iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** IV **Month of publication:** April 2018

DOI: http://doi.org/10.22214/ijraset.2018.4625

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

Optimization of Laser Marking Machine by Design of Fixture to Reduce Cycle Time

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Abstract: ***Laser marking is the exercise of use lasers to imprint on the exterior of the object. The method does not include the use of inks, tool bits that causes damage to engraving surface, beneficial in the sense of eliminating the necessity of changing inks, tool bits on the periodic basis.The influence of laser marking has been more noticeable for special purpose " laser feasible" materials and also on some paints. It contains laser subtle polymers and innovative alloys of metal. The word laser marking is also used worldwide as it covers a wide range of surface acting treatments like printing, hot-branding and laser attachment. As there is one same machine for laser engraving & marking process that confuses to a person without knowledge of these processes. This work is carryout to design fixtures for laser engraving process in medical equipment manufacturing business situated in Ratnagiri. The machine is used to mark product details on the exterior of the work piece with the help of a laser. There is variation in part family created in the industry. Due to such variation, it will take additional set up time for fixturing of different parts. This increases cycle time. So fixture is planned for the part which made in large quantity, where maximum cycle time is lost. Bone screws of two different size are produced in maximum quantity than rest of parts for which fixture design.***

I. INTRODUCTION

Due to some drawbacks of old ink printing processes such as chemical disposal to the atmosphere, non-permanent mark, more curing time for the ink to get dry, untidy working conditions, the laser marking technic becomes popular inside the industry. It is possible to get greater finishing quality of product with greater process reliability. The benefit of laser marking over the old-fashioned technics are:1) long-lasting, high quality marks 2) large work efficiency 3) low operation cost 4) no need of separate working environment5) easy to automate & incorporate6) high reproducibility. The main objective is to design fixture for bone screws to reduce cycle time & increase production capacity.

A. Laser Marking Machine

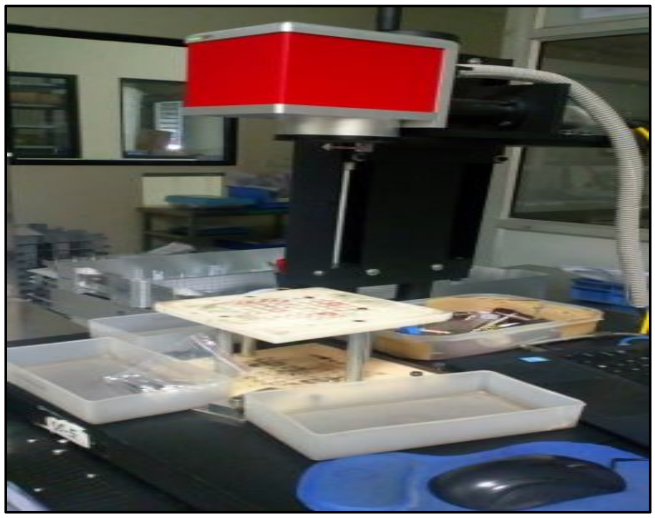

Fig .1 Laser marking machine.

It comprises of three main parts- laser, controller & exterior to act on. The laser is nothing but the ray released from pencil shape emitter which is directed by the controller on the chosen exterior. This exterior compulsory be laserable. The type of laser machine used here having both the laser & workpiece are stable whereas the laser ray is moveable by galvo mirrors as per necessity on the

exterior of the workpiece. The laser ray must touch the exterior at the focal point of the system. Laser ray mark only the area inside this focal point that causes warming of this area by the laser energy & disappears the material from it.

II. LITERATURE REVIEW

Ming- fei- chen [1] explain how the laser marking is superior to ink printing method. This system used in food industry to inform consumers about the freshness of the food & expiry date. ink printing can't be applied straight on the exterior of food as it causes chemical contamination of food. Whereas with laser marking directly figures & characters can trace on food. This process is carried out by using the co2 laser on the eggshell. According to experimental results, the laser coding neither harm to the lowest of eggshell nor heat affect the egg theca.

