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Design and Line Balancing of Emerald Assembly Line According to Expected Demand in Switchgear Manufacturing

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***Abstract:** This paper focus on designing the new layout of Emerald line to fulfill the new expected demand according to takt time. Time study technique is used to record the cycle time of each process. Then cycle time is used for line balancing of the Emerald line by distributing the work properly. There was no one piece flow in the assembly line, so new layout is also design. Suggesting Manpower requirement for new assembly line.*
***Keywords:** Time study, line balancing, manpower allocation, one piece flow, takt time*

I. INTRODUCTION

Circuit breaker is an automatic operating electric switch designed for protecting an electric circuit from damage caused overload or short circuit. Main function of circuit breaker is to stop the current flow when there is any fault is detected in current flow. Circuit breaker can use many times just by resetting it again compare to fuse which can be used only once.

II. PROBLEM

Design the main assembly line for 13500 units per shift. Predicate manpower requirement, no. of station required and redesign the emerald layout.

III.METHODOLOGY

A. Takt Time

Design the line to fulfil 540 breakers per shift i.e. in 8 hours. So takt time of the line can be find as given below.
Takt time= (Total shift time)/no of breaker we wanted
Here, takt time=27000/540
=50 seconds
Now we have to balance this line on 50 seconds

B. Time study

Time study is used find the time of each activates in assembly process. That can be helpful to distribute the work between the operators.

TABLE I
TIME STUDY OF EMERALD ASSEMBLY LINE

Sr. no.	Station Name	Activity		Cycle time(sec)	Man
1	Lower link Riveting	Lower link Riveting	22.21	22.21	1
2	Mechanism	Mechanism assembly	86.70	86.70	2
3	Release	Fit c-core, Thermal screw and Grub screw in release	65.63	65.63	3
4	Drive shaft	Fit 4 release assembly in drive shaft	45.46	45.46	1
5	Lower contact welding 1	Lower contact welding 1	37	37.21	1
6	Lower contact riveting	Lower contact riveting	43	42.84	1
7	Lower contact welding 2	Lower contact welding 2	35	35.42	1
8	Arc chute	Fit Lower contact in arc chute housing	28.22	28.22	1

9	I-core	Fit Three spring in i-core	42.60	42.60	1
10	Kitting	Prepare kit for Assembly Line	53.71	53.71	1
11	Basic housing assembly 1	Take housing, mechanism and drive shaft on table	8.69	52.29	1
		Insert nut in housing	8.93		
		Fit mechanism and drive shaft in housing	19.16		
		Insert lower contact in housing	6.55		
		Check breaker and put in kit	8.96		
12	Basic housing assembly 2	Take housing on table	3.35	35.41	1
		Tap and fit lower contact properly	16.16		
		Apply molycoat on mechanism	13.67		
		Put housing in kit	2.23		
13	Basic housing assembly 3	Take housing and place in fixture	2.72	37.71	1
		Twist left and right plate	10.66		
		Open fixture and fit knob	8.01		
		Apply fevicol in breaker and put in kit	16.32		
14	Basic housing assembly 4	Take housing and insert four screw	13.63	41.23	1
		Fit arc chute in housing using screw driver	22.5		
		Fit cover on it	5.1		
15	Trip Force testing	Trip Force testing	39.18	46.02	1
		Placement and removal of Breaker	6.84		
16	Thermal Testing	Taking and placing breaker on table	6.16	51.34	2
		Thermal Testing	41.35		
		Placement and removal of Breaker	3.83		
17	Magnetic testing	Magnetic testing it has less time compare to manual work	35.11		2
		Taking and placing breaker on table	5.05	54.58	
		Fit three i-core in breaker	33.53		
		Placement and removal of Breaker	7.26		
		Writing reading in book	8.74		
18	Visual inspection & partition	Take breaker from table and insert Partition	16.22	40.25	1
		Check breaker	19.63		
		Placement and removal of Breaker in MV testing	4.4		
19	MV testing	MV testing	23.32	23.32	0
20	Cover Tightening	Insert and fit six screw in breaker	32.65	32.65	1
21	Accessory checking	Take breaker and insert UV and aux in breaker	10.33	47.6	1
		Fit front cover on breaker	2.49		
		Check breaker	26.2		
		Remove UV and aux from breaker	5.49		
		Remove front cover from breaker	1.9		
		Put breaker aside	1.19		
22	Front cover tightening	Take breaker and Fit PTT button	6.05	31.4	1
		Fit cover on breaker	4.21		

