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PRODUCTIVITY ENHANCEMENT IN FIXED POSITION LAYOUT OF AN AUTOMATION INDUSTRY USING INDUSTRIAL ENGINEERING TOOLS

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Abstract

It is of crucial importance for all sorts of industries to consistently remain on the path of achieving optimum productivity in order to survive in the constantly enlarging competitive environment. In process or product layout i.e. in the batch or continuous production, it is much simple to evaluate the productivity by calculating amount of input resources spent for manufacturing unit product. Whereas it is a complex process to calculate productivity of fixed position layout in which every product is a turnkey project. The scope of this research study is to discover and apply some of the methods specified in the contents of industrial engineering sciences to evaluate the productivity of fixed position layout. Those include methods of work study, method study, time study etc. The analysis of wastage is also taken into consideration in order to determine the efficiency of suggested improvements. In order to design the plant layout, activity relationship diagram is the tool used as it accurately positions each activity with respect to the other. By means of this study, an attempt is made to resolve the standard procedure of estimating productivity of fixed position layout type of industries. This study has obtained the numerical values of productivity which are to be uplifted by implementation of suggested improvements.

Keywords: Automation, Fixed position layout, Plant layout designing, Productivity, Work study

1. INTRODUCTION

The automation sector of any industry plays a vital role in the fulfilments of various production and supporting activities with utmost efficiency. Therefore, it is important for this sector to continue the exploration of newer fields to apply automation and thus to provide a helping hand by reducing human efforts. Various process industries find finest applications of automation as there are many environmental constraints such as uncomfortable temperatures, humidity, vacuum where the human body cannot sustain for a long period of time. Minute size of products is also a constraint for human employees to function with efficiency.

This project was performed in an automation industry located in Talawade, Pune where a variety of such machines are manufactured according to the customer requirements and specifications. Taking from simplex bowl feeder, the industry is experienced in manufacturing huge automated setups where minute workpieces pass through them while processing and the finished product is collected at the output manifold. Mainly, the pneumatic system and electrical servomotors are used to achieve all types of actuations. In order to sustain the highspeed production, various industries need handy position of small components at the time of assembly. This is where the products of this industry come into the picture. Using bowl feeders and various other arrangements such as conveyers, sliding lines and various tubes, the industry provides multifunctional singular machine which is capable of providing small components with comfortable positions for assembly. For example, the screws which are randomly poured into the bowl feeder at the input, are held in two supports at their heads and they slide in a line towards the output manifold. In the same way, various food items, packaging items, plastic lids, rubber seals, screw plugs and small bulbs are positioned accordingly which reduces the assembly time by a large margin. These machines also provide rejections of faulty workpieces with the help of sensors and some actuators. Many times, in case of plastic components, a small diameter compressed air hose is provided in a particular direction in order to blow away the faulty workpieces.

Now, it is to be understood that for the purpose of testing of the setup, such small components are provided to the industry by their customers in a definite amount. The bowl feeders are manufactured according to the sizes of such small workpieces and hence, such test specimens are to be provided by customer industry. Here, the occurrence of one of the major problems was observed. Those small components, after being rejected and blown out of the output manifold, were being misplaced and due to lots of packaging and waste materials lying around, it was nearly impossible to find them afterwards. At various instances, due to some vibrations or due to some errors in the manufacturing of output manifolds, many of the acceptable components were also being misplaced from the output line. Hence along with this, the major problems faced by the industry were as follows:

1. Misplacing of small components provided by the customer industry

2. Depreciation of ready-to-assemble consumable components and other outsourced materials
3. Narrowing of walkways due to increasing wastes and packaging materials
4. Numerous defective components machined in-house i.e. varying from required dimensions

It is important to encounter these problems in order to achieve observable rise in productivity. While understanding different methods of determining productivity, these are the problems that result into failure of the functioning of existing system with maximum efficiency. Most of these problems were occurring frequently and the root cause behind their occurrence was the errors in the existing plant layout. Hence it became crucial to review and modify the plant layout with scientific methods determined in facility planning approach.

