WORK INPROVEMENT OF FLASHER HF-1000 W PRODUCTION LINE A CASE STUDY: P.E. TECHNIQUE CO., LTD

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Abstract

In this research, the work process and methods of work were studied. The research was selected as a case study of P.E. Technic Company Limited, Phitsanulok Province. In the signal control product assembly line (HF-1000 W), the principles and theories of motion and time studies were applied. The method of measuring time was directly studied, and the Method of Time Measurement (MTM-2) was selected to collect preliminary data by entering the timer directly by using video cameras to capture the movements of operators while working. It was able to analyze the problem condition and find the cause, then make improvements and fix the bugs along with the standard time and set up a working standard. Improving the work in this research was able to reduce assembly time by up to 12.37% and increase productivity by 23.20%, which increases the choice of operators to use such methods to further improve their work.

Keywords: Standard time, Movement, Time study, Product assembly line

1. Introduction

In any commercial business, the importance lies in the distribution of goods and services. But in order for the business to prosper and stay stable, it is necessary to follow 3 principles: having customers, improving the quality of the product, and better service. Accordingly, resources or factors of production must be utilized for maximum benefit. Improving work is a key factor in the production of goods and services efficiently, and a technique to increase productivity to produce products while keeping up with the demands of today's ever-changing market.

In production operations, there are often many problems that cause production efficiency to not meet the targets. It needs to be corrected and improved in order to achieve the goal of increasing plant productivity, which can be solved by the technique of work improvement. Improving work by studying motion and time is one of the most important fundamental sciences of industrial enterprises (Jirawat, 2013). It studies the movement of operators both freelance and working with machines or equipment. This determines the characteristics and number of operators, type, and number of machines and equipment required. It indicates the cost with the cost of production in detail, including the time required to produce as well. P.E. Technic Company, Limited is a company that produces electronic equipment. The assembly of the signal control device (HF-1000 W) as shown in Figure 1 is a device that has not yet been studied. Therefore, in this research, the research team went to study the work to improve the assembly of signal control devices (HF-1000 W) to be more efficient and find the standard time of work to be used to determine the motivation value (Kanison, 2017.)

Figure 1 Signal Control Unit (HF-1000 W)

2. Research Objectives

To study the procedures and methods for improving the assembly processes of flasher HF-1000W in P.E. Technique Co., Ltd.

3. Research Methodology

In this research, a case study of the procedures and methods for improving the assembly processes of flasher HF-1000W in P.E. Technique Co., Ltd, and find solutions by using analytical principles and tools. The details are as follows:

3.1 data collection

The researcher has studied and timed working in each step in the production line of the product, including direct time study principles and Method Time Measurement (MTM-2) (Nuntakasikorn, 2005).

The steps in such timekeeping are directly timed, which performs the preliminary timekeeping of employees in each workstation in order to calculate the appropriate number of rounds and calculate the standard time value of each job that uses the following conditions

3.1.1 At the confidence level of 95%, the error is 5% where k = 2 and s = 0.05 as in Equation (1).

$$n = \left[\frac{\left(\frac{k}{s\sqrt{n'\sum x^2 - \left(\sum x\right)^2}} \right)}{\sum x} \right]^2 \qquad (1)$$

Where	n	=	Factors of confidence
	S	=	Discrepancy
	n′	=	Number of timer counts
	N	=	Number of times to be timed
	X	=	Time captured each time

In case n < n′ in the calculation, it considers n′.

3.1.2 The pacing system uses the Westinghouse method, employing expertise, effort, consistency, and conditions.

3.1.3 Normal Time = Selected Time x rating factor

3.1.4 Finding Allowance Due to the nature of the work it is not very heavy work. There is not much stress at work, and there is a break period for employees to rest in 2 periods, namely, working in the morning and afternoon, 10 minutes each, while there are few delays in other areas. Before the employees' work, materials and equipment will already be prepared, and from research, the allowance for fatigue is set at 4%.

3.1.5 Standard Time = Normal Time + [% of Allowance Time x Normal Time]

3.1.6 Recording of production line operator movements at all stages of production

3.2 Analysis of Current Work

From the collected data analyze the current working conditions divided int

3.2.1 Analyze the current time spent on each step of work and the total time in product production using the Direct Time Study and Method Time Measurement (MTM) standard time studies.

3.2.2 Analyze the movement conditions of operators using the principles of motion economy (Principle of Motion Economy)

3.3 Analyzing Ways to Improve Work

From the analysis of work in the past steps above, it can be known the problem. This will bring the problem to be analyzed to find a way to solve the problem as well as how to improve and develop the work. It is based on the following principles: (1) Elimination of unnecessary steps; (2) Integration of assembly steps; (3) Ordering of steps; (4) Assembling. required for easier assembly.

3.4 Improve the Workflow

Perform the operation according to the modified method and run the timer again.

3.5 Comparison and Evaluation of Work Improvements both before and after

A comparison of assembly time before and after renovation is considered, then look at the percentage difference in performance by looking at the output that has come out.

3.6 Set Standards

3.6.1 Set performance standards by recording the steps and methods of the new work after the improvement in an appropriate format.

3.6.2 Set the standard time by the timer of the new working method standard and set the standard time for the next work.

3.7 Performance Summary

Summarize all the results from the operation. along with specifying other suggestions in this research.

4. Results and discussion

In this section, details of the study to analyze the problem condition and find the cause, then make improvements and fix the bugs along with the standard time and set up a working standard, including a case study of P.E. Technique Co., Ltd. in order to improve the work, and the details were shown as follows:

4.1 Assembling Analysis of Signal Control Device (HF-1000 W) with Direct Timing

After collecting data and studying about components and assembly procedure of the signal controller (HF-1000 W). There are 6 workstations in total. Workstations are placed in a straight line in order of work. The characteristics of the workstation and timer are as follows:

4.1.1 Workstation 1 has assembly steps: (1) Put 4 copper pins into the fixture, (2) Place the printed plate on the fixture, (3) Place HF 5, and HF 4 on the printed plate, (4) Place the lid Fixture on the legs HF 4 - HF 5 and bring the Fixture into the press, (5) Remove the Fixture from the press, (6) Place the print on the press and press the legs HF 7 onto the print plate, (7) Press the legs. HF 8 on the printed sheet and take the printout of the pattern, (8) Put the C shape and fold the C legs, and (9) Send to the next workstation. The arrangement of workstation equipment 1 is shown in Figure 2.

