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# Literature Review on Industrial Process Optimization by Lean Manufacturing of Techniques

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***Abstract:*** ***The main role of lean production is to save money, produce production rate, and decrease all kinds of wastes [1]. Now a days all industries are trying to produce a good quality product, increases productivity so they are use lean tool and keep a float in market [2]. Single Piece Flow means that transporting parts during process from one step to next step is done without WORK-IN-PROCESS (WIP) involved in between single piece or a small batch at a time [3]. The main purpose of Single Piece Flow is to improve effectiveness and increase productivity, shorter cycle time by eliminating waste and various lean methods [3] [4]. Line Balancing is essential in all the production lines but there are always some bottlenecks in theassembly line which results in a lot of wastages. Here, they discuss lean line balancing as a simple tool forthe improvement in the electronics assembly line [5]. This paper summarizes problems, models and algorithms on robust assembly line balancing and discusses further on research [6].***

## I. INTRODUCTION

Lean manufacturing help to captivate manufacturing operations, select the industrial jobs and finest quality with good customer fulfilment in less amount. In manufacturing region, maximal quantities are produced by constructing fewer non-essential activities. [2]. Single Piece Flow describes the sequence of steps of assembly through a single unit or a small batchat a time. In large batch production, produces a large number of products at a single time [3] [7].

In Single Piece Flow, main focus is on the production process, without waiting, transportation and storing of productsby minimizing production line [3] [7].

Single Piece Flow focusing on to eliminate waste (i.e., NON-VALUE ADDED) [8] [4].

Single Piece Flow system works with various layout such as U-shape, C-shape, L-shape, S- shape, etc., in which all necessary tools and equipment are located near to operators that they can handle with minimum efforts [3].

Line balancing problem: A perfect balance on the line is achieved if the work elements can be arranged so that the station times are equal and hence, we can expect the production to flow fluently. In practical cases, it is very tough to achieve perfect balance.The slowest station (bottleneck) affects and determines the overall production rate of the line when workstation times are unequal.

## II. LEAN MANUFACTURIING TECHNIQUES

### *A. Methodology of Lean Manufacturing*

This study article is based on the literature review of lean manufacturing. In early stage, there are so many modernization concepts through web and books which provided attractiverecourses in research. The most favorable explanation has been identified by literature review. This paper will help to recognize the ideaof lean manufacturing, its enablers and barriers for achievement in industry [2].

### *B. Lean Manufacturing Tools Techniques*

While the foundation of the latest century manyorganizations are trying to be lean. This has ledto the progress/classification ofmany LM tools,techniques, and methodologies and daily new ones are being planned. LM has turn into an integrated system collected of highly inter- related basics and a wide range of managing practice, include 5S, JIT, superiority systems,effort teams, cellular manufacturing, TPM, Kanban, etc.

There are excess of different tools and techniquesfor different purposes and waste exclusion. However, the LM tools and techniques have manynames; some of them overlap with other tools andtechniques, and exacting tools/techniques might evenhave a dissimilar method of execution proposed by different researchers. Many of these tools and techniques are use in concurrence with each other to get the most favorable results [9].

