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EVALUATION ON ABSENTEEISM EFFECT IN PRODUCTION LINE AT AIRCRAFT COMPOSITE MANUFACTURER

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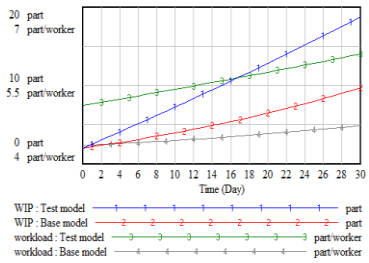
Graphical abstract



Abstract

This paper studies the effect of absenteeism in production line. The analysis shows that the number of absentees at production line increases the workload to the available worker and gives effect to the production. Thus, it gives a major potential for generating bottlenecks. To mitigate this problem and ensure that the workload of workers is at optimum level, an appropriate number of production plans need to be investigated. This paper demonstrates the integration of Discrete Event Simulation (DES) and System Dynamics (SD) in simulating the effect of absenteeism in production flow at an aircraft composite manufacturing factory. Based on the preliminary result, the effect of the absenteeism is found to influence the amount of throughput, waiting and cycle time.

Keywords: Absenteeism, hybrid simulation, production line, throughput, workload

1.0 INTRODUCTION

The goal of a manufacturing company is to ensure it always gain profit. In order to make more money, manufacturing enterprises must make a great effort to increase throughput while minimizing the related costs such as operating and inventory cost [1]. All aspects in manufacturing industry became interested point by researchers to be studied. For instance, researchers are studying on manufacturing system, which focuses on an assembly line, maintenance, inventory control and production flow [2]. In general, a manufacturing system consists of several machines and workers where respectively comprise different interests to be studied [3]. According to Stevenson [4], manufacturing can be defined as a process of transforming raw material to usable products which normally involves a number of stages. Meanwhile, the production line definition is a process in a manufacturing system that consists of machinery and workers to produce products which arranged in line.

In order to accomplish the target to produce products as planned, production planning of production line becomes important role in order to ensure the company stays competitive in the global market. As a result, the research on the production line is stressed by several researchers such as [5–7]. The flow of products in any production line can be disrupted due to machine failures and operator failure. The failure in production will slow down the operations and limits the output in the production line. Therefore, the failure or congestion in manufacturing is known as a bottleneck. Having said that bottleneck in manufacturing can also be divided into two types which are based on machines and human aspects (manpower). In general, bottleneck can cause instability to the amount of throughput in a production system. As stated by [8], managing the bottlenecks effectively and efficiently could yield higher system throughput. The main focus of developing a manufacturing system is to maximize the number of throughput that based on the available resources. Thus, this study strives for improving the performance of manufacturing companies to maximize its production by highlighted on human aspect such as absenteeism and manpower workload.

One of the possible ways to study identifying the bottlenecks in production with considering the human aspect without interrupting the real system is by using computer simulation [9]. There are many production line simulation models have been developed to evaluate the performance of the system using discrete event simulation (DES) approach [10-11]. The DES modeling is well suited to understand the operation of the manufacturing system and at the same time able to look at the variables individually, such as machine breakdown, resource utilization and number in queue at certain workstation. In contrast, the human aspect of a production line is poorly supported [9]. Thus, to simulate the whole system in production line in order to capture the relationships between productions planning and human aspect is needed. For instance, emphasize on absenteeism and manpower workload, give a challenge to the DES model due to requires of vast data in order to represent the behaviour of the whole system.

As a result, System Dynamics (SD) approach is integrated with a DES model in an attempt to solve this study. Unlike DES, the required data for SD is less and able to consider on aggregate values to represent the highest level of a system. In addition, it focuses on feedback and nonlinear relationship [12].

This paper demonstrates the integration between Discrete Event Simulation (DES) and System Dynamics (SD) model in simulating the effect of absenteeism and workload in the production line at an aircraft composite manufacturing. The integration model as known as hybrid model is developed in this study because these approaches are complemented on each other [13-14]. Figure 1 illustrates the hybrid technique between DES and SD.