Figure 2 Equipment and Machinery used in Workstation 1

4.1.2 Workstation 2 has the steps to assemble: (1) Insert C and fold C-legs, (2) Put the printed sheet into the fixture to lock legs HF 7 and HF 8, (3) Solder legs C, legs HF 7, pin HF 8, (4) Cut both pin C, and (5) Send to the next workstation. The arrangement of workstation equipment 2 is shown in Figure 3.

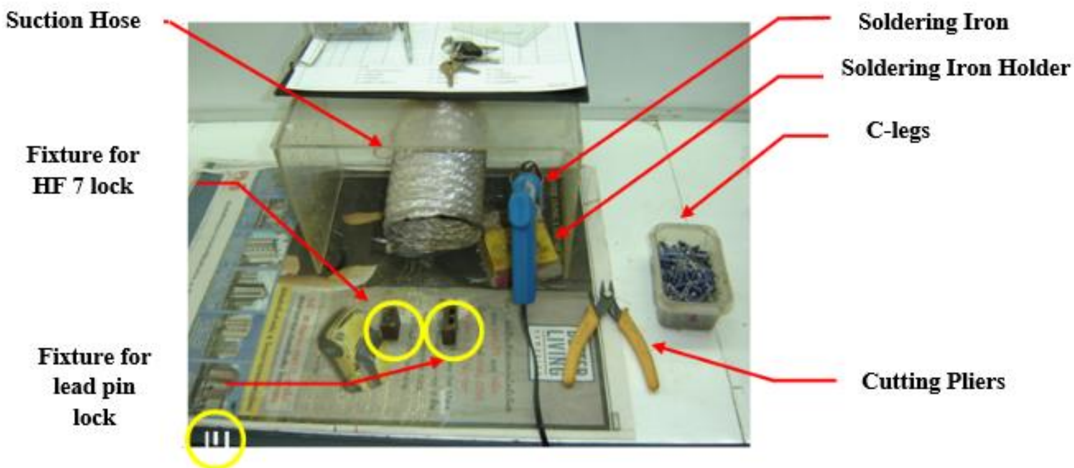

Figure 3 Equipment and Machinery used in Workstation 2

4.1.3 Station 3 has assembly steps: (1) Insert the relay, pull the relay cable into the relay cable groove by pulling taut, (2) Insert the LED, (3) Put the braided wire into the HF 4 pin, (4) Squeeze the HF 4 pin. Clip the braided wire and solder it, and (5)

Send it to the next workstation. The arrangement of workstation equipment 3 is shown in Figure 4.

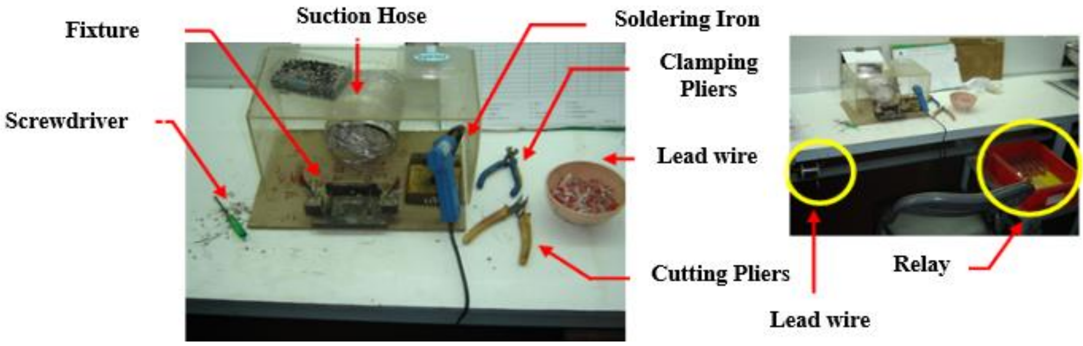

Figure 4 Equipment and Machinery used in Workstation 3

4.1.4 Station 4 has assembly steps: (1) Set the axis distance with the moves and set the white gold face distance, (2) Apply acetone to the white gold face, (3) Put the print into the testing machine, (4) Test Relay by pressing the red button, the LED will light, (5) Put the rubber ball HF 8 and blow air in front of the contact, (6) Blow the air on the top cover, (7) Put the print sheet on the top cover HF 52, (8) Insert the fuse by pressing the fuse firmly down with a press, and (9) Send it to the next workstation. The arrangement of workstation equipment 4 is shown in Figure 5.

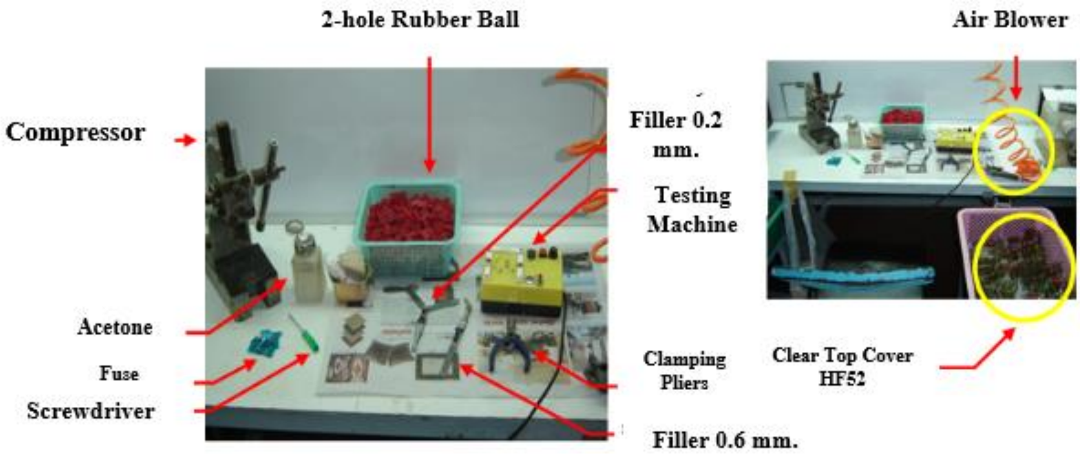

Figure 5 Equipment and Machinery used in Workstation 4

4.1.5 Workstation 5 has assembly steps: (1) Look at the capacitor terminal, the negative terminal of both capacitors will be white and the negative side must be facing outward, (2) Connect the Flasher to the test plug. High voltage Flasher must be working normally, see the LED will blink, the value is at 550-700 ms, (3) Rock the switch to low voltage and turn the switch ON. The flasher must be working normally. By watching the lamp flash, (4) Turn off the OFF switch of the LOW Flasher must stop working. The lamp will stop flashing, (5) Remove the Flasher from the test plug, (6) Apply silicone glue to all 4 screw holes, (7) Put the bottom cover. Tighten all 4 screw holes, (8) Test the low and high pressure again, and (9) Send to the next workstation. The arrangement of workstation equipment 5 is shown in Figure 6.