		Insert and fit three screws in breaker	21.14		
23	Terminal bolt Tightening	Make 8 thermal bolt and insert in breaker and fit it	70.94	70.94	1
24	Laser marking and MV Testing	Laser marking and MV Testing	7.47	46.57	1
		Placement and removal of breaker	39.1		
25	Shop Inspection (Production)	Stick left and right indication label on front cover	14.38	46.59	1
		Check breaker	32.21		
26	Qc inspection	Check breaker	43.77	43.77	1
27	Sealing	Sealing	19.24	19.24	1
28	Packing	Packing	30.95	30.95	1

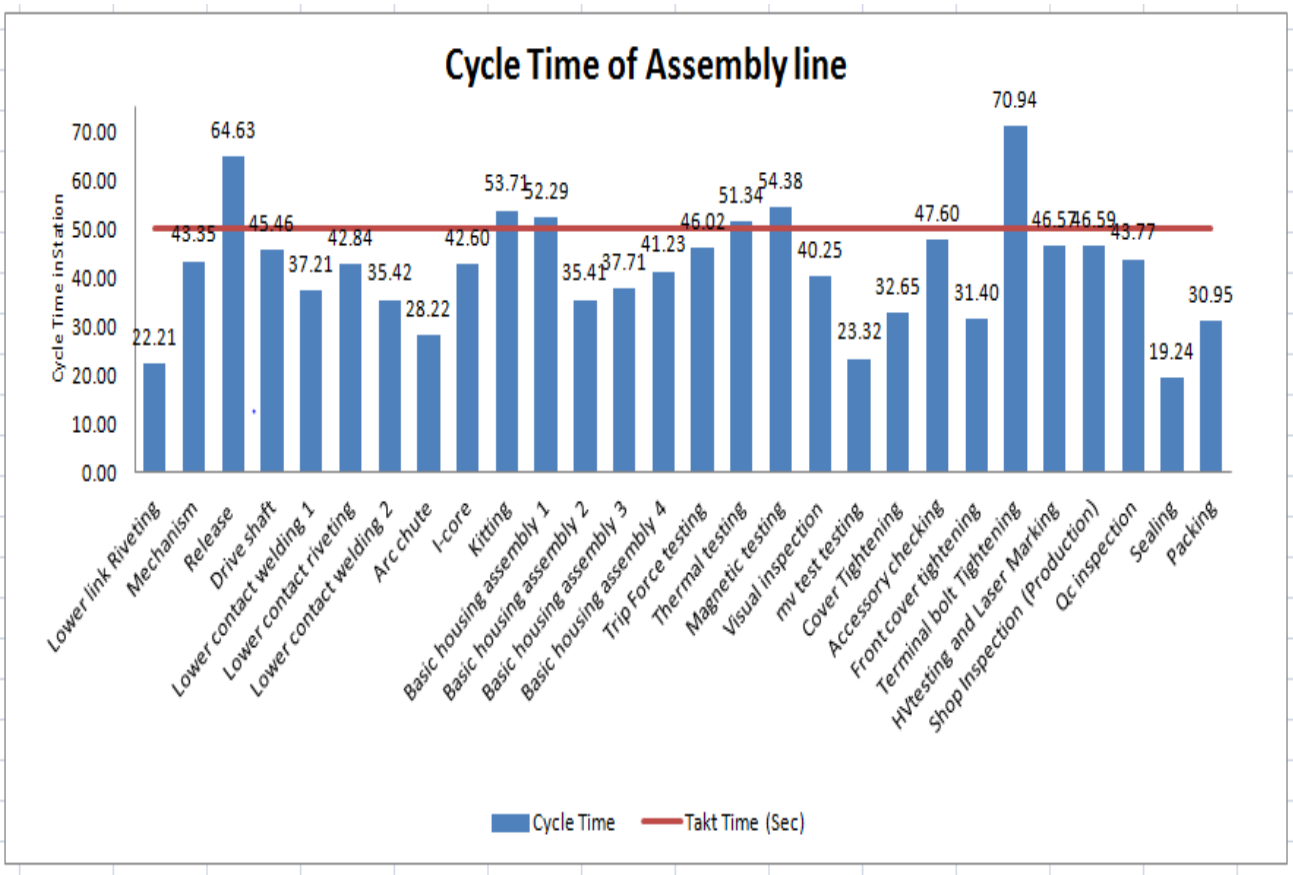

Fig. 1 Cycle time of assembly line

From above graph it can be seen that work distribution between different stations are not proper. Few station are taking more then takt time due to which they are bottleneck and reduce the total production capacity of assembly line.
It should be eliminated from process to increase the production of assembly line. To do so work distribution between station should be done properly and bottleneck station should be removed.