Objectives of the Research:

- To develop clean workplace area by segregating packaging and waste material from useful goods
- To achieve reduction in wastage occurring due to misplacing of small components provided by customer industries
- To achieve reduction in rejections causing due to improper machining
- To avoid degradation of different outsourced materials placed in shop floor

Increment in customer satisfaction is also an important parameter in evaluation of productivity of any industry. Consistent errors in machining were reflecting into increased load on quality department, at the same time minute errors unnoticed by quality control were causing numerous customer complaints. Reduced number of customer's small products at the time of delivery was also damaging the image of industry.

2. METHODOLOGY

A. Depreciation of Outsourced Goods on Shop Floor

As every product of this industry was customer specified and hence unique, a general practice was being followed in order to save the costs of packaging materials. The packaging material received from various supporting industries was stacked in the shop floor after removal of goods in it and it was reused while packaging of complete setups i.e. the finished product of this industry. Hence, huge stacks of packaging materials were observed at random places and due to duration of assembling the setup was comparatively short, there was no botheration regarding these randomly stacked materials. It is to be understood that this industry was assembling the setups and hence not all of its components were manufactured in-house. Many of the components such as customized conveyers, vibrating element of bowl feeders, many electrical components were outsourced by the industry.

Fig. 1: Mini conveyer

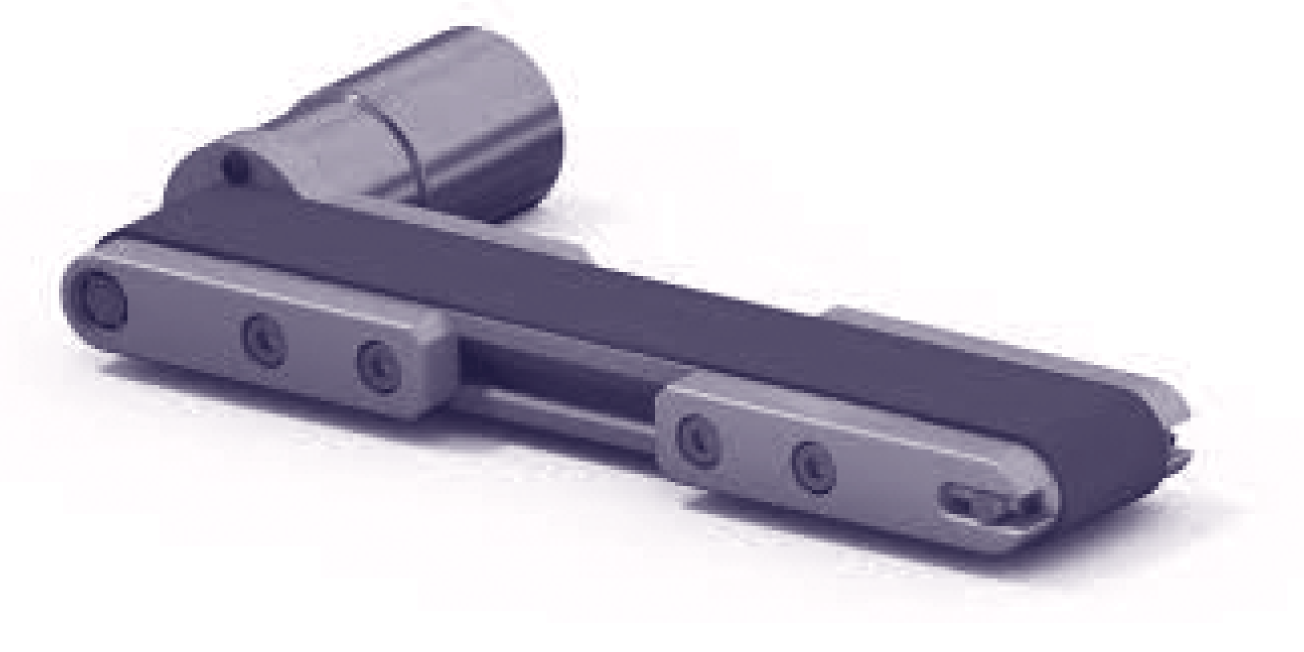


Fig. 2: Vibrating bowl feeder

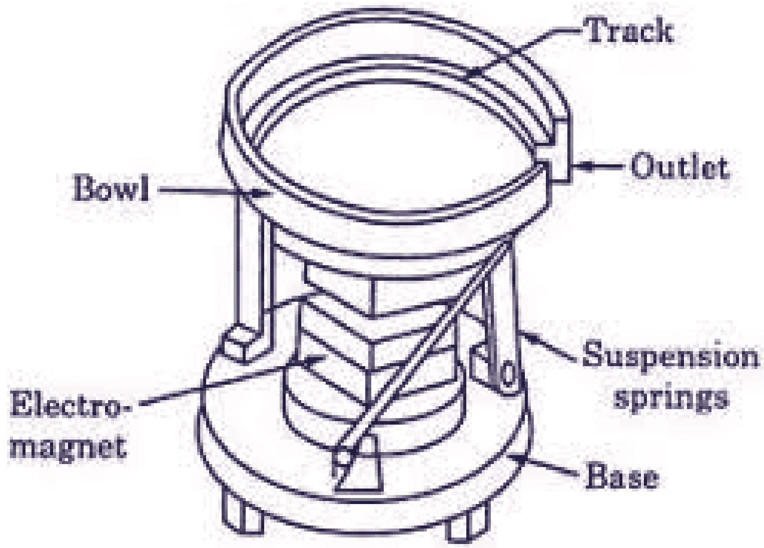


Fig. 35.3. Vibratory Bowl Feeder.

Due to constraints of space availability, these outsourced goods were placed in shop floor only till the point of their consumption in the assembly. Now, because of randomly placed packaging materials and other wastages, these products were being exposed to various unnecessary environmental conditions such as machining chips, dust, dirt etc. Also, due to machining vibrations and welding temperatures, electrical components inside these goods were damaged very frequently. It was being impossible to separate them from the waste materials and hence there was no provision for providing appropriate conditions to these materials. At the time of assembly, the defects of these goods were observed and it was very hectic to troubleshoot their defects at that instant. The manufacturers of these products were not responsible for their defects and still they had to recover such defects in very short period. At many instances, vendors used to refuse the repair or replacement in such short period and thus, all this phenomenon was resulting into delay in delivery and customer loss. Also, a separate team was assigned to resolve the problem in-house if possible and that costed into overriding of the schedules. Hence it became crucial to solve this problem of depreciation of these goods.

