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Optimization of the production process using simulation modeling

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Abstract

This document seeks to enhance the manufacturing procedure of graphics card assembly within a certain organization. To enhance the manufacturing workflow, The Siemens Tecnomatix Plant Simulation application is utilized. The initial and crucial action to enhance the production procedure is to examine the existing workflow to identify where delays or interruptions are happening. Consequently, the initial simulation focusses on the existing manufacturing procedure. During the subsequent trial, the modifications have effectively executed all the suggested modifications in the enhanced production procedure. The encompassed substituting the human labour force with a pair of machines in the tenth phase, which entails the construction of sizable parts. The execution of the enhanced procedure enables the assembly of 44 graphics cards within a single hour, marking a rise of 15 graphics cards relative to the existing method. During a work period of eight hours, a total of 353 graphics cards can be put together, exceeding the existing production method by 118 graphics cards.

Keywords: Tecnomatix Plant Simulation; Manufacturing; Modeling; Product Lifecycle Management and Machine Production Management

1. Introduction

In order to stay ahead in the market, production firms must continually enhance the excellence of their operations using cutting-edge resources. A particular resource is simulation software, which will be addressed in this study. Modelling enables a broader spectrum of businesses to enhance their internal operations. The piece is segmented into four interconnected sections. The purpose of the initial section is to familiarize readers with the background of the topic and equip them with the essential theoretical insights needed to grasp the subsequent portion of the article. The following section of the paper outlines the employed methods, examination of the existing manufacturing procedure, modelling of the existing manufacturing procedure, and modelling of the novel manufacturing procedure. In the final section of the piece, we examined the findings thoroughly using the data from the analytical tools offered by the TX Plant Simulation software. The final section encapsulates the impact of our study.

1.1. PLM

Product Lifecycle Management (PLM) is a concept focused on overseeing all data concerning a product and associated procedures throughout its lifespan, from conception and manufacturing to retirement. The primary idea revolves around rapid retrieval of essential and current details regarding the item, serving as the foundation for maintaining standards, minimizing duration, and lowering expenses. When we refer to a PLM system, we are not talking about a singular, all-encompassing product, but rather a collection of software solutions (which may come from various vendors) [1]. The framework must interact with the project oversight platform and, when required, with the client's or organization's data systems. The PLM framework serves as the foundation for Industry 4.0, encompassing various other systems that are essential for execution in manufacturing. [2].

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Production Workflow Oversight - oversight of manufacturing processes, electronic production. Typically, it comprises a collection of tools, techniques, and software employed in the creation of goods [3].

The Machine Production Management (MPM) approach enables organizations to develop representations of technological workflows and subsequently analyze them, through the integration of information management resources and enhancing assembly into a shared platform. MPM systems in various settings shorten lead times, enhance design capabilities, and offer increased adaptability for modifications in product design [4-5].

1.2. Advantages of implementing MPM systems:

- Reduction of preparation time to produce new products.
- Reduction of commissioning and production time to achieve projected capacity.
- Optimization of production management

2. Methodology

This piece examines the production method of graphics card construction and highlights the crucial factors influencing the existing output. In order to assess the effectiveness of this method, the simulation tool TX Plant Simulation developed by Siemens is utilized [6]. Through simulation, the existing manufacturing method against the novel, cutting-edge graphics card assembly technique is evaluated.

Within the existing production method, the challenging obstructions in the hands-on assembly of sizable parts that necessitate particular care are recognized. This process requires a significant amount of time and may result in mistakes and reduced effectiveness [7]. To enhance this procedure, the hands-on assemblies of substantial parts are substituting with a pair of specialized machines. The operation of these machines will be handled by staff who has previously been involved in hands-on assembly work.

2.1. Analysis of the current production process

This examination centres on a particular method of constructing a graphics card during manufacturing. During the creation of visual processing units, numerous intricate procedures necessitate significant effort and intensity from the employees involved. The existing manufacturing procedure is segmented into thirteen phases, which we outline comprehensively:

- Employee oversight of standards: The initial phase in the assembly procedure involves oversight of standards conducted by staff members. This evaluation aims to confirm that every part and substance utilized in the construction procedure complies with the necessary criteria and regulations.
- Coating the top surface of the circuit board: At the start of the assembly process, the coating is spread over the top surface of the circuit board, which serves as the foundation for the electronic parts that will be attached.
- Assembly of parts: The following step involves placing each electronic part on the top side of the circuit board. The elements consist of microchips, resistors, capacitors, and additional parts essential for the effective operation of the graphics card.
- Attaching the elements: Following the placement of the elements, a joining procedure takes place where the electronic parts are securely bonded to the circuit board utilizing heat and solder material. This phase guarantees a dependable and lasting link between the elements and the circuit board.
- Employee-led quality assurance: Once soldering is finalized, a subsequent quality assurance check is conducted to confirm the accuracy and standard of the component connections to the PCB. Staff members verify through observation and testing that every component is accurately placed and linked.
- Coating the rear side of the PCB: A layer is subsequently spread on the rear side of the PCB, which will act as a foundation for additional elements and guarantee a secure link.
- Assembly of Parts: Following the application of the adhesive, additional electronic elements are positioned on the reverse side of the circuit board. These elements might consist of minor pieces and connectors.
- Attaching the elements: The elements on the reverse side of the circuit board are subsequently affixed, guaranteeing their dependable linkage to the board.
- Employee-led quality assurance: Following the soldering process, a secondary quality check is conducted, during which staff confirm the accuracy and dependability of the connections between the components on the reverse side of the PCB.
- Hand installation of substantial elements: This stage entails the hand installation of significant elements like connectors or larger pieces that necessitate careful handling.

- Setting up the cooler: The following phase involves the setup of the cooler, which guarantees adequate cooling for the graphics card and safeguards it from excessive heat.
- Examination: Once the construction is finalised, comprehensive evaluation of the graphics card is conducted, ensuring its performance and proper operation under diverse conditions and stresses are confirmed.
- Wrapping and following delivery: The final phase involves the wrapping of the completed graphics card and its transport to the location where it will be allocated and offered to buyers.

At present, there are 15 employees engaged in a single shift for the manufacturing of graphics cards. The personnel hold various positions in the manufacturing workflow, and their contributions are crucial for maintaining seamless operations without interruptions. Among the most active and crucial team members are evaluators and personnel tasked with the hands-on assembly of substantial parts.

Regulators play a crucial part in maintaining the standard of output. Their role involves examining and confirming that every component and item aligns with the set criteria and specifications. Their role involves guaranteeing that every graphics card is produced to the utmost standard and free from mistakes. Workers tasked with the hands-on setup of substantial parts play a significant part as well. These employees undertake the challenging task of accurately positioning sizable parts that necessitate careful management. Their responsibility is to guarantee the accurate and dependable linkage of these elements to the graphics board. Their efforts demand knowledge, attention, and proficiency. The application of paste, along with the assembly and soldering of components, is performed utilizing machinery.

2.2. Simulation of the current production process

Employing the TX Plant Simulation application, we modelled the existing manufacturing workflow for graphics card assembly, comprising 13 stages, which are elaborated upon in subsection 2.1. Table 1 displays the durations of separate manufacturing tasks.

Table 1 Work of all machines in current production

Name of the operation	Process time (s)
Quality control 1	45
Paste application 1	20
Installing components 1	30
Soldering components 1	60
Quality control 2	45
Paste application 2	20
Installing components 2	30
Soldering components 2	60
Quality control 3	45
Installation of large components	200
Installing the heat sink	40
Testing	80
Packaging	20

Table 1 shows that the longest operation of the manufacturing process of graphics card assembly is the installation of large components. This operation takes 200 seconds.

In Figure 1 the current production process can be seen in 3D.

Figure 1 Simulation of current production in 3D

The simulation of the current production process is set up for one work shift that lasts 8 hours.

2.3. Simulation of innovative production process

Within the context of the latest technological transformation, streamlining operations is a crucial objective. For this manufacturing facility, a decision was made to substitute the human labour force with a pair of machines to enhance the tenth stage, which pertains to the assembly of sizable parts. This modification could offer numerous advantages, including enhancing the efficiency and precision of assembly while minimising the likelihood of mistakes. Displayed in Figure 2 is the cutting-edge manufacturing procedure, modelled using the TX Plant Simulation application. The bright rectangle indicates the revised location in the production sequence of the graphics card construction.