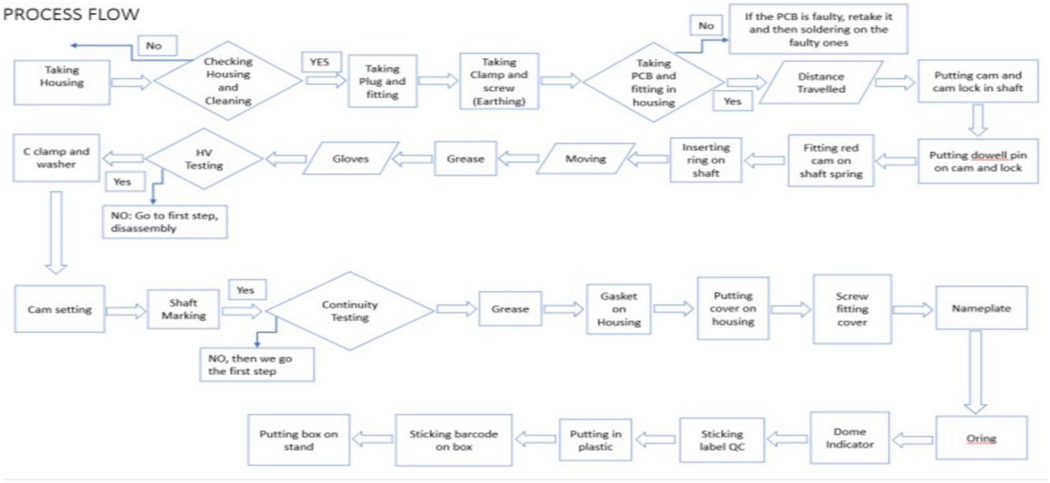
 

| Sr No. | Lean Manufacturing Techniques | Requirements |
|---|---|---|
| 1 | 5S | Decrease Wasted time and motion. |
| 2 | Automation | Decrease man power and provide correct automatic system. |
| 3 | Continuous Flow | Assure the constantly flow throughout the value stream. |
| 4 | Continuous Improvement | Make sure that every small progress every day and improve overall good organization. |
| 5 | Kan-Ban | Program production and reduce work-in-process. |
| 6 | Kaizen | Modify for best every day. |
| 7 | Six Sigma | Progress quality, operational presentation, practices and systems. |
| 9 | Total Quality Management | Progress quality by preventing error from happening. |
| 10 | Value StreamMapping | Think about of process and their conformance to lean manufacturing Philosophy. |
| 11 | Inventory Management | Place all stock products in a correct sequence to supply these items incorrect system. |
| 12 | Zero Defect Concept | To reduce all opportunity which are responsible for wastage. |
| 13 | Lean Thinking | Determine latest thoughts to bringmuch comfort level and profit toindustry by eliminating waste. |

### *C. Wastes in Lean Manufacturing*

Womack and Jones outline waste as any human action that absorbs resources however creates noprice. 'Muda' could be a Japanese word for waste and Ohno has known seven varieties of waste that also are called Ohno's seven muda. Waste is often joined to lean. Waiting is directly relevant to flow and it's in all probability the second most significant waste, this kind of wastehappens once product isn't moving, and it affectsboth the products and staff. [10]. This will affectproductivity and quality issue [10].

