting using case studies," in Proceeding SCI 2003, Orlando Florida,.