A. Astarita [2] focused on the study of laser marking of cold sprayed layers of titanium on the aluminum sheets. The trial is directed by changing the course constraints. Results indicate the usefulness of laser to have superiority marks on titanium layer & sheet. Also, there are chances of hidden damages in both materials if the constraints are not set properly.

Jianmei L [3] investigates the impact of dissimilar laser processing constraints such as fill spacing, current intensity, laser scanning speed, pulse rate on the quality of laser marked on the surface of aluminium alloys using ND: YAG laser. Effect of an individual factor is tested at a time. Results shows the impact of these constraints mostly on the exterior irregularity in unlike intervals.

Krystian L. [4] in their paper, reported about the newly developed laser-centered straight writing process. This helps to have security markings on the exterior of desired metals. It reduces problem-related to the use of holographic labels such as tempering & biocompatibility.

Christian Marx [5] investigates the profits of direct laser marking & identify the factors affecting it. The testing is carried out with the help of different laser wavelengths to mark a simple 9mm 2 sized 2D barcode on the outside of apple fruits. The process parameters like laser energy, laser wavelength, pattern dimensions, pattern design disturb the exactness of the pattern used. With suitable laser marking energy, damage to product exterior & possibility of fungal infection is minimized.

Stefan Rusua [6]presents a paper on the effect of radiation processing on titanium alloy.femoto laser marking technique is used instead of commercial etching methods. The examination has been done by using scanning electron microscopy, energy dispersive x-ray, spectroscopy & x-ray diffractometry.

Hyuk-jin kang [7] presented a paper on the use of laser marking process for the assemblage of light guide panel(LGP). It is a part of liquid crystal display(LCD), a backlight unit(BLU) used for display devices. Four constraints like power, scanning speed, the ratio of live gap & number of lines are selected along with a web-based device to develop sample patterns of (LGP)

C Leonea [8] presented paper on laser marking on AISI 304 steel using a Q- switched diode-pumped Nd: YAG laser. The aim is to determine the connection between working parameters such as pulse rate, beam scanning speed, current intensity & visibility of marks. Results imply that exterior roughness & oxidation is increased due to pulse frequency & mark visibility is affected by low scanning speed & minor current intensity.

Chetankumar M. Patel [9]presented paper on hydraulic fixture. It is design & construction of 8 hydraulic cylinder. It use to perform drilling and boring process on its both sides one after another by revolving it through half revolution. Yoke itself is consider during fabrication of fixture. Important feature of this fixture is collet. This collet enlarges to definitely fix yoke while performing an operations on it. The production time displays great variation after the use ofthis fixture while working on yoke.

Edurne Olaiza [10], in this the paper discussed adaptive fixture use to adjust the centre of the workpiece. It is adjusted twice, first with the center of the fixture when it is not connected to lathe machine. After that during centring of lathe when the workpiece with pallet & fixturing. For final centre alignment purpose, the actuator is used that is evaluated with the help of test bench. This fixture along with the actuator reduces the need for the manual inspection as well as process set up time.

Jigar D Suthar [11], presented paper on the fixture made for manufacturing of impeller used in the exhaust system of drum mix plant. Impeller helps to take out dirt out of the system. This fixture helps to secure different parts of impeller together for welding operation during business. the impeller itself used as fixture instead of additional fixture that will not only reduce unbalanced mass from 100gm to44gm but also alteration produced throughout the welding process

III. METHODOLOGY

A. select the exact part/part family which produce in huge quantity from a series of the parts that undertakes the laser marking process.

B. Collect information related to the laser marking process of the selected part

C. Note down the arrangement time taken off the definite product undergoing marking process.

D. Calculate the handling time per part.
E. Now design the fixture for a selected part placed on the laser marking process.
F. Apply the newly design fixture to perform marking process
G. Again note down the cycle time of the process & compute the processing time per part.
H. compare together the time before & after implementation of the new fixture.