The segregation of outsourced goods from the packaging and waste materials and positioning them safe from the machining and welding shop was only possible through modifying the existing plant layout. After reviewing all possibilities of positions for these goods, management decided to provide them a position nearest to the assembly area. Allocated position to these goods is shown in the modified plant layout in fig 7. Now, before and after this modification was implemented, some weekly observations were taken to analyse usefulness of the modification and increase in productivity through it.

Table I: Observations for depreciation

Before Modification			After Modification	
Week .No	Number of products consumed	Number of defective products	Number of products consumed	Number of defective products
1	22	7	27	2
2	17	4	24	3
3	29	9	32	5
4	21	5	22	3

The estimation of productivity is performed by considering the ratio of number of useful products found to the total number of products consumed in the months of observation before and after the modification. Therefore, productivity before implanting modification is 64/89 = 71.91%. On the other side, productivity after implementing modification is 92/105 = 87.61%.

B. Misplacing of Small Components Provided by the Customer Industry

This problem was not only delaying the delivery dates, but the continuous production was being hectic for the employees because of this problem. Various small components which were products of the customer industry were getting misplaced on a large amount. Such products included plastic rings, seals, bottle caps, rubber lids, small screws, screw plugs, clamps etc. These products were provided by the customer industry in a definite amount as a reference for manufacturing of bowl feeders and other systems and it was expected to return these products at the time of delivery. But such products were getting misplaced due to vibrations, faulty guideways, rejecting actuators and thus the number of returned products at the time of delivery of the setup was relatively low.

The complexity of searching such missing products was very high due to random racking of packaging and waste materials. Usual practice was to remove these materials once per month and hence at that instant, such lost products were found. But the setup related to those products being already delivered along with available number of products, those products at that time were nothing but the waste. This resulted into enlarged amounts of waste and thus into reduced productivity. In the earlier problem as well, randomly racked packaging and waste materials affected the outsourced goods on a large extent. Therefore, it was important to remove such materials more frequently and to filter those materials for missing number of products before sending them to waste management.