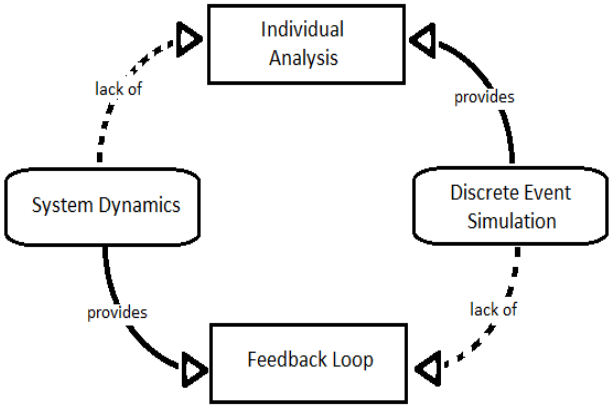


Figure 1 The hybrid technique between DES and SD (as illustrated by [16])

2.0 MATERIAL AND METHOD

2.1 System Description

Figure 2 shows the processes during production operation activities in company A. There are eight layup teams operated simultaneously to produce a different type of product with different number of operators. Company A produces 19 types of product with 961 composite parts for five customer groups. The developed model refers to the product that frequently produced for one customer group.

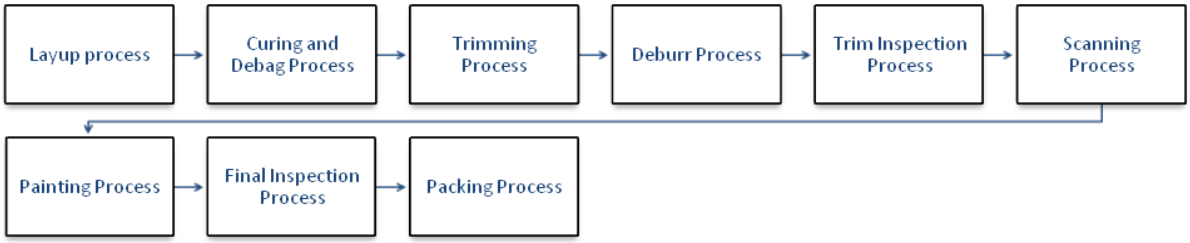


Figure 2: General processes of operation activities flow

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Batch processing is also applied at a few workstations. In the model, the shipset of product 1 represents the entity that moves throughout the system.

2.2 Data Collection

The data collections were conducted from both methods that are primary and secondary data. The primary data sources were gathered from system observation, interview and measurements. Meanwhile, the data that obtained from daily activity records is classified as a secondary data.

Then, the raw data was processed by using the Arena Input Analyzer. This tool was embedded with Arena software that allows the user to process the from daily activity records is classified as a secondary data. Then, the raw data was processed by using the Arena Input Analyzer. This tool is already embedded in Arena software that allows the user to process the related raw data and fit it into a statistical distribution.

2.3 DES Model Development

The DES model has been developed into computer simulation programmed using Arena software package version 13.9. Arena is a general-purpose simulation package and is a powerful tool for simulating any field such as military, hospital, banks and including for many manufacturing applications [15]. The model of the system is based on a production line as illustrated in Figure 2. The first process was done manually consisted of a number of steps by high skill workers. The variability of production rates is different from day to day. Different attributes, variables and expressions were used in developing the DES model. Figure 3 shows a part of the DES model logic of the developed model. The model was developed based on several assumptions as follows:

- Each process consists of skillful workers with full attendance and work in a shift per day
- Simulation run time is one month and 24 hours per day include break time
- Travel time between all processes is ten to twenty seconds, uniformly distributed