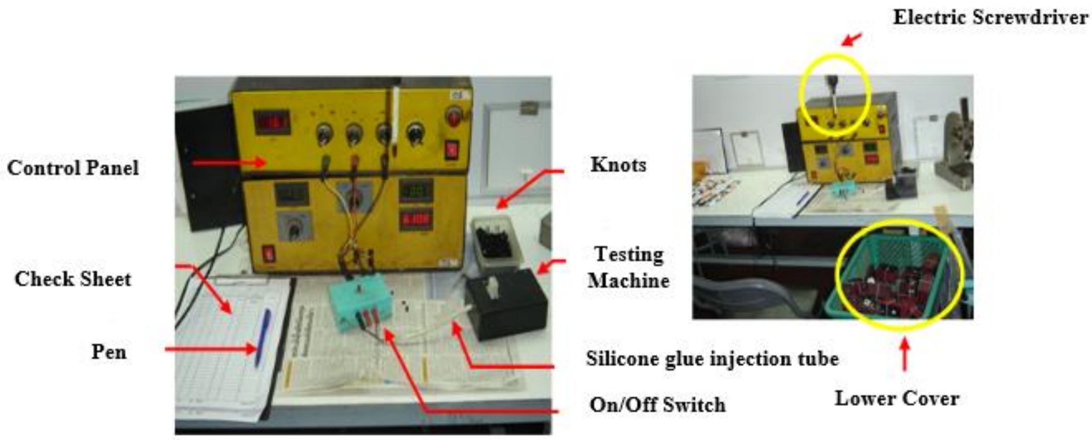

Figure 6 Equipment and Machinery used in Workstation 5

4.1.6 Station 6 has assembly steps: (1) Wipe the glue on the bolt head, (2) Clean the whole thing, (3) Attach the sticker, (4) Look at the neatness of the product, (5) Fold the Flasher box, (6) Put the Flasher in the box and close the lid of the box, (7) Pack the Flasher box, and (8) Arrange it in the Flasher box (large box). The arrangement of work station equipment 6 is shown in Figure 7.

Figure 7 Equipment and machinery used in Workstation 6

From the product assembly of all 6 workstations, the time value of the signal control device assembly step (HF 1000 Watt) can be shown in Table 1.

Table 1 shows the time value of the assembly process for all 6 workstations by direct timing method.

Workstation	Normal Time (seconds)	Allowance Time (%)	Standard Time (seconds)
1	115.89	4	120.53
2	102.68	4	106.79
3	81.23	4	84.49
4	78.70	4	81.85
5	103.80	4	107.95
6	64.47	4	67.05
	Total		**568.66**

4.2 Analysis of the assembly of the signal control device (HF-1000 W) by means of a time study. Predetermined Motion Time by MTM-2

4.2.1 The position and layout of the assembly to be analyzed by the MTM-2 technique of workstation 1 are shown in Figure 8.

4.2.2 The position and layout of the assembly to be analyzed by the MTM-2 technique of workstation 2 are shown in Figure 9.

4.2.3 The position and layout of the assembly to be analyzed by the MTM-2 technique of workstation 3 are shown in Figure 10.

4.2.4 The position and layout of the assembly to be analyzed by the MTM-2 technique of workstation 4 are shown in Figure 11.

4.2.5 The position and layout of the assembly to be analyzed by the MTM-2 technique of workstation 5 are shown in Figure 12.

4.2.6 The location and layout of the assembly to be analyzed by the MTM-2 technique of workstation 6 is shown in Figure 13.