IV. PROBLEM DEFINITION

Laser etching instrument is used in this production to mention manufactured goods details on a particular part. It includes company name, part number, lot number, in sequence numbers, date codes and barcodes & further important info. For this purpose at the end of the production process, each & every part arises at laser etching machine.

Around 50,000 components including 6000 subcomponents go under laser engraving machine per month in this industry. It includes Bone screws, orthopedical plates, hip joints, Exterior fixation devices, knee joints, backbone implants, Nailing system for leg fractures & various body joints. Every part is different in size from a bone screw up to Exterior fixation devices. Due to such variety of part size, it takes separate set up a time for each part. This consumes more time that will affect overall process time. Ultimately it reduces overall part production. So in order to overcome this problem, there is need of the fixture mostly for the part which produces in large number. The part which is on top of this list is a bone screw. These are of two type 1) 8mm Head- 8578 per month 2) 6mm Head- 13479 per monh.

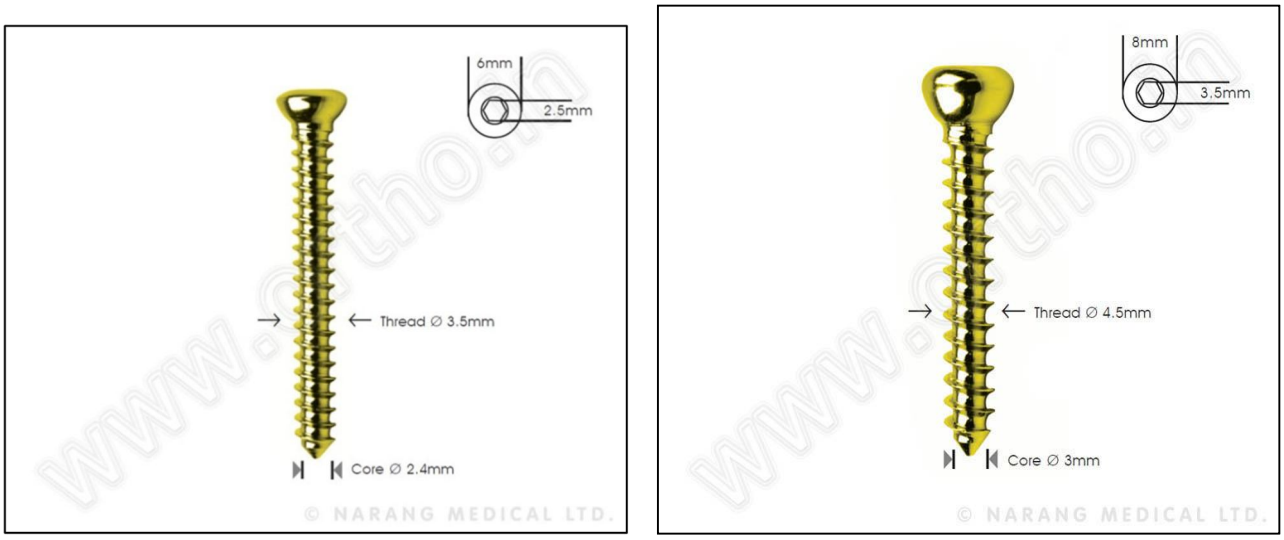

Fig.2 Bone screw of 1) 6mm head 2) 8mm head

A. Case study

For bone screw of 6 mm head:

1) By manual operation: n this method, by the use of existing fixture screws are feed manually. During this method, the time required to engrave one screw is calculated. It includes the setup time taken for every screw. The time occupied for production of the finished screw is as follow.

The overall number of bone screw produced throughout one shift = 2000
The overall number of bone screw produced per month =13479 no.
Total time available one shift = 8 hours – ½ hour of lunchtime
=7 hours & 30 minutes
= 450minutes
= 27000sec.
So, time required for production of one screw = 27000/2000
=13.5 sec per screw
This comprises set up time required for bone screws. So this setup time is needed to reduce taken by manual feeding operation
Following fixtures are used for manual operation of Bone screws.