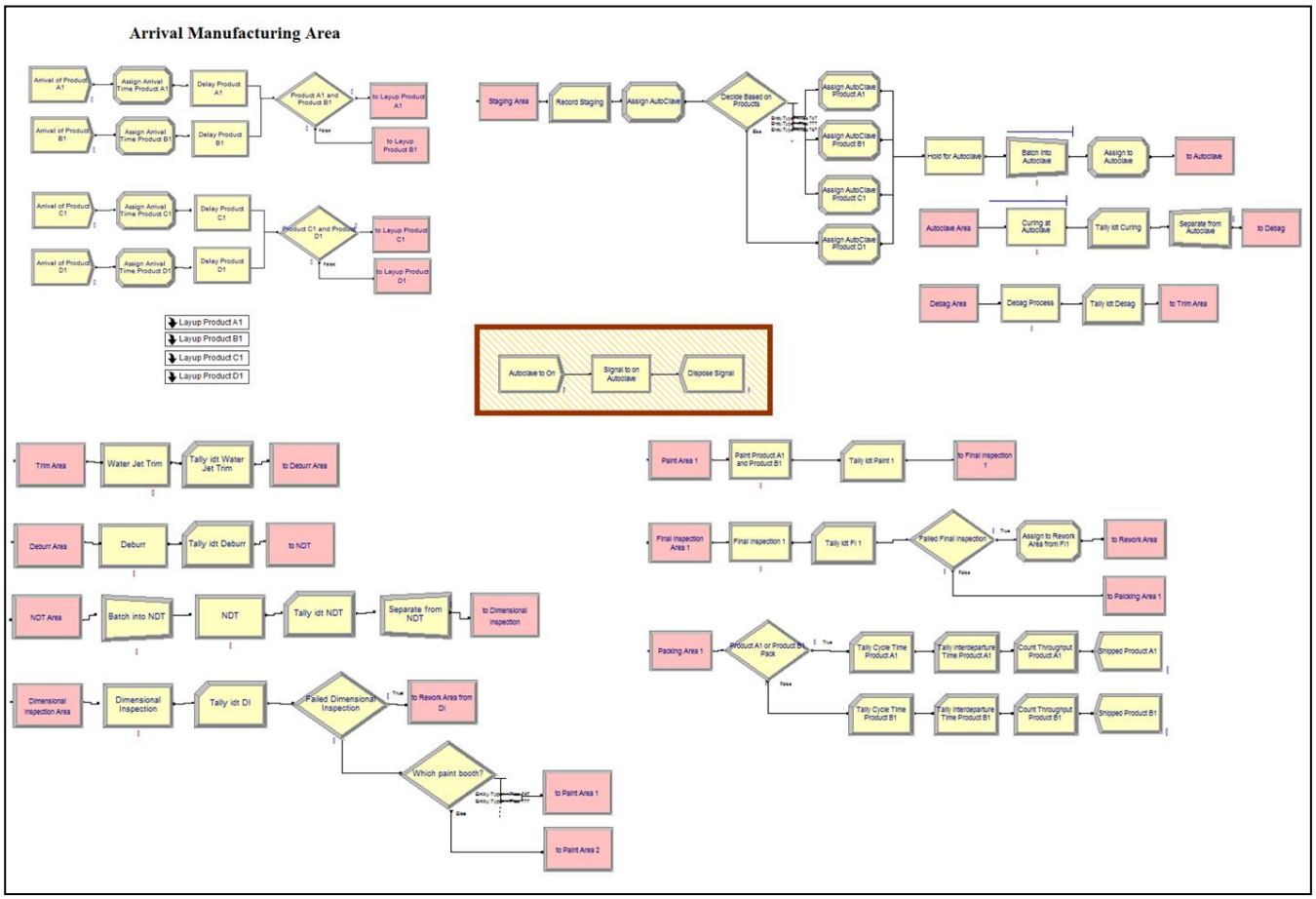

Figure 3 A part of the DES model logic

2.4 SD Model Development

The development of SD model is to simulate and understand the behavior in the production line based on the human aspect that influences the production planning. In order to investigate the effect on the human aspect of this model, SD method is used to understand how far changes in the system will affect the whole production system and its components over time. SD model was developed to understand the interrelationships between production line operation and human aspect such as absenteeism and workload. The SD model development was built using Vensim software version 6.0b. Thus, this model consists of work in process (WIP) as a stock while production start rate and production rate as a flow with several factors were formulated as follows.