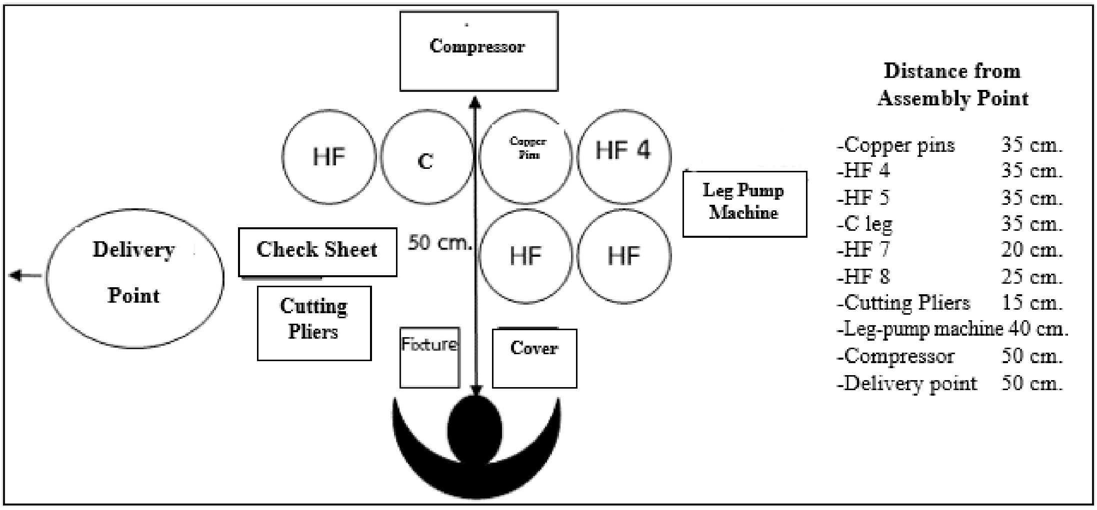

Figure 8 Location and Layout of Working Station 1

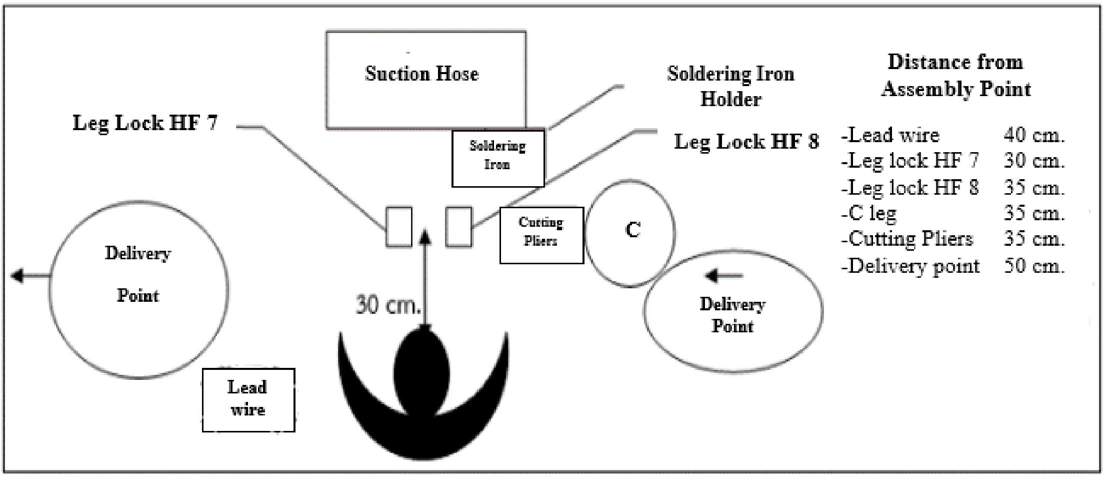

Figure 9 Location and Layout of Work Station 2

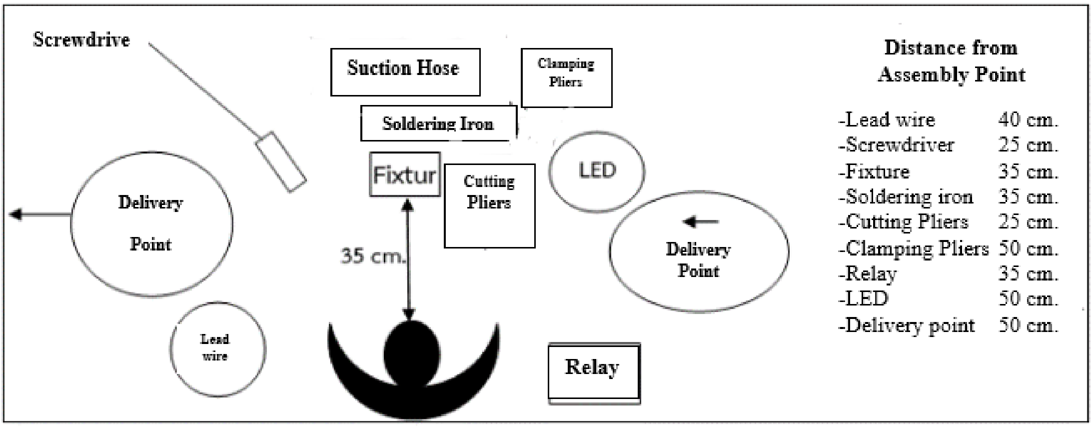

Figure 10 Location and Layout of Work Station 3

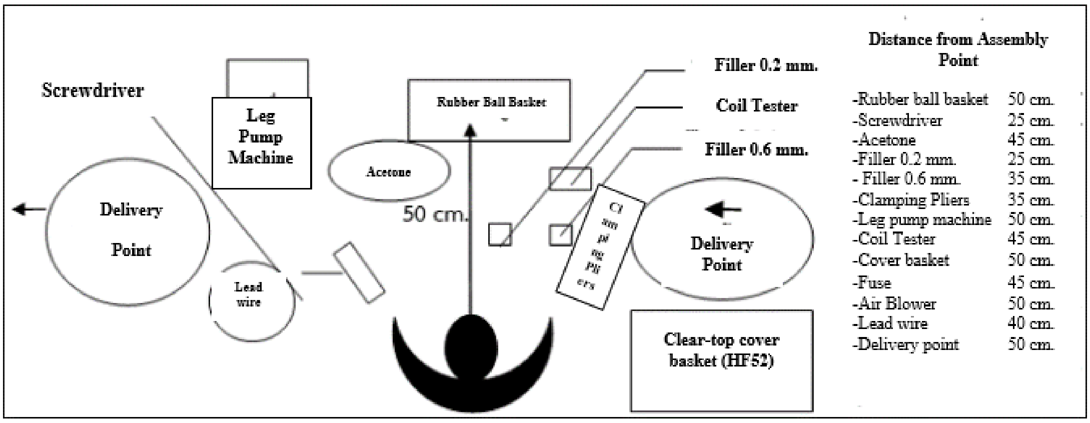

Figure 11 Location and Layout of Working Station 4

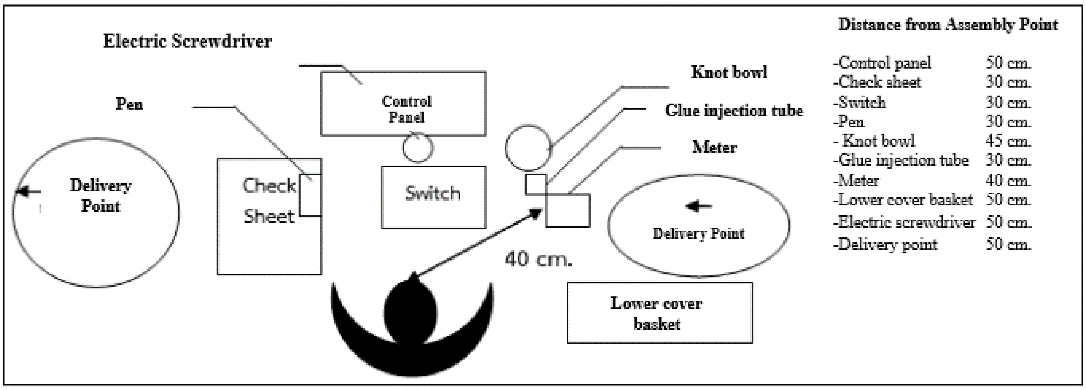

Figure 12 Location and Layout of Work Station No. 5

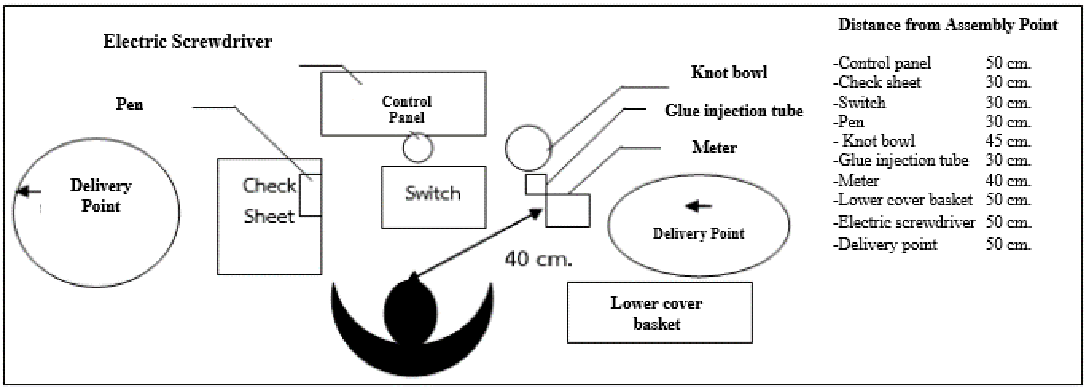

Figure 13 Location and Layout of Work Station 6

From the analysis of these 6 workstations, it can be expressed as the assembly time of the MTM2 method as shown in Table 2.

Table 2 The time value of the assembly process of all 6 workstations using the MTM2 method.

Workstation	Standard Time (second)	MTM2	Difference	% Difference
1	120.53	113.13	7.40	6.13
2	106.79	102.10	4.69	4.39
3	84.49	82.27	2.22	2.63
4	81.85	80.24	1.61	1.97
5	107.95	104.64	3.31	3.07
6	67.05	63.27	3.78	5.64
Total	**568.66**	**545.65**	**23.01**	**4.04**

From Table 2, the times obtained from standard time and MTM2 have different values. The assembly time from the MTM2 method was 23.01 seconds faster, representing 4.04%.

4.3 Problem Condition Analysis and Work Improvements

It was noticed that in the 1st, 2nd, and 5th workstations, the assembly time was high, resulting in a bottleneck. Therefore, in this research, we analyzed the problem conditions and improved the work process in assembling the signal control device (HF-1000 W), which found that the main problems were as follows:

4.3.1 The placement of the assembly parts is inconsistent with the movements of the hands in the assembly in Station 1. The research team has arranged the parts and equipment used in the assembly in Station 1 to make it easy. To pick up and use by arranging the parts and equipment used in the assembly to be in line with the movements of the hands and in relation to the order of assembly steps by placing various parts used in assembly. According to the pre-post process of picking up by arranging copper pins, printing plates, HF5, HF4, and the C in an arc around the fixture, HF7 HF8 is placed close to the pin press because the pin press must be used inside. Recording also prevents the problem of obstructing the work of employees by eliminating the overlapping workpieces as shown in Figure 14, the workstation before renovation, and Figure 15, the workstation after renovation.