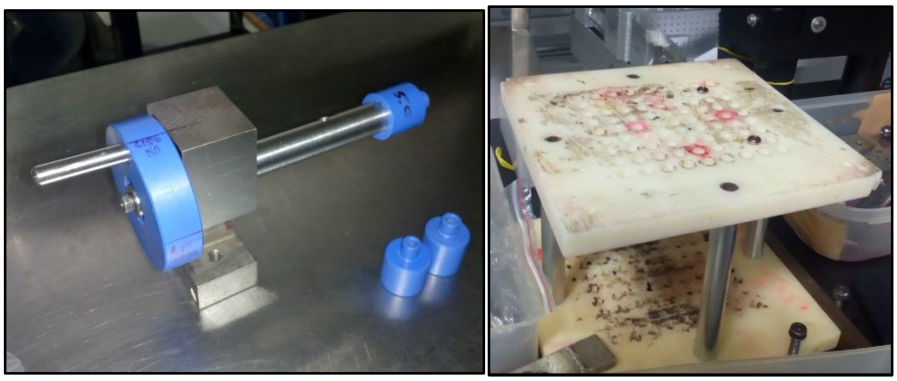

fig 3.existing fixtures use for laser marking

2) Using Automated Fixture

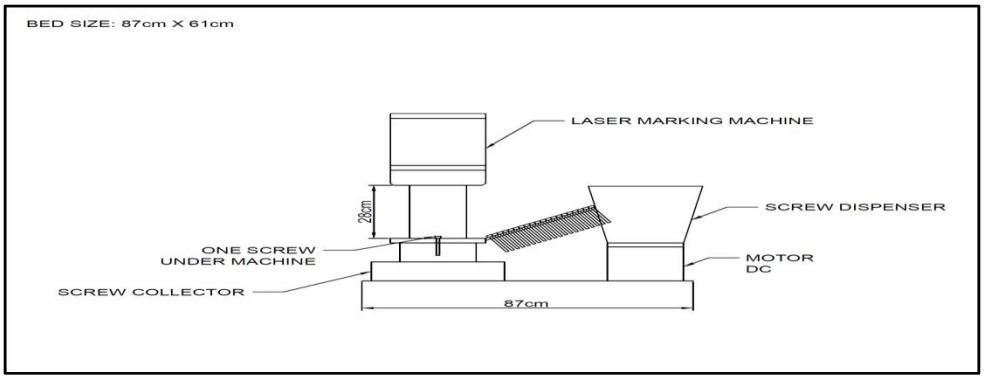

Fig 4.Automated fixture Prototype for laser marking

After manual method now automated fixture is applied for laser marking process. Instead of manual feeding of screws that consume more set up time, the automated fixture is applied for laser marking process. Now the time taken for marking of one screw is calculated as follow: By the use of automatic fixture, the time essential for the creation of per piece will be reduced to 8.5 sec. Now total time available during each shift =450 minutes = 27000sec. After use of automated fixture number of screws produced during one shift = 27000/8.5=3100 no. This shows a rise of 1100 pieces produced through one shift. The increment in production capacity will effect on the former count i.e.13479 per month. So, now a total number of pieces produced per month =20900no. This not only drops process time but increases production capacity of the company

V. RESULT & CONCLUSION

In this study, we not only focus on reducing overall fabrication time but also rise the making volume of company. Production time is decrease by decreasing course time taken by laser marking process. The more time consumption is due to manual serving of screws during engraving process. With the usage of automated fixture that feeds the screws in less time than manual feeding, we save set up time that is lost during manual method. After using automated fixture there is huge difference in time taken per screw than before. This is shown with the help of graph below:

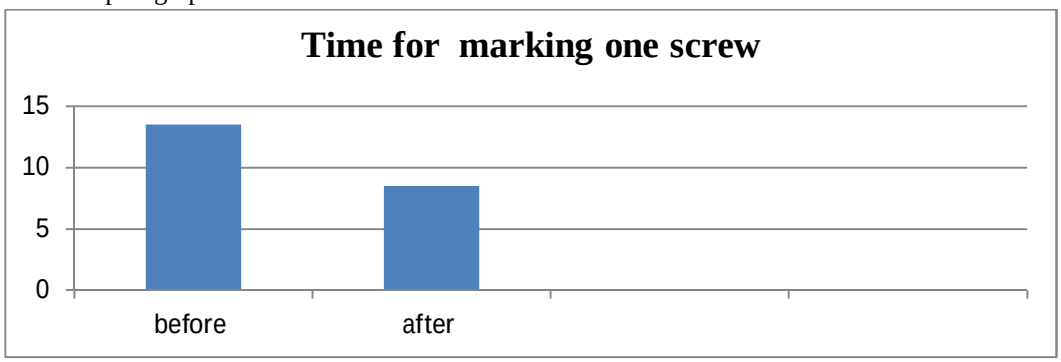

Fig 5.Time taken per screw before & after use of automated fixture

This decrease in time taken per screw largely effect on making ability of company per month. For 8mm head – production growths from 8578 to 13,300 per month For 6mm head – production rises from 13,479 to 20,900 per month.
This also shown in graph below

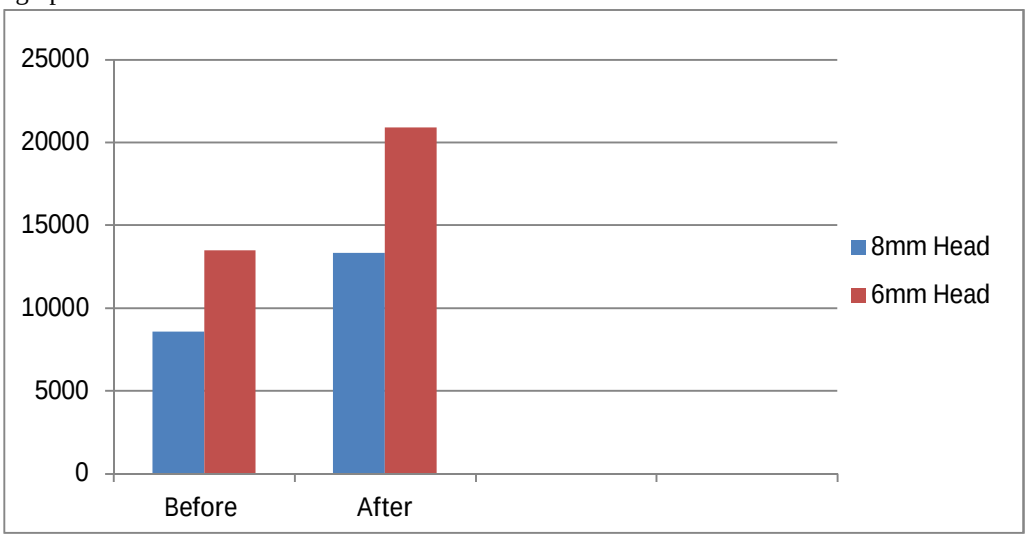

Fig 6. Production capacity per month before & after use of automated fixture**.**

Hence, it is finally conclude that with the use of automated fixture instead of fixtures that need manual feeding of parts the cycle time is greatly decrease..
Laser marking is the effective, a fewer time-consuming method of using lasers to engrave an object when compared to other techniques. But proper use of fixture is more important to make the laser marking efficient. Here in our case due to the variety in part size, there is need to use different fixture for each part type. This ultimately takes more set up a time for every part type. In order to decrease the cycle time, an automated fixture design is needed for the part which produces in huge quantity i.e. Bone screws. By the use of this automated fixture, it is not only possible to save cycle time but there is an increase in productivity. This decrease in course time have major effect one total production capacity. It will definitely rise the production amount by greater margin. At the same time, it makes effective usage of laser marking machine Also, it is possible for one operator to handle two machines simultaneously which also increases the production rate**.**