$$d(\text{WorkInProcess})/dt = \text{Production start rate } (t) - \text{Production rate } (t)$$

2.5 The Hybrid Model

This paper demonstrates two types of simulation were developed which one based on DES and one on SD model. In this study, DES model and SD models have been built using specific general simulation software

and were run separately. The DES model was developed for the purpose of understanding the operation of production line such as operator utilization, waiting time and number of throughput while the SD model was developed as explained in the previous section. Data for each model will become as the input to the other models, in a feedback cycle.

3.0 RESULTS AND DISCUSSION

Based on the preliminary result, the effect of the absenteeism is found to influence to the amount of throughput, waiting time and cycle time as shown in Table 1 and Figure 4. The result of the hybrid model shows that the differences in related performance measures compared to the DES-only model. Generally, similar results are obtained from both approaches which based on their own specification, but there were still the differences in some aspects. The base run model highlighted to the full attendance of workers in production lines which also known as no absences. Meanwhile, the test model underline on the number of absentees. The test model underline on the number of absentees. Thus, 3 workers absentees in the production line as a preliminary work in order to understand the behavior and effect to the workers workload and WIP. Figure 4 shows the output from the SD model after considering DES output (hybrid). The WIP will increase when the absenteeism was included in the model. This condition will validate the SD model as it happens in the real world. The results in difference model are shown in Table 1 whereas Figure 4 illustrated the effect of absenteeism, WIP and workload in production line.

Table 1 Results from DES model for product 1

	DES model full attendance	DES model with absentees	Hybrid DES-SD model
Number of Absenteeism	-	**3**	**3**
Consider workload	-	**No**	**Yes**
Throughput	**884**	**882**	**814**
WIP (part)	**67**	**93**	**72**
Cycle time, CT (day/part)	**9.93**	**10.18**	**7.86**
Average waiting time in system (day/part)	**9.53**	**9.79**	**7.46**

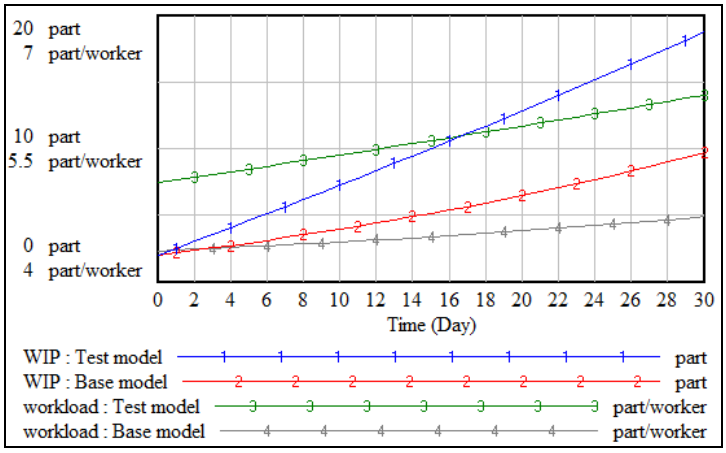

Figure 4 Behaviour of absenteeism and workload in production line

4.0 CONCLUSION

This paper describes preliminary work in evaluating the effect of absenteeism in the production line at aircraft composite manufacturing. The hybrid model is capable of analyzing the performance in production line operation with considering the human aspects especially on absenteeism cases. The aimed of developed the hybrid model is to mitigate the bottleneck problem and ensure that the workload of workers is at optimum level. As a result, an appropriate number of production plans will need to be further discussed in the future work where the findings of this study show that the number of absent affects the performance in production line systems. The developed DES-SD model can be used as a decision making tool by the plant's management to assist in the production planning. The future work will be highlighted on the interrelation and affected based on number of absentees and workload with productivity. The results generated from both the DES and SD is reliable and can be used as a decision support tool.

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