IMPROVEMENT OF PRODUCTIVITY BY REDUCING CYCLE TIME USING MOST IN FIBER WORK INDUSTRY

[1]Rahul Tandel, [2]Prashant Khanna,
[1] M.tech scholar, [2]Professor,
[1] Production technology,
[1] Parul university, Gujarat, India

Abstract : Century Polymer industries (A division of Hindustan fiber glass works) manufacture body size window of railway coach. At present situation, company is having less productivity due to ineffective utilization of plant layout, less space for storage, material handling problems etc. So the objective is to improve productivity in the best and effective manner without compromising quality of products. The main aim is to accomplish our objective by effective utilization of plant area, applying Maynard's Operation Sequence Technique (MOST), Work measurement, Work Content, Non value Added Activities (NVA), reducing the non-value added activities and applying laws of ergonomics.
IndexTerms **– MOST, Time Study, Non Value Added Activities And Value Added Activities.**

I. INTRODUCTION

Our history of association with Rail Industry goes back by 50 years to 1949, two years after independence as suppliers of timber products such as sleepers, logs, wooden windows etc. to Indian Railways for coach manufacture and maintenance. Century Polymer Industries accompanied Indian Railway's phenomenal development and progress right from the start, through the ability to transform experience into improved products. Company makes Windows, Glass windows, louver shutter, and emergency windows for railway.

One of the major problems in applying MTM to manufacturing operations is that it is time consuming, since an observer must observe and document each movement in great detail. The development and release of the MOST in the 1960s which is much simpler and more efficient. It classifies all human movements into three basic categories, and the description of each category is done by assigning values to only a few standard parameters.

II. LITERATURE REVIEW

Maynard Operation Sequence Technique (MOST) developed by Kjell Zandin and H. B. Maynard and Company, Inc. in 1974. MOST is based on MTM. The movement of objects follows consistently repeating patterns and the repeated patterns in the sequence of MTM have been consolidated. MOST times represent ranges of motions and do not required precise measurement. MOST gives very accurate results because ranges are statistically derived.

Basic MOST

MOST Work Measurement Systems has defined work in terms of operation, sub operation, time standard, activity, method step, sequence model, sub activity and MOST analysis. The concept of MOST and the basic MOST sequence models has three versions Basic MOST for the activities between 20 sec to 2 min and are clearly discussed by focusing on MOST as a productivity improvement technique. Mini MOST for the activities shorter than 20 sec. The Maxi MOST system is for the activities above 2min. It helps an Industrial Engineer as a tool to measure, and control manufacturing methods and cost. MOST focuses on three types of object movements Such as General Move, Control Move, and Tool Use.

Time Measurement Unit used in MOST

The time measurement unit (TMU) is used as a time unit for MOST study.
1 T.M.U = 0.036 sec
= 0.0006 min
= 0.00001hr.

calculations
Frequency = higher index in MOST
MOST Index = Frequency × summation of MOST
TMU = MOST Index × 10

Table 1 Basic MOST Sequence Model

General Move activity sequence model = A B G A B P A				
Index	A = Action distance	B = Body motion	G = Gain control	P = Placement
0	Close ≤ 5 cm (2 in.)			Hold, Toss
1	Within reach (but > 2 in.)		Grasp light object using one or two hand	Lay aside Loose fit

3	1 or 2 steps	Bend and arise with 50% occurrence	Grasp object that is heavy, or obstructed, or hidden, or interlocked	Adjustment, light pressure, double placement
6	3 or 4 steps	Bend and arise with 100% occurrence		Position with care, or precision of blind, or obstructed, or heavy pressure
10	5, 6, or 7 steps	Sit or stand		
16	8, 9, or 10 steps	Through door, or climb on or off, or stand and bend, or bend and sit		

III. METHODOLOGY

This paper project work is carried on the Body Size windows manufacturing company in India. Paper work is mainly focus on NVA Identification & Elimination and Resource Optimization. And space and resource optimization using MOST. This work carried out following steps.

Work Measurement using MOST

Using MOST, cycle time (CT) and work content (CW) of each operation are calculated. Complete sequence of operations and actual time by using MOST technique is studied. The concept of the cycle time (CT) and work content (CW) is well understand by following explanation.

Cycle time represents the total time required for final finish product formation and Content of work represents the amount of the manual work present in to a job. In our case Content of Work is equal to the Cycle Time. Cycle time helps in calculating the capacity of a production line and The Content of the Work helps to calculate the manpower required for the certain task. Most important concept in the line balancing sheet is engagement .Which easily understood by following explanation

Engagement=Work Content/Unit X Quantity Produced) / (No of Operators Deployed) engagement is a dynamic measure and will vary on daily basis as per the conditions. In our case engagement is as compared to 420 min.