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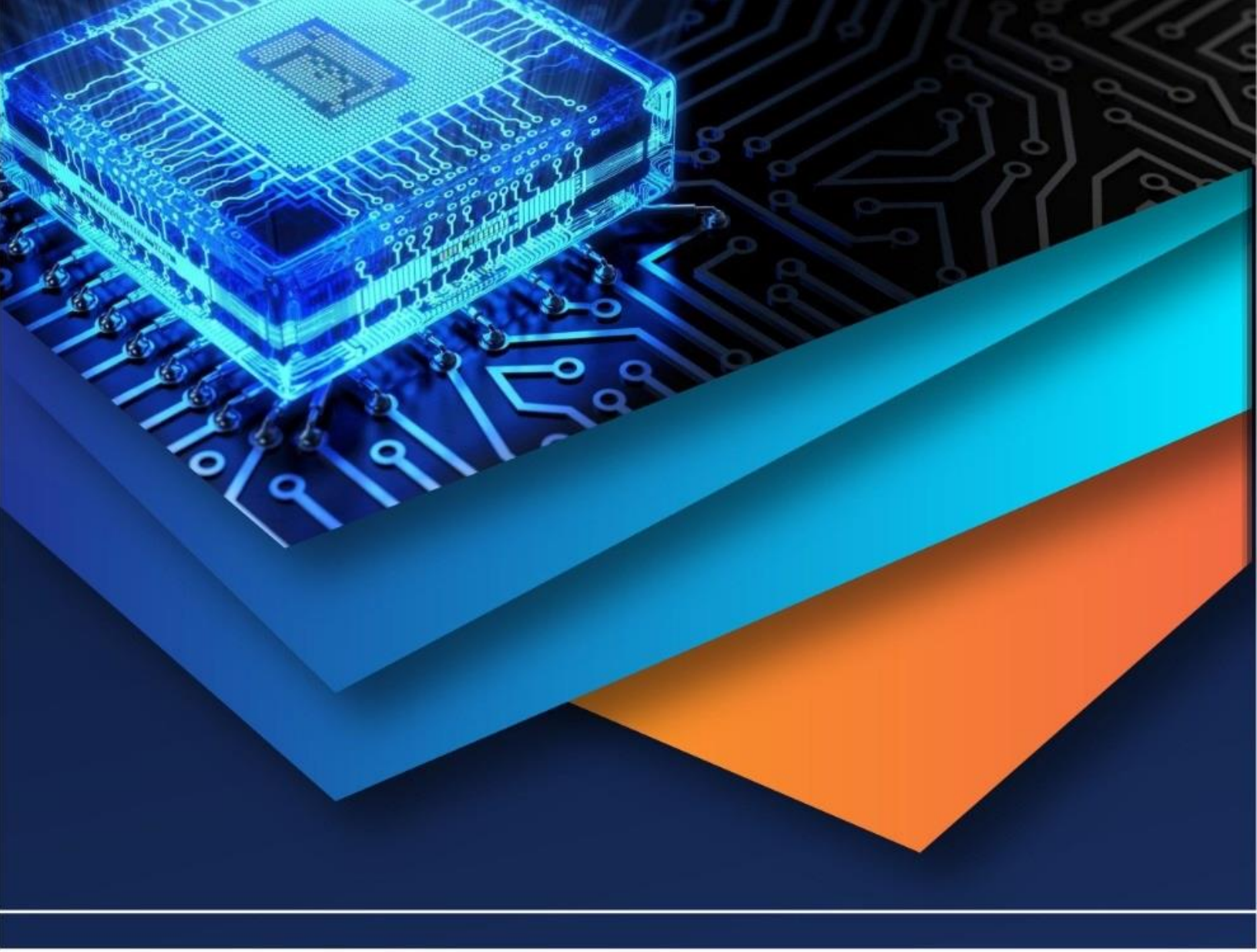

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