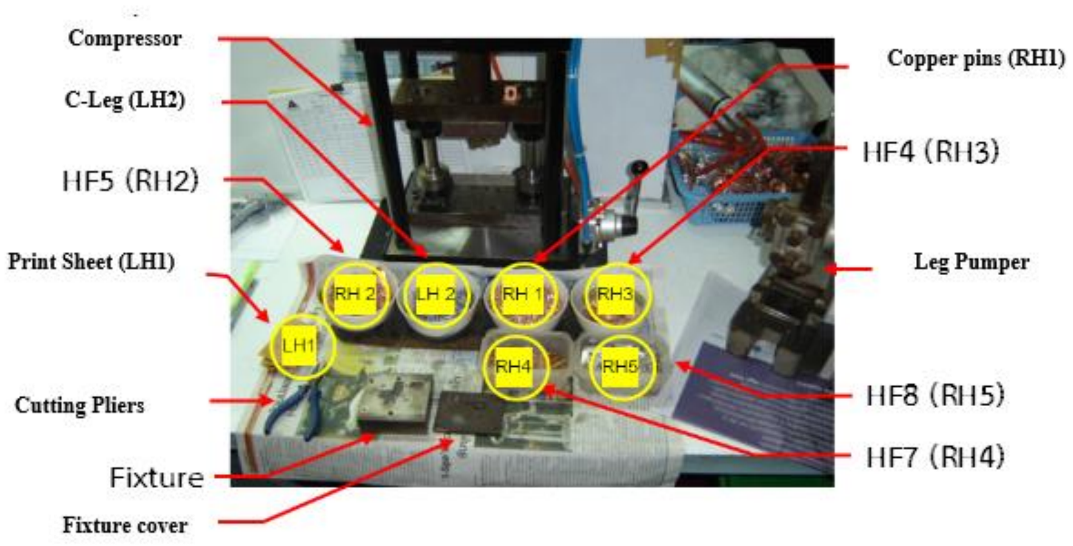

Figure 14 Work station 1 before renovation

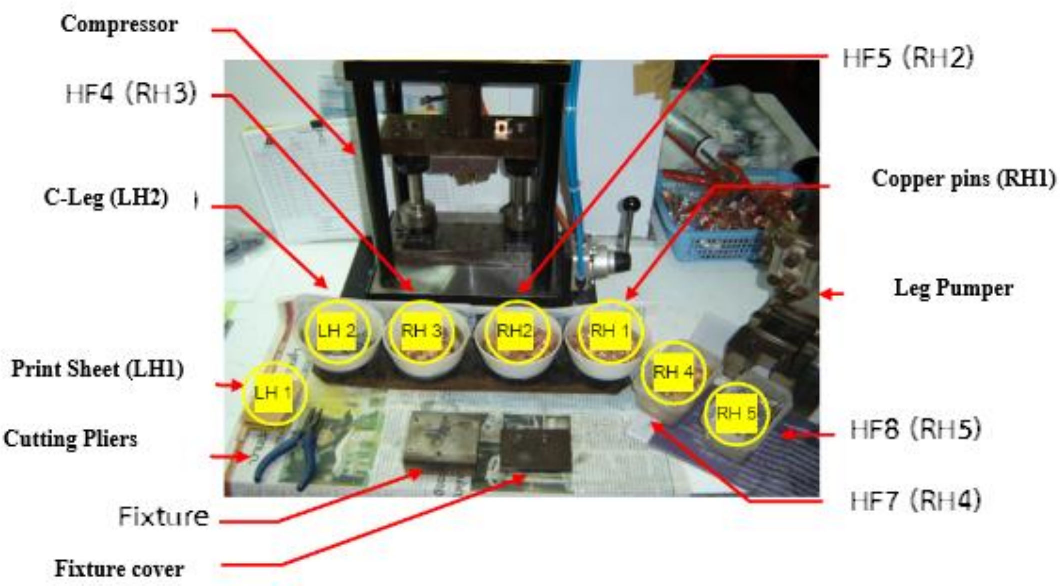

Figure 15 Work Station 1 after renovation

4.3.2 Unnecessary waiting in the assembly process in workstation 1 occurs.

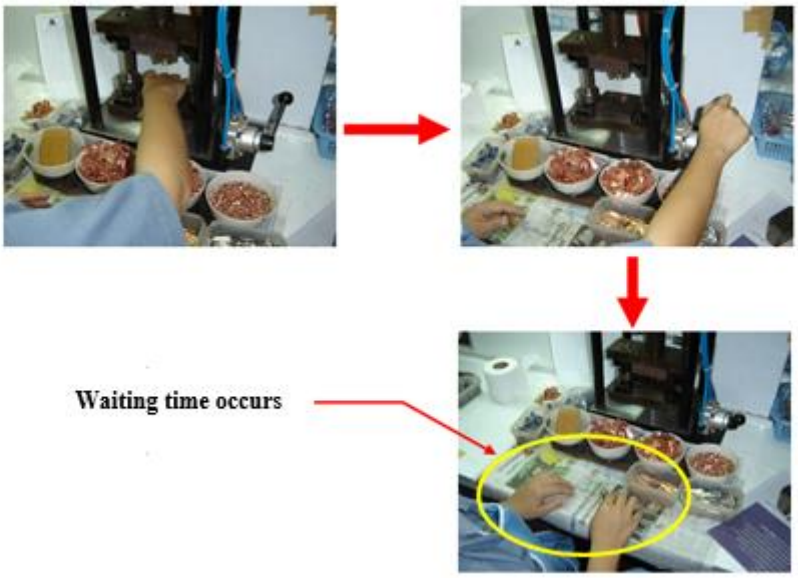

Figure 16 An unnecessary wait has occurred in workstation 1.

From Figure 16, the assembly process in workstation 1 has unnecessary waiting that occurs when the fixture is put into the pressing machine. Press the lever to make the compressor work. While the compressor is working, there will be a long waiting time. During that time, both hands were free and waiting, resulting in more wasted time for assembling.

From the process of assembling, there is a procedure for working while waiting for the compressor to work. while the compressor is recording. The researcher has come up with a new method of working in a loop. In the first assembly cycle, when the press machine is finished, take the Fixture out of the press take the print sheet out of the Fixture, and then put the print sheet on the press machine. Legs and the rest have returned to assemble from the beginning in the next work cycle and when the machine compresses both hands assemble the printed plate placed in the leg press machine until the assembly is complete.

4.3.3 The tools used for assembly are not suitable for workstation 2

From Figure 17, it can be seen that the fixture that helps to assemble is not efficient enough. and cause unnecessary work steps to increase in order to bring the Print plate to be soldered, the Print plate must be put into the fixture by inserting one side at a time according to the characteristics of the fixture, causing redundant work procedures, aiming and inserting 2 times, resulting in time. to assemble more.

Figure 17 Tools used for assembly before improvement

The research team has created a new Fixture by improving the original Fixture to look the same piece and have the same size as the Print sheet, which can reduce redundant work processes, reducing aiming in the process of bringing the sheet. Print out the Fixture one side at a time, and reduce movement. In the process of putting the Print plates into the Fixture one by one by changing to aiming and inserting only once, causing the assembly time to be reduced as shown in Figure 18.

Figure 18 Tools used for assembly after improvement

4.3.4 Procedures are not suitable in the 5th workstation.

Station 5: To assemble the back cover, it reaches out to pick up the bolts and fix the bolts at all 4 corners of the cover. each corner, which will cause 4 redundant operations, increasing the assembly time in the 5th workstation as shown in Figure 19.

Figure 19 Tools used for assembly after improvement

After putting silicone glue on all 4 corners, therefore picking up bolts to put in all 4 corners and fixing all 4 corners of the workpiece in one step can reduce redundant work. As a result, assembly time is reduced.

From the improvements in workstations 1, 2, and 5, the researcher has timed the assembly of these 3 stations as shown in Table 3.

Table 3 Comparison of standard times before and after the improvement of Work Stations 1, 2, and 5.

Workstation	Standard Time		Difference	%Time Reduced
	Before Improvement	After Improvement		
1	120.53	81.57	32.96	32.32
2	106.79	90.60	16.19	15.16
3	84.49	-	-	-
4	81.85	-	-	-
5	107.95	92.73	15.22	14.10
6	67.05	-	-	-

4.4 Comparison of the number of pieces of output per day before and after the improvement

The work schedule of employees in PE Technic Co., Ltd. is shown in Table 4.

Table 4 Employee work schedule in 1 day

Activity	Time
Morning Work	08.00 – 12.00 a.m.
Morning Break	10.00 – 10.10 a.m.
Meal Break	00.00 – 01.00 p.m.
Afternoon Work	01.00 – 05.00 p.m.
Afternoon Break	03.00 – 03.10 p.m.

From Table 4, total working time = 7 hours 40 minutes, working time (7 x 60 x 60) + (40 x 60) = 27,600 seconds per day.

Therefore, before improvement, the working time is 27,600 - 568.66 = 27,031.34 seconds, and the number of products obtained = 27031.34 / 120.53 = 225 pieces per day while after the improvement, the total working time is 27,600 - 498.29 = 27,101.71 seconds. and the number of products obtained = 27,101.71 / 92.73 = 293 pieces per day. It can be seen that the number of products increased by 68 pieces, representing 23.20%.

4.5 Checking the Standard Time

By comparing the yield (pieces/day) of calculating the yield from the standard time set after adjustment with the amount of output actually coming out of production, which is obtained from inspecting the number of products that come out per day in the case study industry.