C. Material flow in Emerald

Alongside bottleneck, the layout of the shop is not good. There is no proper flow of material between station. Like thermal testing should be first then magnetic testing. But in current layout magnetic testing station is before the thermal testing.
Kitting station and main assembly line the rack due which operator has to walk 10-12 steps to take empty kit and place full kits.
Visibility of sub-assembly is low due to which, what are operator doing cannot been properly.

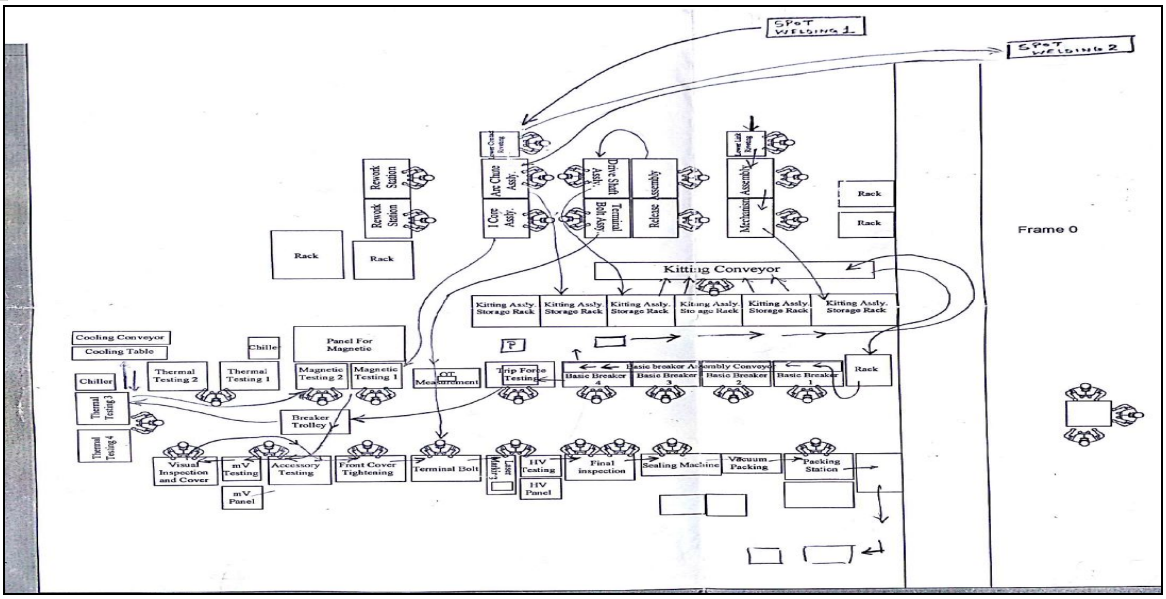

Fig. 2 Material flow in Emerald assembly line

D. Find improvement scope

As there is not proper work distribution as per takt time, so we can redistribute the work and bring cycle time of each station below takt time.

Walking of operator for kitting can be reduce by new layout.

Material flow in assembly can be improve.

Visibility of sub-assembly station can be improve by new layout design.

E. Line balancing

By doing work distribution between each stations and giving required manpower where they are required, the line balancing is done. New activity chart is given with cycle time.

TABLE II

TIME STUDY OF EMERALD ASSEMBLY LINE

Sr. no.	Station Name	Activity		Cycle time(sec)	Man
1	Lower link Riveting	Lower link Riveting	22.21	22.21	1
2	Mechanism	Mechanism assembly	86.70	86.70	2
3	Release	Fit c-core, Thermal screw and Grub screw in release	49.85	49.85	4
4	Drive shaft	Fit 4 release assembly in drive shaft	45.46	45.46	1
5	Lower contact welding 1	Lower contact welding 1	37	37.21	1
6	Lower contact riveting	Lower contact riveting	43	42.84	1
7	Lower contact welding 2	Lower contact welding 2	35	35.42	1
8	Arc chute	Fit Lower contact in arc chute housing	28.22	28.22	1
9	I-core	Fit Three spring in i-core	42.60	42.60	1
10	Kitting	Prepare kit for Assembly Line	47.91	47.91	1
11	Basic housing assembly 1	Take housing, mechanism and drive shaft on table	8.69	45.74	1
		Insert nut in housing	8.93		
		Fit mechanism and drive shaft in housing	19.16		
		Check breaker and put in kit	8.96		
12	Basic housing assembly 2	Take housing on table	3.35	41.96	1