### *D. Existing Process flow of Assembly of Limit Switch*

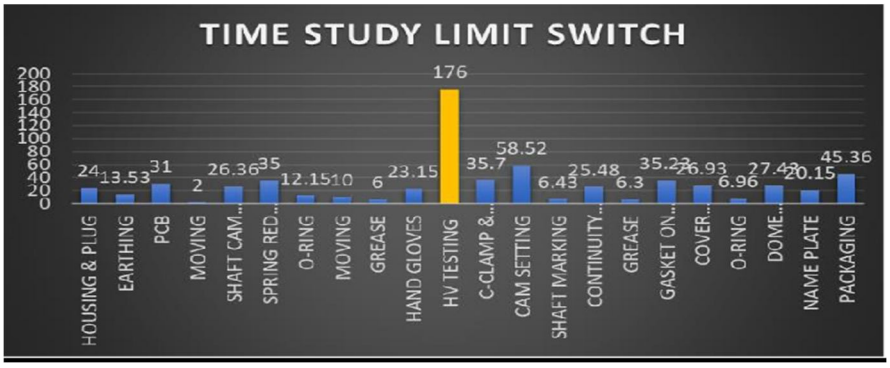


Time-motion study of limit switch

| PROCESS | NON VALUE ADDED | VALUE ADDED | NON ESSENTIAL VA |
|---|---|---|---|
| | | | |
| HOUSING & PLUG | | 24 | |
| EARTHING | | 13.53 | |
| PCB | | 31 | |
| MOVING | 2 | | |
| SHAFT CAM CAM LOCK | | 26.36 | |
| SPRING RED CAM FIXING | | 35 | |
| O-RING for shaft | | 12.15 | |
| MOVING | 10 | | |
| GREASE | | 6 | |
| HAND GLOVES | | | 23.15 |
| HV TESTING | | | 176 |
| C-CLAMP & WASHER | | 35.7 | |
| CAM SETTING | | 58.52 | |
| SHAFT MARKING | | 6.43 | |
| CONTINUITY TESTING | | | 25.48 |
| GREASE | | 6.3 | |
| GASKET ON HOUSING | | 35.23 | |
| COVER TIGHTNING | | 26.93 | |
| O-RING for Dome | | 6.96 | |
| DOME INDICATOR | | 27.43 | |
| NAME PLATE | | 20.15 | |
| PACKAGING | | 45.36 | |
| | | | |
| TOTAL SECONDS | 12 | 417.05 | 224.63 |
| TOTAL MINUTES | 0.2 | 6.95 | 3.74 |

*1)* This is the entire time-motion study of limit switch assembly.
*2)* The current cycle time is **10.89 min** and we have segregated the processes as non-value added, value added, and non-essential value added.
*3)* We have done time study on 15 assemblies to understand timing required for every assembly stages.
*4)* This data will be used to identify various bottlenecks and further improvement actions.

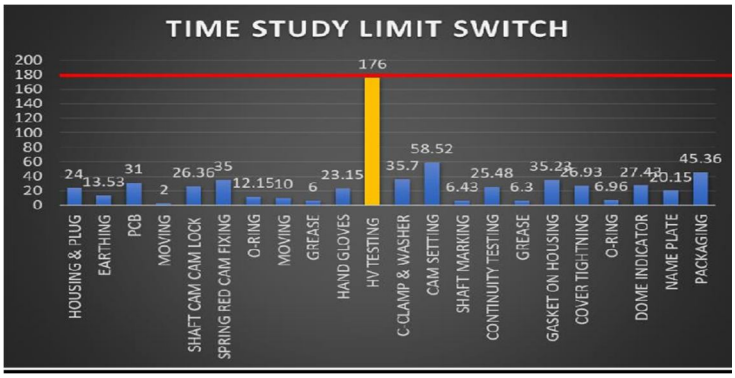
*E. Bottleneck (Identifying the Problem)*




*1)* Total Cycle Time for Limit Switch Assembly 653.68 Seconds (10.9 Minutes).
*2)* Bottle Neck Process HV Testing 176 Seconds (2.9 Minutes).
*3)* We have identified HV Testing Process as the bottleneck and hence it should be analyzed and reduced.

