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Title

ENHANCED PRODUCTIVITY THROUGH STANDARDIZED WORK CELL-

A CASE OF STANDARD WORK KAIZEN APPLIED TO VALVE ASSEMBLY PROCESS W.R.T TO A VALVE MANUFACTURING ORGANIZATION IN PUNE.

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Abstract:

This paper would provide us with an overview of concepts like ‘Standardized work kaizen’, ‘Overall Equipment Effectiveness’ and ‘Structured On-The Job Training’ and its implications on manufacturing processes. This paper would also give an account of successful standardized work concept as applied to a valve assembly process and its effect on the Business Unit as a whole on various parameters. All the necessary steps, formulas and concepts are detailed out and explained in their respective topics.

Also, hypothesis test has been carried out to determine whether there was a significant difference in measurable parameters after replacing the traditional assembly cell / process with standard work cell.

Conceptual Framework:

In today’s agile manufacturing facilities, worker accuracy, consistency and flexibility is more important than ever. Organisations have realized that it is necessary to structure & standardize any tangible process within their purview to ensure that they are able to utilize the resources **effectively & efficiently**. This means **optimum utilization** of resources. Effective utilization of resources would mean the extent to which an individual / organization is able to meets its goal / objective. Efficiency would mean how well are we able to utilize our limited resources i.e. minimum use of resources to achieve maximum output. ‘**Productivity**’ as a whole depends on both effectiveness & efficiency.

Productivity= (Effectiveness) X (**Efficiency)**

For example: Let us take an example of a process ‘X’.

Process: ‘X’

Monthly Target: 500 units of product ‘Y’

Maximum Resources Required: 1000 units of part ‘Z’.

Minimum Resources Required: 500 units of part ‘Z’

Resources Available: 750 units of part ‘Z’

Now there are two operators: Operator 'A' & Operator 'B'. We are interested in determining their productivity individually.

'A'	**'B'**
Target: 500 units of 'Y'	**Target:** 500 units of 'Y'
Achieved: 475 units of 'Y'	**Achieved:** 455 units of 'Y'
Max. Resources Required: 1000 'Z'	**Max. Resources Required:** 1000 'Z'
Min. Resources Required: 500 'Z'	**Min. Resources Required:** 500 'Z'
Utilized Resources: 610 units of 'Z'	**Utilized Resources:** 512 units of 'Z'
***********************************	******************************
Effectiveness = Achieved / Target	Effectiveness = Achieved / Target
= (475 / 500)	= (455 / 500)
= 0.95 (95%)	= 0.91 (91%)
Efficiency = Achieved / utilized resources	Efficiency = Achieved /Utilized Res
= (475 / 610)	= (455 / 512)
= 0.779 (77.9%)	= 0.89 (89%)
Productivity = 0.95 X 0.779 = 0.745= **74.5%**	Productivity **=** 0.91 X 0.89=0.81=**81%**

From the above, we can see that 'Operator B' is more productive at 81% as compared to 'Operator A' at 74.5%. Operator 'B' is more productive because he utilized the resources more efficiently. Effectiveness and Efficiency is lost because of some identified industrial wastes. These Industrial wastes are categorized as follows:

'C'→ 'Correction' or **'Re-work'**

'O'→ 'Over-Production'

'M'→ 'Motion'

'M'→ 'Movement'

'W'→ 'Waiting'

'I' → 'Inventory'

‘P’ → ‘Over-Processing’

Hence, If we are able to identify and eliminate these wastes in every tangible process, then there would be considerable improvement in productivity which in turn would help the business unit as a whole. Hence irrespective of any area / field / department, there is always a scope to identify opportunities for waste reduction & productivity improvement.

Methodology:

Study of existing valve assembly process:

In all there were 12 types of valves with varying sizes being manufactured & assembled in the organisation. For our study we are considering the methodology adopted for only one particular size of valve

Identification of Process: Assembly Process of 2’’ Flow control valve.

Method: Observation Method.