		Insert lower contact in housing	6.55		
		Tap and fit lower contact properly	16.16		
		Apply molycoat on mechanism	13.67		
		Put housing in kit	2.23		
13	Basic housing assembly 3	Take housing and place in fixture	2.72	37.71	1
		Twist left and right plate	10.66		
		Open fixture and fit knob	8.01		
		Apply fevicol in breaker and put in kit	16.32		
14	Basic housing assembly 4	Take housing and insert four screw	13.63	41.23	1
		Fit arc chute in housing using screw driver	22.5		
		Fit cover on it	5.1		
15	Trip Force testing	Trip Force testing	39.18	46.02	1
		Placement and removal of Breaker	6.84		
16	Thermal Testing	Taking and placing breaker on table	3.16	48.34	2
		Thermal Testing	41.35		
		Placement and removal of Breaker	3.83		
17	Magnetic testing	Magnetic testing it has less time compare to manual work	35.11		2
		Taking and placing breaker on table	5.05	46.68	
		Fit three i-core in breaker	25.63		
		Placement and removal of Breaker	7.26		
		Writing reading in book	8.74		
18	Visual inspection & partition	Take breaker from table and insert Partition	16.22	40.25	1
		Check breaker	19.63		
		Placement and removal of Breaker in MV testing	4.4		
19	MV testing	MV testing	23.32	23.32	0
20	Cover Tightening	Take breaker and inserting six screw in cover	32.65	47.03	1
		Stick left and right indication label on front cover	14.38		
21	Accessory checking	Take breaker and insert UV and aux in breaker	10.33	46.41	1
		Fit front cover on breaker	2.49		
		Check breaker	26.2		
		Remove UV and aux from breaker	5.49		
		Put breaker aside	1.9		
22	Front cover tightening	Take breaker and Fit PTT button	6.05	48.92	1
		Insert and fit three screws in breaker	19.1		
		Make 4 thermal bolt and insert in breaker	21.73		
		Put breaker aside	2.04		
23	Terminal bolt Tightening	Make 4 thermal bolt and insert in breaker and fit it	48.87	48.87	1
24	Laser Marking and HV testing	Laser Marking and HV testing	46.57	46.57	0
25	Qc inspection	Check breaker	43.77	43.77	1
26	Sealing	Sealing	19.24	19.24	1
27	Packing	Packing	30.95	30.95	1

F. New Layout

With work distribution the new layout is also proposed with one robot in the assembly line. Now material flow in the assembly line has become proper. And walking distance of operator is reduced.