## III. RESULTS

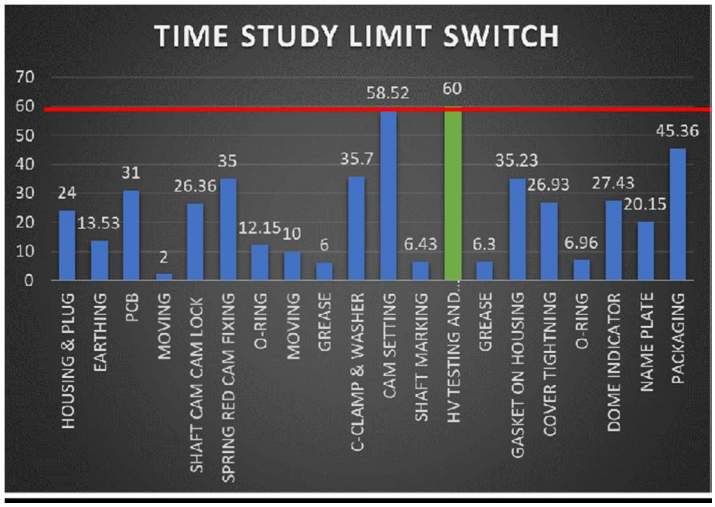
### A. *Before*

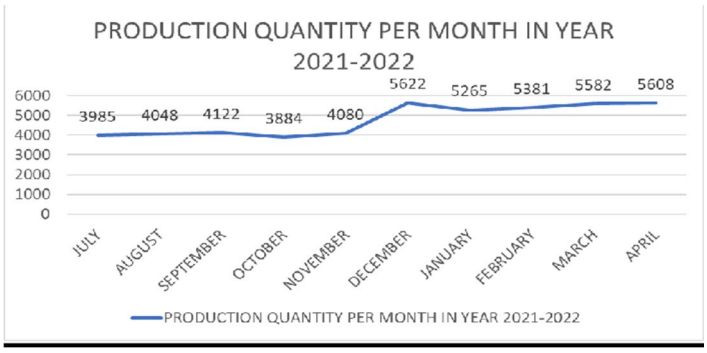



1) HV testing– cycle time 176 sec.
2) Continuity Testing- cycle time 25.48 sec.
3) Total production per month 4000 units avg.
4) HSE Risk: Manual HV and continuity testing by hand

### B. *After*

1) HV testing- cycle time 60 sec.
2) Continuity Testing – Cycle time included in HV testing
3) Total production per month 5500 units avg.
4) HSE Risk: Automation in HV and Continuity Testing



## IV. SINGLE PIECE OF FLOW

### *A. Research Background of Single PieceFlow [3]*

The sense of material flow optimization is to assist planners to satisfy customer's demands in shortened manufacturing orproduction time cycles. The subject of material flow optimizationfalls into production flow management or engineering management, which includes all aspects of all flows of raw materials, work in progress or finished goods within a plant orwarehouse.

### *B. Achieving Single Piece Flow*

Achieving Single Piece Flow Achieving Single Piece Flow (or connected flow) means implementing a way of connectingindividual process step within a value stream [7].

Single- piece flow is the ideal technique for creating connected flow because product is moved from step to step with essentially no waiting time [7]. There are many Single Piece Flow Lean Techniques and one of the techniques is JUST INTIME (JIT) well known as kaizen technique. In JIT unnecessary inventories in the factory will be completely eliminated, making space for stores orwarehouses. [3]

### *C. Implementing Single Piece Flow*

The initial step in implementing a single piece flow cell is to determine which products or product families will move into the cells and identify the sort of cell: Product-Focused or Mixed Model. For mixed model cells to work, changeovertimes must be kept short; a general rule of thumb is that changeover time should beless than one takt time. [3] [7]

Takt time is the rate at which a product should require to complete within a deadline to meet customers demand.

$$TAKT\ TIME = \frac{NET\ AVAILABLE\ WORK - TIME\ PER\ SHIFT}{CUSTOMER\ DEMAND\ PER\ SHIFT}$$

Finally, balance the cell and make standardized work for each operator within the cell.

$$NUMBER\ OF\ OPERATORS = \frac{TOTAL\ WORK\ CONTENT}{TAKT\ TIME}$$

### *D. Single Piece Flow Activity*

By rearrangement traditional straight assembly lines into a U-shaped layout, workers can move between the two legs of the U- line to perform combinations of tasks that otherwise are not permitted when using a straight-line layout. [3] In single piece flow,product is manufactured or assembled one at a time.

### *E. Effectiveness of Single Piece Flowinto Organization*

It can be measure in term of lead time and production output. Both standards can be measure in cellular production line by organize Gemba walk to draw the value stream mapping (VSM) for calculate lead time by using stop watch and observationto calculate the output. [3]

### *F. Value Stream Mapping (also called as VSM)*

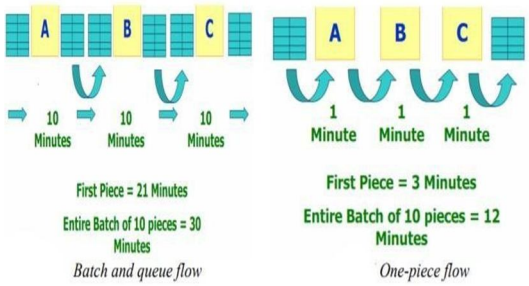
VSM is a lean manufacturing technique to analyze, design, and manage the flow of materials and data required to bring a product to a customer. Based on the VSM analysis the lead time will consider and value-added ratio (var) will be calculating tomeasure the efficiency of the singlepiece flow concept [3].