Purpose: To study the existing work flow and determine opportunities for reducing 7 industrial wastes as detailed out earlier in the paper

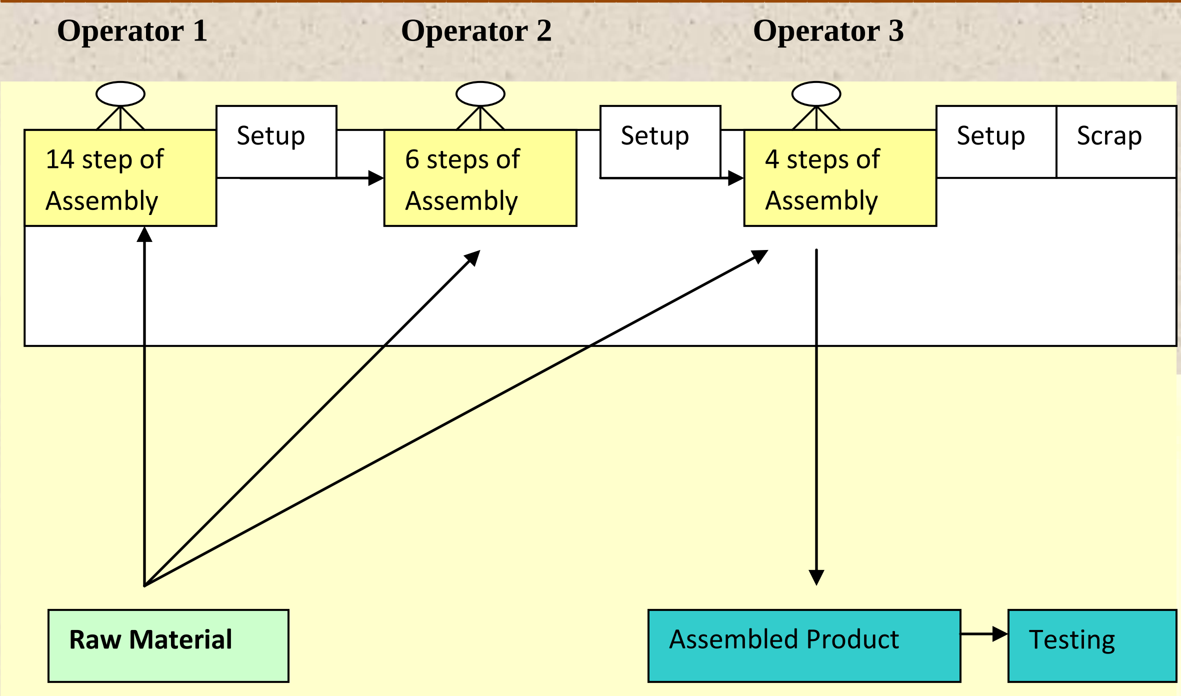
Tools used: Work Measurement

Duration: 2 Months

(1 Month for identification and validation of work flow)

(1 Month for Data Collection on total productivity & related factors)

Existing Assembly Process Details: 2’’ Flow control valve was a 24 step assembly process.



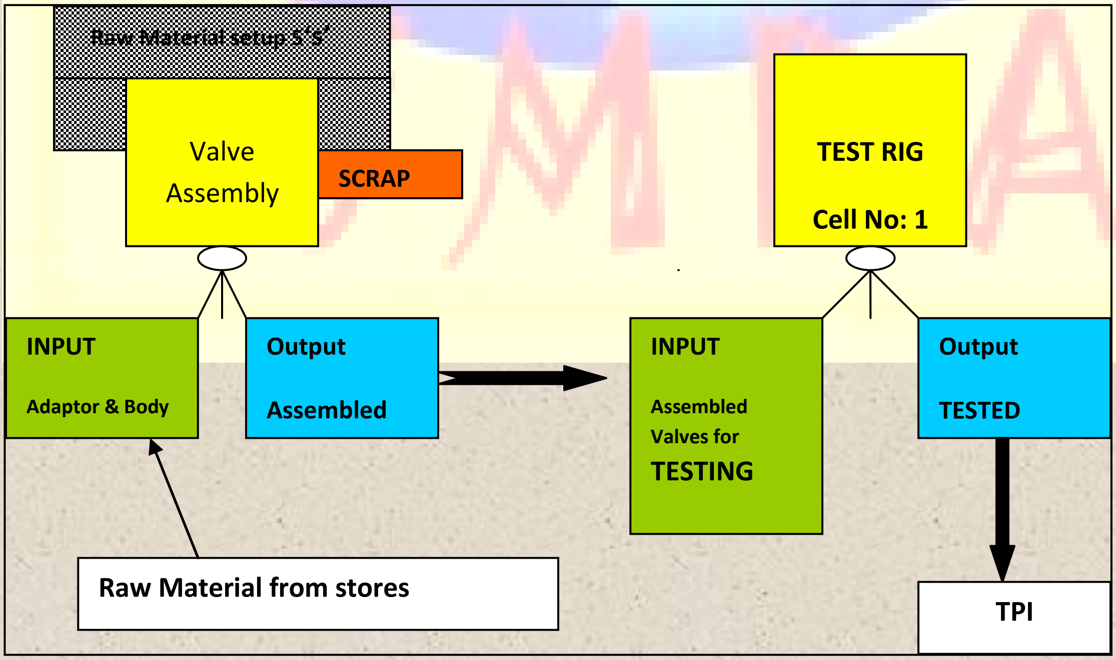
BEFORE **WORK FLOW- Assembly of 2" Flow control Valve**