To provide a system of waste removal, an arrangement of a trolley was performed and it started to visit each workstation on weekly basis. The work of that trolley carrier was to collect all sorts of non-metallic waste materials in order to keep workplace area clean. This system solved the problem of narrow pathways and accidental hazards were reduced by a large margin. A provision i.e. a tray was additionally attached to the trolley to hold the small workpieces so that whenever the trolley carrier found any small workpieces while removing the waste, those components were stored it that tray.

Fig. 3: Trolley for waste collection

Table II: Observations for misplaced products

	Before Modification			After Modification	
Industry	Number of products provided	Number of products returned	Number of products provided	Number of products returned
1	177	145	148	127
2	183	162	103	86
3	126	88	89	78
4	168	113	176	153
5	119	84	147	132
Total	773	592	663	576

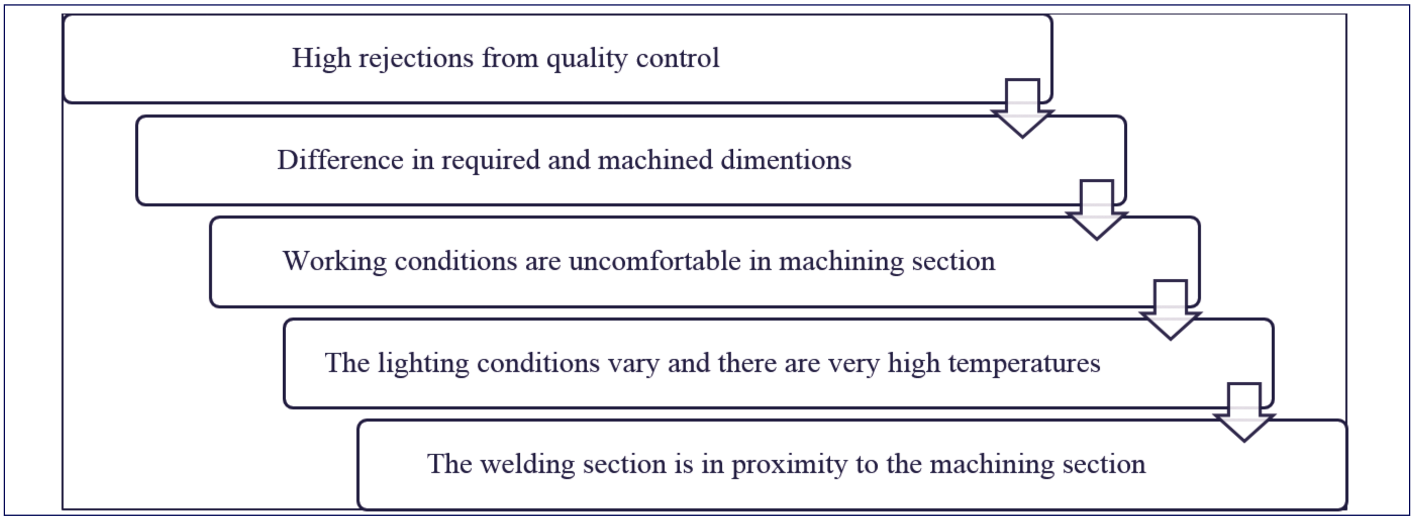
The numbers of returned products before and after the successful and consistent implementation of weekly waste removal system were observed over a month and total number of products provided by the customer industry was considered as a reference. The productivity was calculated by the ratio of number of products returned at the time of delivery to the total number of products provided by five customer industries.

Now, productivity before the weekly waste removal system can be found out as 592/773 = 76.58% whereas the productivity after the modification is 576/663 = 86.87%. Thus, the improvement in the productivity due to implementation of weekly waste removal system can be clearly observed. When the waste removal was performed monthly, a small truck was used to carry the waste and it was loaded with the waste by the employees only. But as a trolley was used in weekly waste removal process, human efforts were reduced and hence employee job satisfaction was also achieved. The allocation of trolley carrier duty was distributed using rotation method among the employees.

C. Consistent Errors in the Machining Process

This problem was observed occurring most frequently and due to this, the workload on quality control department was increasing. A large number of products machined by the employees were getting rejected in quality checking and a lot of efforts were being wasted in reworking and rechecking their dimensions. To understand the root cause of this problem, the 5WHY analysis was performed.