Single piece activities manage to minimize the waste or non-value- added activities, Highest percentage of value- added ratio (var) means the successful of the project. Another technique to measure the efficiency of the single piece flow is by monitoring the production based on hourly and daily. [3]

*G. Impacts of Singe Piece Flow Activity into Organization*

The impact of single piece flow activity into organization is illustrated by following example which shows the impact ofbatch size reduction when comparing batch and-queue flow with single piece flow.




We can see differences between these both flow systems are very huge. Single piece flow system saved 18 minutes for thesame batch (or lot) of 10pieces. [3] [7]

## V. REVIEWING THE METHODOLOGY- LINEBALANCING

*A. Motivation of the Authors/Why did they do it?*

To give continuous improvement and value to customers with less resources by introducing leanmanufacturing to drive the waste out. The aim of this project is to increase the operation effectiveness of the line while maintaining high productivity, resources efficiency, and reducing wastages [11]. Almost any changes in product design, directly affects the entire system which requires the rebalancing of the line and reallocation of resources. This paper discusses theproblem of reducing number of workstations.

This review shows that even a single product canlead to rebalance of assembly line in case of newcycle time. Assembly line balancing problem is interlinked with improvement of material and operations flow, better utilization of workstations (machines, robots, manual operators, etc.) and therefore we need to consider all the other possibilities. [12].

*B. How Did They Do it?*

A line should be analyzed with respect to assembly process, workstation layout, and workstation cycle time. There is a multiple activity chart used to calculate the cycle time at the workstation with the coordination between anoperator and machine, known as operator- machine chart [11]. Takt time is also calculated and then the line balancing chart should be drawnto identify bottlenecks points on the line and further value-added and non-value-added processes should be identified. Multiple activity chart, Ishikawa chart, and activity analysis table help in finding out reasons and the other alternatives to improve the line [13].

*C. How Did They Do it?*

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*D. Tools and Techniques Used*

A method was introduced in order to help the industrial engineers evaluate the impact of the design decisions on the assembly line performance during the whole program lifecycle. DELMIA method Engineer software and EADS is used because of the significance of the simulations at the stage [5]. Rank Positioned Weight Technique is applied to prioritize the tasks assigned to a workstation according to the remainder lead time. The preference is given to the tasks having a larger backward lead time. [14]

## VI. WHAT ARE CONSTRAINTS THEYCONSIDERED / LIMITATIONS?

The problems are in terms of structure and solution methods, and at the same time, they varyin the final objective to be achieved. Therefore, they have to deal with different sets of data, mustprovide with different kind of solutions and also mustbe addressed with different approaches. Themodelling the gap between data structures and main objectives should be minimum [5].

 

### *A. Research Gaps and Future Researched to Be Done*

Line balancing studies in assembly line do not mainly consider machine breakdowns, quality problems or absenteeism of experienced worker which drastically affect the line performances. So, therefore these uncertainty scenarios should also betaken into account in the design phase. Further work can be done in the variation of resource availability and variations inproduct mix could be examined and thus robust optimization models that incorporate these uncertainties should be devolved [6]. It guarantees workforce planning and resource optimization, but can it also improve the robustness of the line and does workload smoothing guarantee achieving the target cycle time and production amounts. [6].

### *B. Discussion*

Lean is a sea-depth idea in now days in industrial sector and for research study. We have found that lean manufacturing concept was followed by industries as a roadmap philosophy. In this paper, different lean program was talked about that canbe achieved through giving lean training to all workers. [2]

## VII. CONCLUSION

It is agreed that Lean manufacturing is the most valuable idea for manufacturing industries [2]. From the review of the papers, lean manufacturing is extremely necessary but there is a short achievement in industry. Lean is an energetic system to give a new achievement to industry & buyer. In most cases, a piece of a value stream can be changed or transformed into a single piece flow process (operation). This will decrease inventory levels, decreases manufacturing lead time, and advances (improves) customer service levels [3] [7]. The quality of the electronics assembly line was increased in terms of line balancing index, productivity, overall labour effectiveness, and elimination of wastes. From the research it is found that there are many wastes which could be eliminated with the simple lean tools [11]. The computer simulation helped in predicting system performance and in optimizing utilization of their resources through effective line balancing [15].