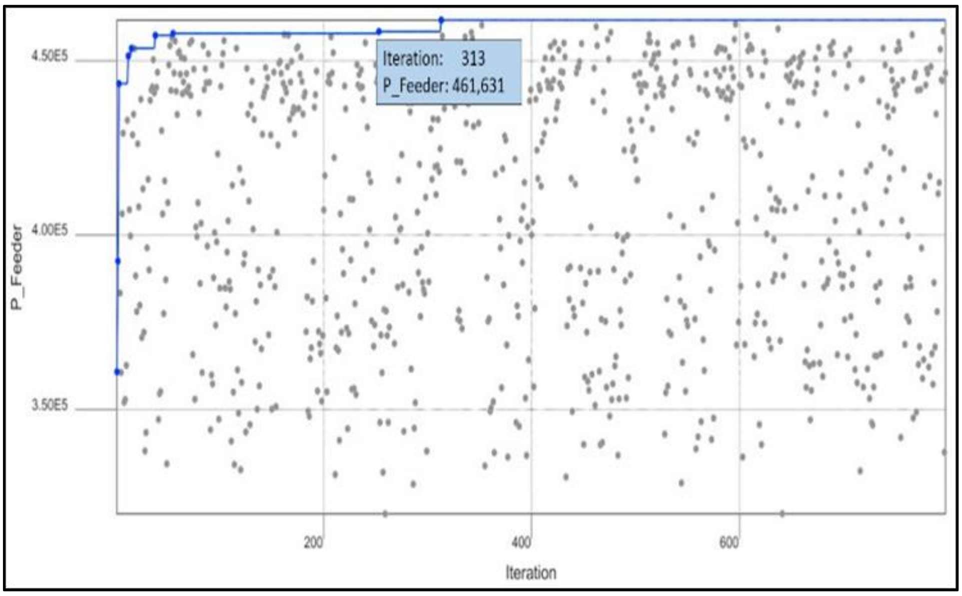

Figure 2 Simulation of innovative production in 3D

In Table 2, we can see the times of each production operation in the innovative production process.

Table 2 Work of all machines in innovative production

Run Number	# of Iterations	Execution Time (Mins)	P_Feeder Mean	P_Feeder Max	P_Feeder Min	P_Feeder STD
1	800	102	452,089	460,854	448,547	2,760
2	800	101	454,250	461,631	450,689	2,513
3	800	105	452,999	461,917	449,352	3,059
4	800	96	453,467	462,391	450,491	2,584
5	800	102	451,088	460,344	447,158	2,859
6	800	102	453,426	461,949	449,932	2,696
7	800	110	451,805	460,750	448,458	2,806
8	800	105	453,473	462,664	450,312	2,741
9	800	109	452,905	460,002	450,101	2,187
10	800	107	453,537	462,664	450,685	2,477
Average	800	104	452,904	461,517	449,573	2,668

In Table 2, the process time for installing large components has been reduced to 100 seconds compared to the original 200 seconds in the current production process.

The simulation of the innovative production process is set up for one work shift that lasts 8 hours.

3. Results and discussion

The efficiency results of the graphics card assembly production process using the statistical report offered by the Tecnomatix Plant Simulation software is evaluated. First, the evaluation of the simulation results of the current production process is carried out. In both cases, the simulation time is set to 8 hours.

4. Conclusions

In enhancing the manufacturing procedure, it is crucial to take into account every element that influences our production workflow. It is essential to thoroughly examine the reason behind the obstruction, explore ways to eliminate it, and consider if its removal might lead to another obstruction in the production process. Consequently, it is crucial for us to consider even the tiniest aspects to prevent setbacks [8]. The execution of the groundbreaking method enables the assembly of 44 graphics cards within an hour, marking a rise of 15 graphics cards relative to the current situation. In a span of eight hours, a total of 353 graphics cards can be put together, exceeding the current production method by 118 graphics cards.

This groundbreaking method of creation will offer numerous benefits. Initially, utilizing machines to streamline the setup of substantial elements will enhance the productivity and precision of this phase. Machines will have the capability to execute duties more quickly and with reduced mistakes. Additionally, workers currently engaged in hands-on assembly will have the opportunity to focus on other significant responsibilities that necessitate personal involvement and specialized knowledge. In general, the cutting-edge production method employing automation for the assembly of substantial parts is anticipated to greatly enhance the effectiveness, caliber, and overall functionality of graphics card production.

Considering the outcomes mentioned earlier, the groundbreaking manufacturing method realized a notable enhancement in efficiency. The existing manufacturing method enables the construction of 29 graphics cards within a single hour and 235 graphics cards over the course of an eight-hour period. Following the introduction of the groundbreaking method, efficiency rose markedly. A total of 44 graphics processing units can be put together within an hour, exceeding the existing method by 15 units. In a span of eight hours, a total of 353 graphics cards can be put together, representing an increase of 118 compared to the current output.

The findings suggest that the cutting-edge manufacturing method utilizing automated technology through robotics leads to a notable enhancement in effectiveness and output.

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