The output from the standard time set after the improvement is 293 pieces per day, and inspecting the actual production of 272 pieces per day, it can be seen that the actual output is less than the number calculated. 21 pieces, representing only 7.18%. From the analysis, it was found that the actual output was different with a small output from the set standard time. This may be due to the inconsistency in the work of employees. Because the work process has been set up again, employees are not as proficient in their work as they should be.

4.6 Establish work standards

The researcher has arranged working standards for employees to use as requirements that are suitable for employees and to create working habits as shown in Figure 20-25.

Figure 20 Standards in the work of Station 1

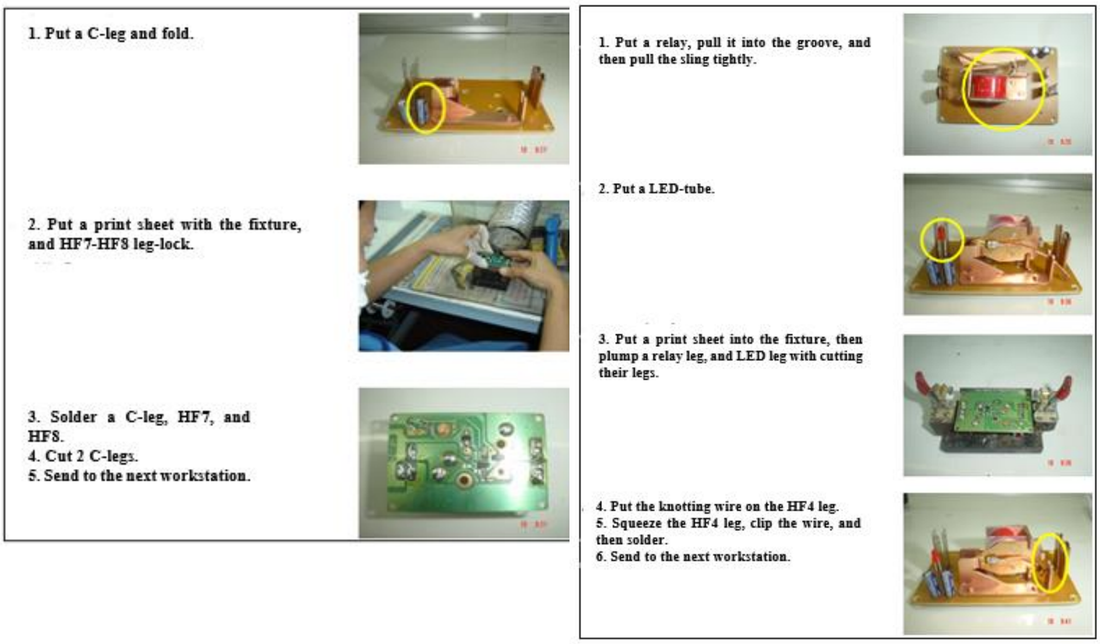

Figure 21 Working standards of Station 2,3

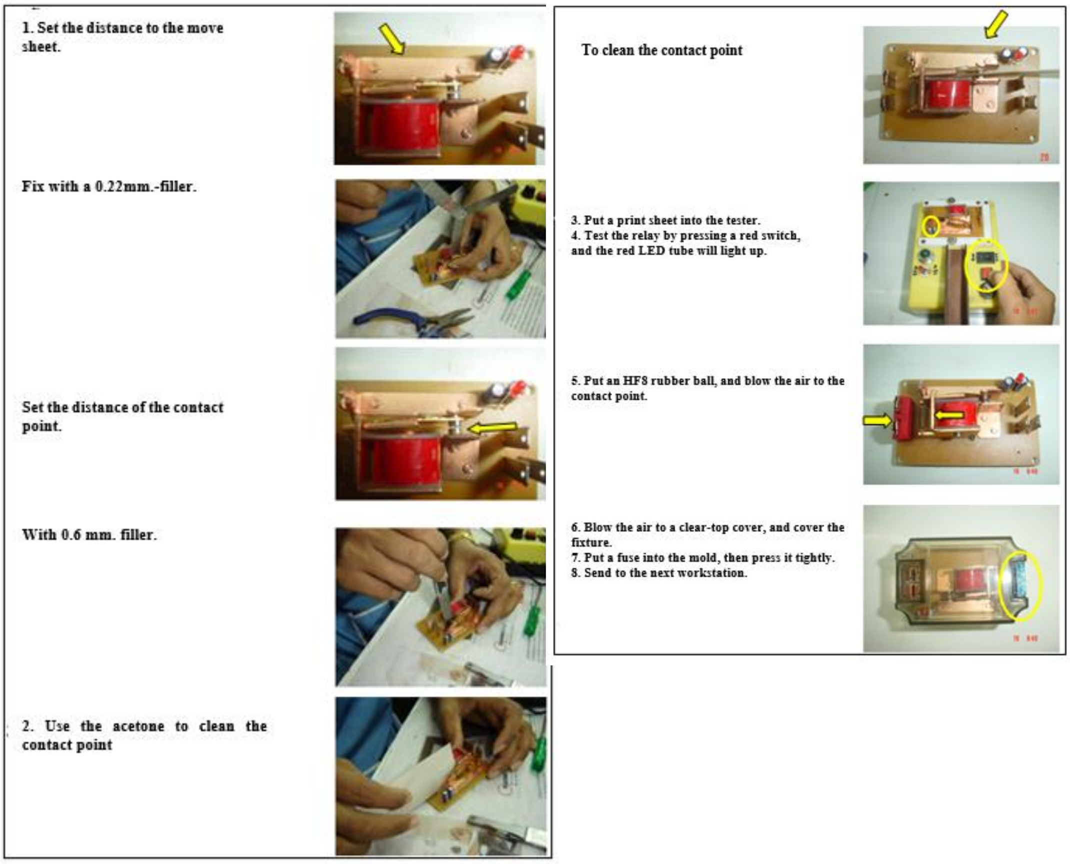

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Figure 22 Working standards of Station 4