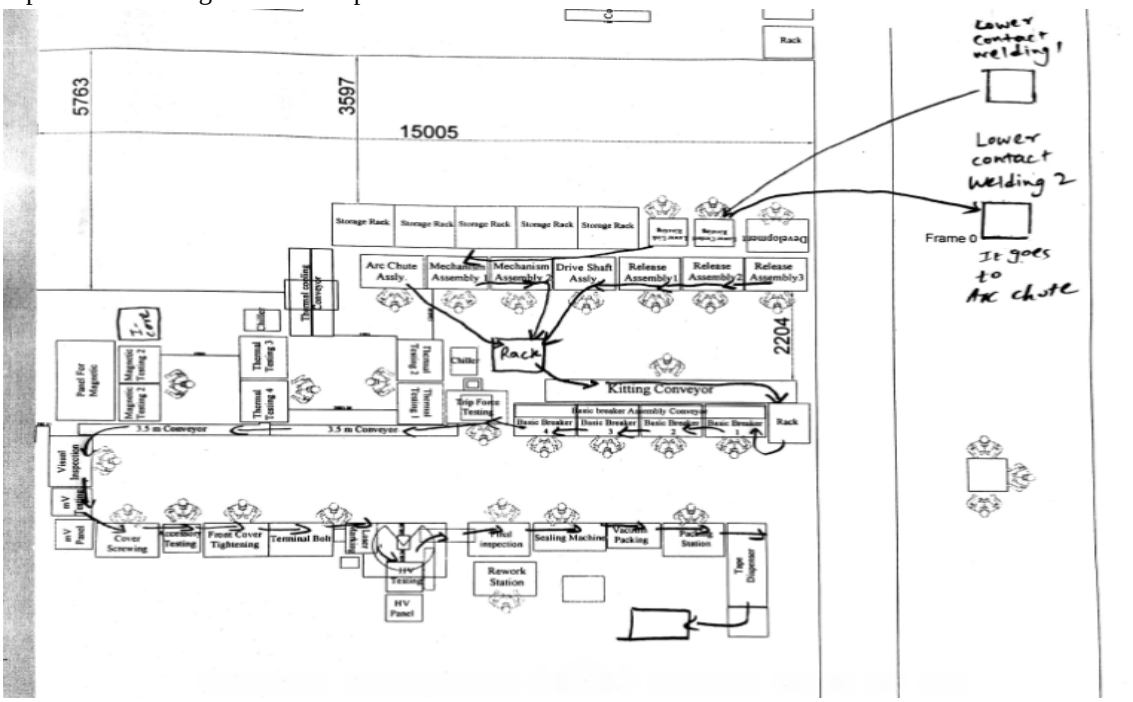

Fig. 3 Material flow in Emerald

IV. RESULTS

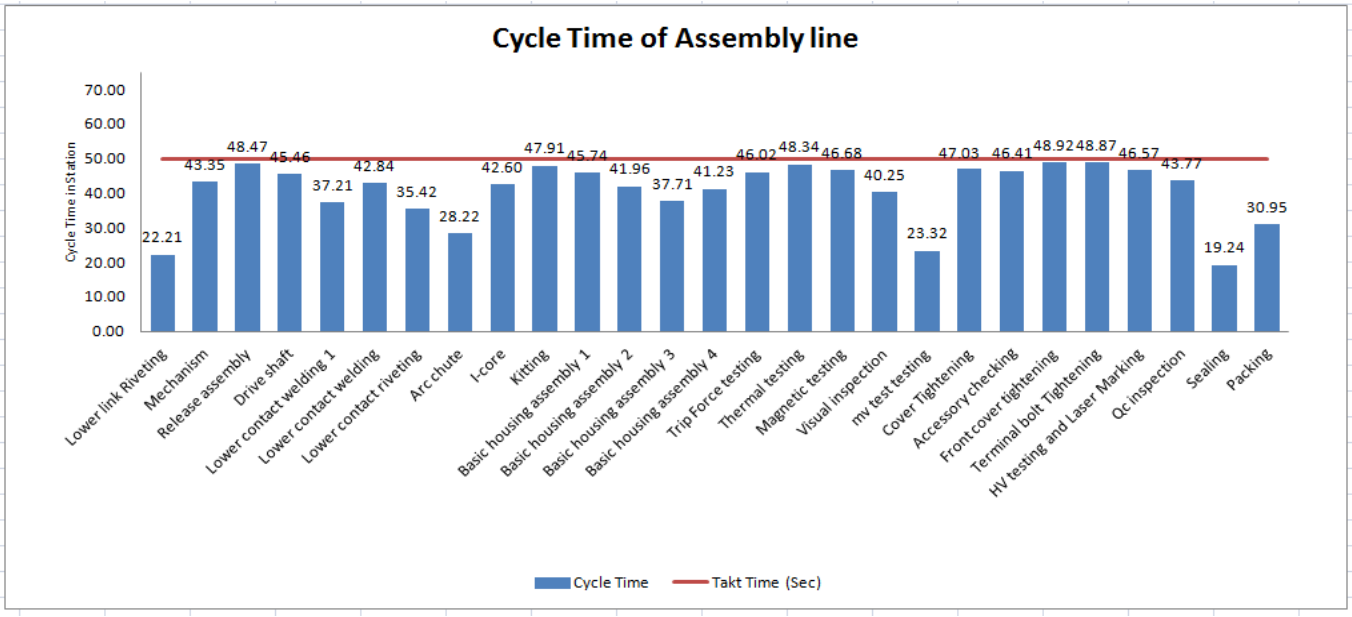

FIG. 4 CYCLE TIME OF ASSEMBLY LINE

It can be seen by doing work distribution the line balancing can be done properly. Now cycle time of each workstation is less than takt time as shown in graph above. As now all the cycle time of every station below takt time now required demand can be fulfill easily. Alongside of line balancing, new layout was also proposed for emerald assembly line. Now material flow has become smooth. Unnecessary movement of the operator is reduced. Visibility of sub-assembly station is now also improved.