Fig. 4: 5WHY analysis



Hence, after performing the 5WHY analysis, it was observed that the employees in the machining section were observing constantly varying lighting conditions and relatively high temperatures while working due to proximity of welding section to the machining section. After discussions, it was found out that they were not able to observe the machined dimensions even using metrological instruments accurately because of the varying lights emitting from welding. The high temperature around the welding section was also the reason behind uncomfortable working environment near the machining section. The welding process is performed in this industry to provide the upward helical tracks for components inside the bowl feeder. Here, two small welding tables were provided with the steel shield at front and the welders were properly using personal protective equipment while working. As the machining section was located behind the welding section and there was no protection for the welding tables in the back, the employees working in the machining section wee observing hazardous welding fumes with unprotected eyes while working. Also, the machining section was located below the corporate offices and hence the ambient light was barely reachable to it. Hence, the machining was always performed with the help of artificial lights and here the welding fumes were causing the problem to the employees to read the observations on their metrological instruments. In order to redesign the plant layout, it was important to understand the relationships between the activities so that the planning of positioning the sections could be performed.

Here, A stands for Absolutely necessary, E stands for Especially important, I stands for ordinary closeness, O stands for important, U stands for unimportant and X stands for undesirable. Hence while planning the facility layout, these ratings of relative closeness of activities were taken into consideration. Only solution to this problem was to change the position of two welding tables and to position them somewhere near to a wall. If their backs were facing the wall while welding, the fumes were unreachable for anyone having no welding shield. Thus, the position of welding tables was changed and it can be observed in modified layout in fig. 7.

Now, in this case, the estimation of productivity is simple as it is the ratio of number of Accepted components to the number of total observations made before and after the change in positions of welding stations.

Fig. 5: Activity relationship diagram

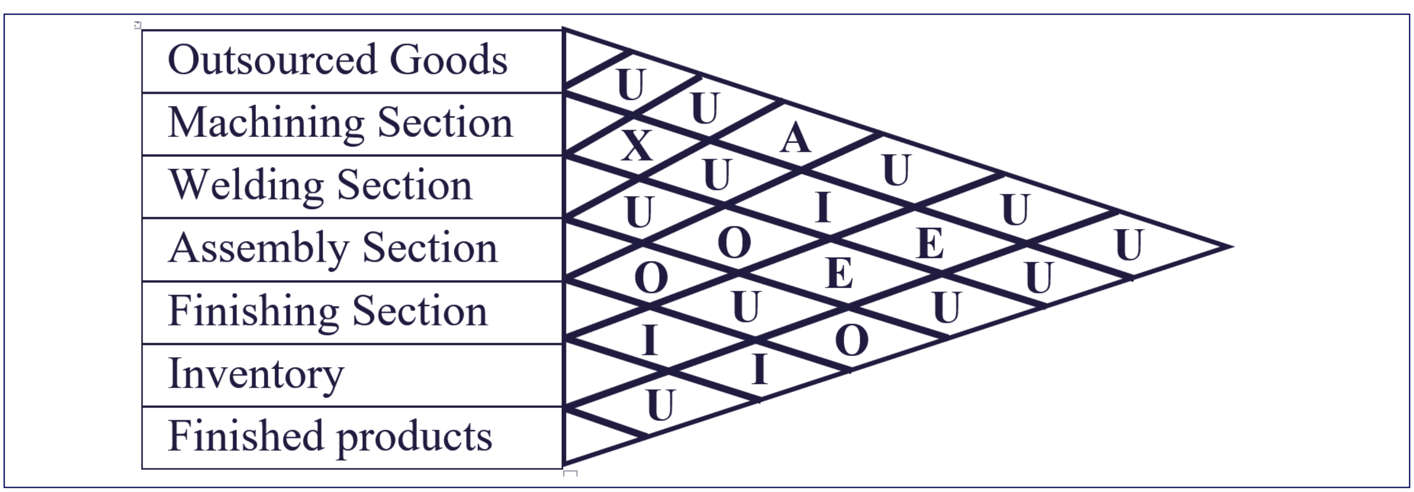


Table III: Observations for rejected products

Before Modification			After Modification	
Week	Number of products observed	Number of rejections	Number of products observed	Number of rejections
1	37	13	29	3
2	28	9	46	7
3	24	7	39	5
4	42	12	23	4

Therefore, before welding station positioning modification was implemented, the productivity can be evaluated as 90/131= 68.70% and after the modification, the productivity can be found out as 118/137= 86.13%.