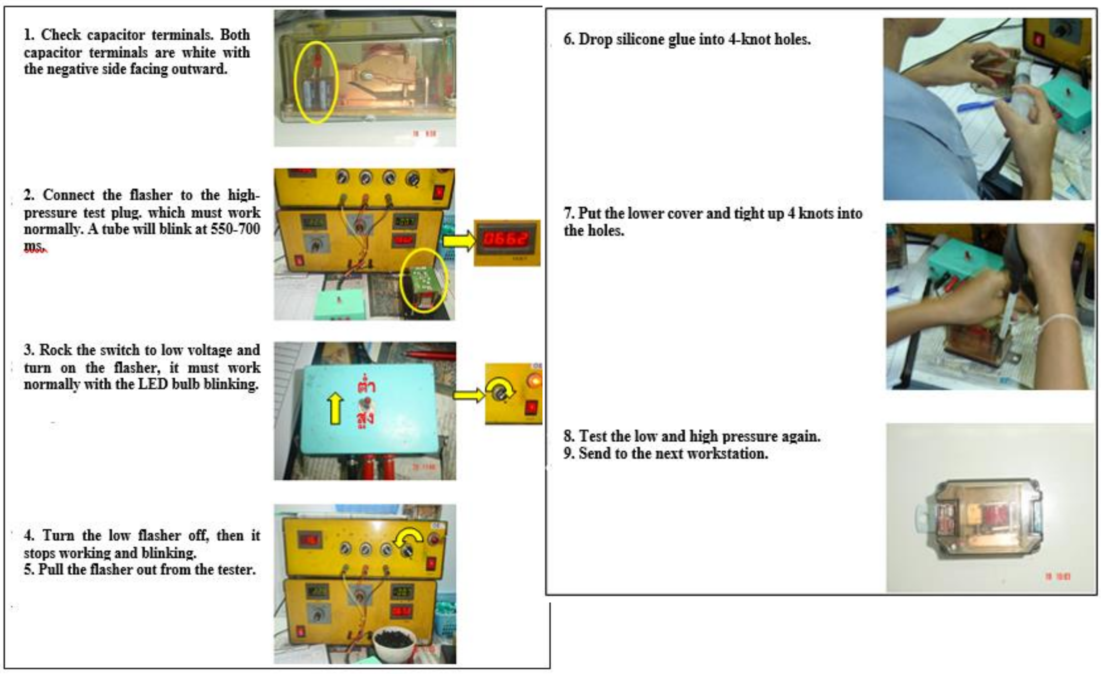

Figure 23 Working standards of Station 5

Figure 24 Working standards of Station 6

5. Conclusion and Discussion

5.1 Analysis of assembly of signal control devices (HF-1000 W) by direct time study method and method time measurement method (MTM-2)

5 Entering the timer using the principle Direct Time Study and Method Time Measurement (MTM-2) standard time study, the results are as follows:

The standard time in the composition of Direct Time Study and Method Time Measurement (MTM-2) is only 4.04% different, which is caused by the analyzer not be able to see. Check all the details of the assembly movement in detail.

The Standard Time values that come out can be seen that the 1st, 2nd, and 5th workstations take a lot of time to assemble, thus causing the assembly line to become a bottleneck in the said workstations.

5.2 Problem condition analysis and improvements

From the standard times obtained by data collection, there was a bottleneck in the 1st, 2nd, and 5th workstations, so we focused on improvements in those workstations. Accordingly, in the analysis of the problem conditions, it was found that (1) Work Station 1 encountered a problem, namely, the arrangement of the parts in the assembly was not consistent with the movement of the hands in the assembly, and there was unnecessary waiting in the assembly process. Corrections and improvements are to place tools and equipment used in the assembly in workstation 1 in accordance with the assembly process, and reordering the assembly process to reduce the waiting time. From solving problems found in workstation 1, it was found that the assembly time was reduced to 38.96 seconds, equivalent to 32.32%. Corrections and improvements of the fixture in workstation 2 were renovated. From fixing problems found in workstation 2, it was found that the assembly time was reduced to 16.19 seconds, representing 15.16% (3) Workstation 5 found a problem, including inappropriate work procedures, then the revisions and improvements are to improve the procedures for assembling the back cover by reducing redundant work. By solving the problems found in the 5th workstation, it was found that the assembly time was reduced by 15.22 seconds, equivalent to 14.10%.

5.3 Timing After Improvement

After analyzing the problem condition revised, working, and then entering the timer for assembly after improvement has the following results: The total assembly time was reduced to 70.37 seconds, equivalent to 12.37%, and the output increased to 68 pieces per day, equivalent to 23.20%.

5.4 Setting Work Standards

After fixing and improving the work and finding the standard time after the improvement has established a work standard that is a certain form for employees to follow. correctly and as a standard.

5.5 Checking the Standard Time

After the work standards have been prepared the standard time is checked to see whether it is exactly as set by comparing the output per day of the standard time set with the actual output. The results show that the employees can actually produce less than the standard set of 21 pieces, representing 7.18%. This difference is due to the inconsistency in the work of employees. Because the work process has been set up again, employees are not as proficient in their work as they should be.

5.6 Research recommendations

5.6.1 Performance

(1) From the standards that have been set It can be seen that the assembly time in the 5th station is the most valuable. As a result, the workflow in assembly is uneven, therefore, work should be allocated to the 6th workstation, which takes the least time to assemble. It is by dividing the final inspection process from the 5th station to the 6th station to inspect instead. Because he saw that the factory had another 1 machine to check that it was not working and would result in a continuous flow of work. more consistent.

(2) In the 6th station, workers should be arranged to fold the boxes. while waiting for the workpiece to arrive.

5.6.2 Safety

Operators in soldering workstations should be provided with masks or protective equipment for soldering fumes. Even if the smoke exhaust pipe is used, in fact, the suction pipe cannot suck out all the smoke.

5.6.3 Motivation Setting

Information should be obtained from research (Production capacity per day) to determine the incentive value for the worker. It is by charging extra wages for each group of the entire assembly line when employees can produce higher than the specified standards. It gives operators a feeling of enthusiasm for work and a good attitude toward the establishment.

5.6.4 Research Extension

This research is a study of time and improvement of workflow by means of motion and time studies only. But in the actual establishment can also research other areas, such as determining the appropriate incentives for employees because it is a work that produces a number of pieces per day, which results in an increase in the number of products. Plant layout to reduce movement in other assembly lines, and warehouse management, since there is no definite warehousing system in the factory. It often uses experience in ordering materials, equipment, etc. Therefore, those who are interested can do further research and can build on it in the future.

6. Recommendations

The research team would like to thank the Faculty of Industrial Technology. Pibulsongkram Rajabhat University is highly accommodating in various paperwork. and expenses for traveling and presenting this research.

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