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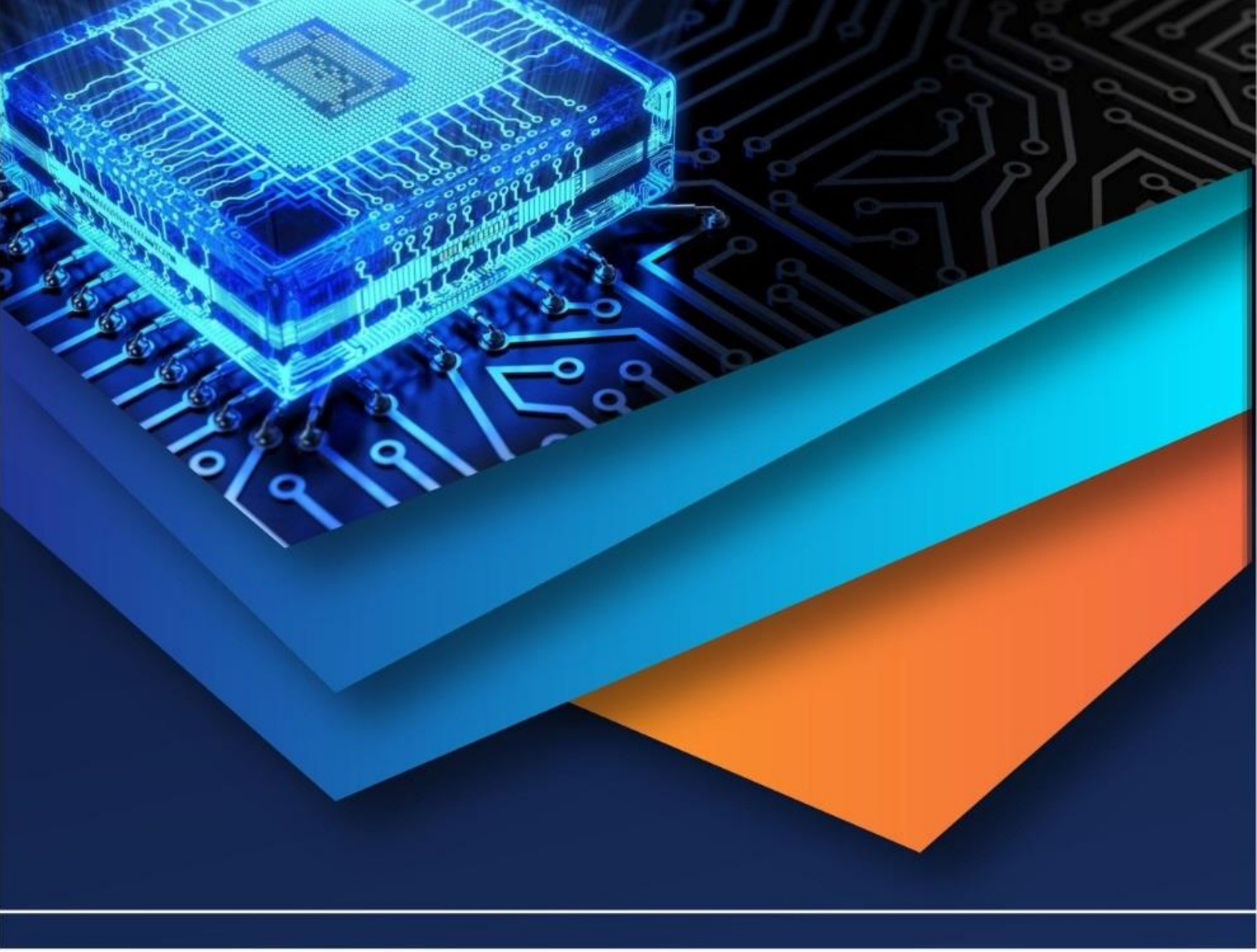

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