Finally now we can make 540 units per shift. And manpower required for assembly are 31 operators.

V. CONCLUSIONS

Line balancing of emerald assembly line was not proper before. Some stations were taking more time then that of takt time. Due to which they were bottleneck of assembly line. Layout of the assembly line was not also good. There no proper flow of material. After redesign the layout, unnecessary movement of operators where reduced. The material flow in assembly is become smooth now. After line balancing of assembly bottleneck station were eliminated. Now 540 units per shift can be made easily. And manpower required are 31 operator for smoothly running of assembly line.

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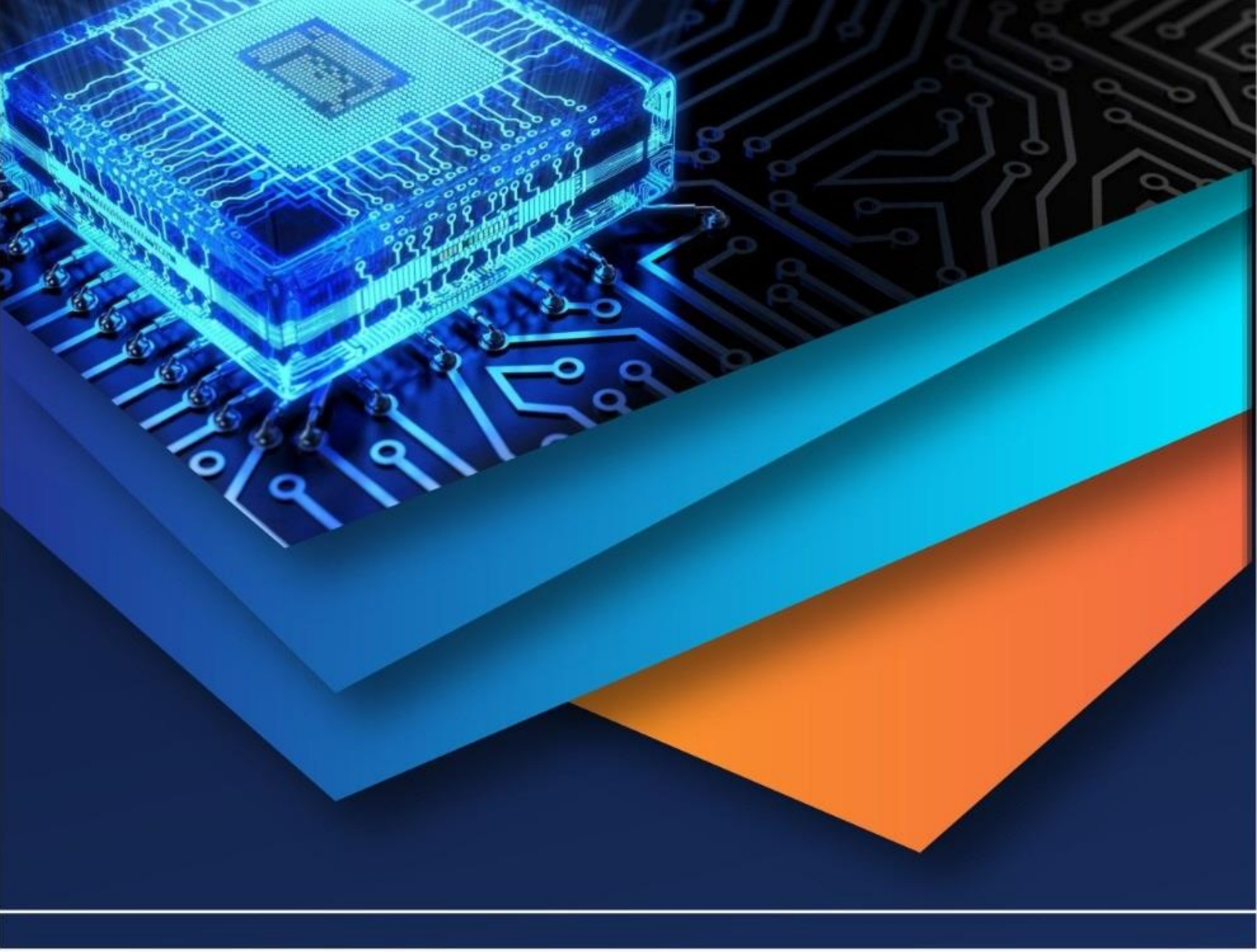

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