Key Findings:

- 24 step Assembly process was divided by 3 operators
- All the 3 operators had to setup the raw-material individually before starting the assembly process.
- 1 Casual operator was required for rework and setup
- All the scrap was collected at extreme corner of the assembly table.
- The distance between raw material storage area and assembly table was significant
- All the data related to assembly was recorded in an Assembly Register. This was filled at the end of the shift.
- Not verified or validated by supervisor
- No exact details of the exact causes of bottleneck in the assembly process or rework of valves recorded.
- The Total Area of Assembly Line was 2.25 Sq.mtrs
- Total No of Valves assembled by 1 person in 1st shift was 25.
- Total Time Available in 1st Shift= 420 minutes
- Total time taken by 1 Operator for Assembly of 1 valve = 16.8 minutes

→ Brainstorming session to identify opportunities for productivity improvement by focussing on the following areas:

1. Idea to introduce 5'S' Kaizen to ensure operator has all the necessary resources in the required numbers and kind within his reach
2. Focus on Cellular Manufacturing.
3. Principle of 1 Operator 1 Cell
4. Streamline the flow of raw-material.
5. Identify value adding & non-value adding activities in the existing assembly process and try to eliminate the same.
6. Identify the existing capacity of assembly line against the actual demand
7. Design and commission a Cellular Manufacturing Assembly table with the concept of 1 operator 1 cell
8. Test run the same for 1 month
9. Introduce Cell 1 (Cellular Mfg) after successful completion of tests.
10. Record the data and do comparative analysis of before & after standard work cell.



AFTER Standard Work Kaizen- Streamlined Work Flow of Valve Assembly Process.

Key Results:

1. Area of Assembly Line: 1.28 Sq.mtrs
2. No: of person per Cell / Assembly: 1 operator
3. No causal required for individual material setup
4. 1st half an hour of the shift devoted for raw material setup on the assembly table. To be done by the operator himself under the guidance of supervisor
5. Targets, standard procedure for assembly of valves and hourly activity sheet displayed on the Assembly table itself.
6. Hourly data of assembly / rework / causes of stoppage and rework recorded by the operators
7. Documentation & validation of the same by the supervisors
8. Daily meetings to discuss the causes behind the bottleneck in assembly with the respective department heads / authorities.
9. Total No: of valves assembled by 1 operator in 1 shift was 42 Nos
10. Capacity of Cell 1 in shift 1 set to 42 nos
11. Process Time for Valve assembly reduced to 10 minutes.

Hypothesis Testing:

Data was recorded on some critical parameters for 15 days before implementing standardized work kaizen, and subsequently data was collected for 15 days after implementing standardized work kaizen to observe any significant changes in productivity.

The basic idea behind carrying out paired hypothesis test was to prove the effectiveness of standardized work cell for valve assembly process.

CAPACITY & UTILIZATION:

Hypothesis: Standard work cell improves capacity & Utilization of assembly line.