Fig. 6: Existing layout

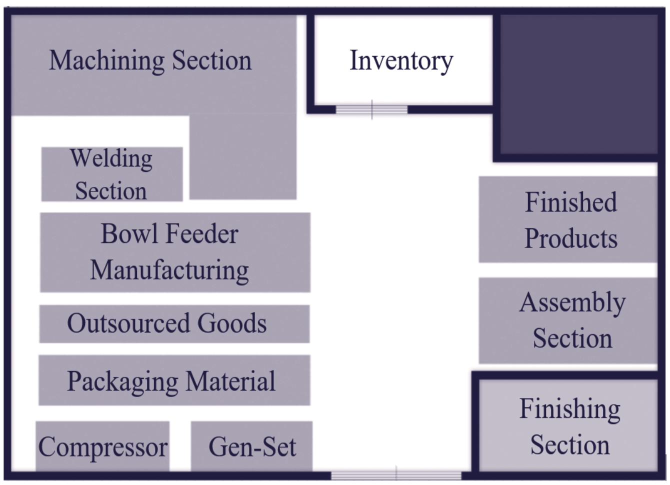
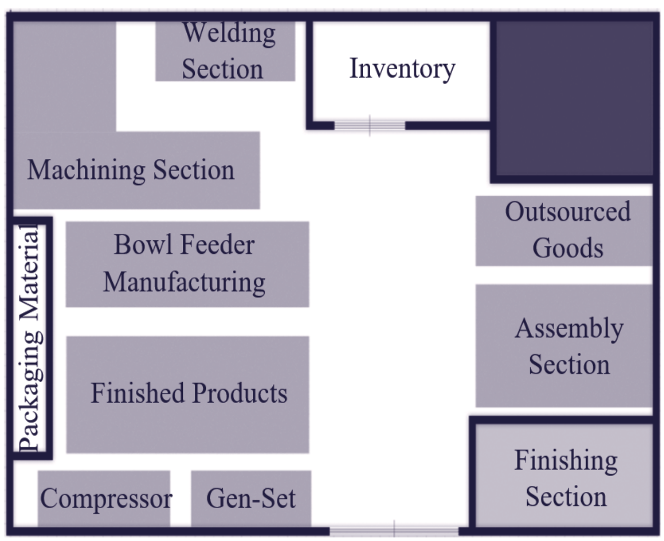


Fig. 7: Proposed layout



3. CONCLUSION

Hence, after implementation of all suggested improvements, the average increment in the productivity can be observed in the table IV.

Table IV: Estimation of productivity increment

Condition	Productivity before modification	Productivity after modification	Increment in productivity
Degraded goods	71.91%	87.61%	15.7%
Misplaced products	76.58%	86.87%	10.29%
Higher rejections	68.70%	86.13%	17.43%
Average	72.39%	86.87%	14.47%

Here, it can be observed that the rise in productivity is not a function of a single parameter. Rather, if the productivity of any industrial plant is to be determined, various factors are to be considered where each factor has its own impact over the numerical value. A rise of 14.47% in the productivity can be observed after implementing suggested improvements. These results are obtained using various industrial engineering methods but engineering economy is also considered while implementing them. Numerous suggestions were collected but at the end, only most effective and economical were to be implemented. No industry wants its flow of production hampered for the change in already settled layout. Still there are industries thriving towards optimum productivity and hence they implement scientifically and experimentally proven improvements in order to remain competent in terms of speed of production, lead time and cost. This is the only way of achieving customer satisfaction.

In conclusion, it was understood that the existence of any problem is not dependent completely on human factors or machine factors but most of the times it mainly depends upon environmental, surrounding conditions. In order to encounter such problems, those conditions are to be experienced. Theoretically on-paper solving of such problems is not possible but the operator experience and opinions prove crucial in solving of such problems. It can be concluded that the productivity is ultimately the function of customer satisfaction. It is determined with help of some numerical ratios of output to inputs but it actually determines efficiency of the industry in achieving customer satisfaction. This research study is based on determining the productivity of a fixed position layout type of industries. Through this study, it is proven that by solving frequently occurring problems, the flow of production can automatically be made smooth and the increment in in productivity can be achieved.

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