Ho: There is no significant improvement in capacity & utilization of assembly line after commissioning of standard work cell.

H1: There is significant improvement in capacity & utilization of Assembly line after commissioning of standard work cell.

t-Test: Two-Sample Assuming Equal Variances

	Before	*After*
Mean	22.26666	38.8
Variance	7.06666	13.45714
Observations	15	15
Pooled Variance	10.26190	
Hypothesized Mean Difference	0	
Df	28	
t Stat	-4.13438	
P(T<=t) one-tail	0.024602	
t Critical one-tail	1.701132	

As P-Value is 2.4 %, there is significant improvement in capacity & utilization of assembly line after commissioning of standard work cell as against significance of 5 %.

We reject Null Hypothesis and accept alternate hypothesis at 5% level of significance.

TOTAL PRODUCTIVITY:

Hypothesis: Standard work cell improves productivity

Ho: There is no significant improvement in productivity after commissioning standard work cell

H1: There is significant improvement in productivity after commissioning standard work cell

t-Test: Two-Sample Assuming Equal Variances

	Before	*After*
Mean	17	36.4
Variance	3.428571429	19.25714
Observations	15	15
Pooled Variance	11.34285714	
Hypothesized Mean Difference	0	
Df	28	
t Stat	-5.77506402	
P(T<=t) one-tail	0.019298	
t Critical one-tail	1.701130908	

For all the above cases, 1 tail is applicable. There is significant improvement in total productivity as P value is 1.9% against 5% level of significance. Hence we reject Null hypothesis and accept alternate hypothesis at 5% level of significance.

REWORK:

Hypothesis: Standard work reduces the no of rework in an valve assembly process.

Ho: There is no significant reduction in the no. of rework after commissioning of standard work cell.

H1: There is significant reduction in the no. of rework after commissioning of standard work cell.

t-Test: Two-Sample Assuming Equal Variances

	Before	*After*
Mean	5.266666667	2.4
Variance	4.20952381	1.828571429
Observations	15	15
Pooled Variance	3.019047619	
Hypothesized Mean Difference	0	
Df	28	
t Stat	4.518276939	
P(T<=t) one-tail	0.013016894	
t Critical one-tail	1.701130908	
P(T<=t) two-tail	0.026033789	
t Critical two-tail	2.048407115	

There is significant reduction in total no. of rework as P value is 2.6% against 5% level of significance. Hence we reject Null hypothesis and accept alternate hypothesis at 5% level of significance.

Overall Equipment Effectiveness:

From the following table, we can conclude that capacity of the assembly line has increased by 68%

Utilization of the resources has improved by 3.31%

Total no of valves assembled has increased by 114 %.

Short production has reduced from 21.07% to 5.71%.

Before		
Available Capacity	375	100.00%
Actual Planned / Utilized against capacity	334	89.07%
Not Planned	41	10.93%
Produced against capacity	255	68.00%
Short produced	79	21.07%
After		
Available Capacity	630	100.00%
Actual Planned / Utilized against capacity	582	92.38%
Not Planned	48	7.62%
Produced against capacity	546	86.67%
Short produced	36	5.71%

Summary Chart:

Area	Improvement	Before	After
Space	44%	2.25 sq.mtrs	1.28 sq.mtrs
Manpower	67%	3 persons per cell	1 person per cell
Productivity	60%	25 Nos per person per shift	42 Nos

From the following table, we can infer that there is 44% space reduction in the valve assembly coupled with 67% reduction in manpower and an overall of 60% improvement in total productivity.

Concluding Remarks:

The activity of standardizing work may, at times, be painful to start, but the benefits in learning by all will certainly outweigh the costs and become welcome place and expected by everyone. The key is to understand the important variables for which you wish to measure. As you stabilize and improve your process, you will understand the barriers that had traditionally kept you from meeting your expectations. Remember, as Taiichi Ohno pointed out, "Where there is no standard, there can be no kaizen."

References:

- If you want to be successful with standard work, read on, By Jim Huntzinger.
- OEE Pocket Guide.
- 'Standardized Work', Document your process and make problems visible, Tim Whitmore.
- Six Sigma Tool Masters- Dr R.S Chalapathi.