Table 2 Cycle time and Manpower (before)

Sr. No.	Work Station description	Cycle Time	Manpower/Day
1	Mixture M/C	47.88	2
2	SMC M/C	60.48	5
3	Moulding M/C (Louver)	66.6	2
4	Moulding M/C (Guide)	58.68	2
5	Finishing	44.64	6
6	Painting	265.32	3
7	ASSEMBLY SECTION(FIT ROLLER GUIDE BREAKET ON FIBRE GLASS & FIT (4) SCREW SPRING WASHER)	147.24	6
8	ASSEMBLY SECTION(FIT RUBBER STRIP ON WINDOW ONE SIDE)	33.84	2
9	ASSEMBLY SECTION(DO GLASS WINDOW ASSEMBLY (USE ITEM 1 & GLASS RUBBER STRIP & WINDOW FRAME)	25.92	2
10	ASSEMBLY SECTION(FIT WALLET STRIP ON GUIDE LH USING ADHESIVE)	163.8	2
11	ASSEMBLY SECTION(DRILL HOLES (8) IN WALLET ON GUIDE LH -USE CONE GRINDING WHEEL)	19.08	2
12	ASSEMBLY SECTION(FIT 8 STEEL BUSHES IN GUIDE LH)	16.2	2
13	ASSEMBLY SECTION(FINAL ASSEMBLY OF BODY SIDE USING LH & RH GUIDES, LOUVER ASSY AND EQUIVILIZAR)	46.44	2
	TOTAL	996.12	38

Table 3 MOST Analysis and VA/NVA

SR NO	ACTIVITY DESCRIPTION	MOST														FREQUENCY	MOST INDEX	TMU	TIME (SEC)	VA/NVA
STN 1	MIXTURE MACHINE																			
1	Tacking plastic bag	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
2	Filling powder in	A	1	B	6	G	6	A	1	B	0	P	3	A	1	6	108	1080	38.88	VA

	the plastic bag																			
3	mesure weight of powder and mixed(20 kg ATH, 4 kg cl, 800 gm zn, 500 gm Mgo, 400 gm TBPB)	A	1	B	1	G	1	A	1	B	1	P	3	A	1	1	9	90	3.24	VA
4	pouring the resin in big drum	A	1	B	0	G	1	A	1	B	0	P	1	A	1	1	5	50	1.8	NVA
5	mix the powder in drum with resin	A	1	B	0	G	1	A	1	B	0	P	1	A	1	1	5	50	1.8	VA
STN 2	SMC MACHINE																			
1	Tacking resin paste from the mixture machine	A	3	B	1	G	1	A	3	B	0	P	3	A	0	3	33	330	11.88	VA
2	Arrange the glass of fibre on the SMC machine	A	3	B	1	G	1	A	1	B	1	P	3	A	1	3	33	330	11.88	VA
3	spread resin in fibre glass	A	1	B	0	G	6	A	1	B	1	P	3	A	1	6	78	780	28.08	VA
4	taking the final product SMC sheet and arrange on the racket	A	1	B	1	G	1	A	1	B	0	P	3	A	1	3	24	240	8.64	VA
STN 3	MOULDING MACHINE(louver)																			
1	Take the SMC sheet on the racket	A	1	B	0	G	1	A	1	B	1	P	3	A	1	3	24	240	8.64	VA
2	put the smc sheet on the surface	A	1	B	1	G	1	A	1	B	0	P	3	A	1	3	24	240	8.64	VA
3	cut the SMC sheet	A	1	B	1	G	1	A	1	B	1	P	1	A	1	1	7	70	2.52	VA
4	take the cutting sheet from the SMC section to the next station	A	6	B	1	G	1	A	6	B	1	P	3	A	1	6	114	1140	41.04	NVA
5	put the cutthing sheet on the (1) table	A	1	B	0	G	1	A	1	B	0	P	1	A	1	1	5	50	1.8	VA
6	cutting the sheet molded size of product and put the the (2) table	A	1	B	1	G	1	A	1	B	0	p	1	A	1	1	6	60	2.16	VA
7	putting the cutting pices in moulding machine	A	1	B	0	G	1	A	1	B	0	P	1	A	1	1	5	50	1.8	VA
STN 4	MOULDING MACHINE(GUIDE)																			

1	Take the SMC sheet on the racket	A	1	B	0	G	1	A	1	B	1	P	3	A	1	3	24	240	8.64	VA
2	put the smc sheet on the surface	A	1	B	1	G	1	A	1	B	0	P	3	A	1	3	24	240	8.64	VA
3	cut the SMC sheet	A	1	B	1	G	1	A	1	B	1	P	1	A	1	1	7	70	2.52	VA
4	take the cutting sheet from the SMC section to the next station	A	6	B	1	G	1	A	1	B	1	P	1	A	1	6	72	720	25.92	NVA
5	put the cutthing sheet on the (1) table	A	1	B	0	G	1	A	1	B	0	P	1	A	1	1	5	50	1.8	VA
6	cutting the sheet molded size of product and put the the (2) table	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
7	putting the cutting pices in moulding machine	A	1	B	0	G	1	A	1	B	0	P	1	A	1	5	25	250	9	VA
STN 5	FINISHING AREA																			
1	take the moulded product from the moulding section	A	6	B	1	G	1	A	6	B	1	P	1	A	0	6	108	1080	38.88	VA
2	and put the finishing section	A	1	B	1	G	1	A	1	B	1	P	1	A	1	1	7	70	2.52	VA
3	adjust the tool	A	0	B	1	G	0	A	1	B	1	P	1	A	1	1	5	50	1.8	VA
4	and finished the product	A	0	B	1	G	1	A	1	B	0	P	1	A	0	1	4	40	1.44	VA
STN 6	PAINTING SECTION																			
1	Taking finished product from the finishing section	A	6	B	1	G	1	A	6	B	1	P	1	A	6	6	132	1320	47.52	VA
2	and parrallel arrange finished product in the painting section	A	1	B	1	G	1	A	1	B	1	P	1	A	1	1	7	70	2.52	VA
3	paint the one by one product	A	1	B	1	G	0	A	1	B	1	P	1	A	1	1	6	60	2.16	VA
4	take painted product	A	6	B	6	G	1	A	6	B	6	P	1	A	6	6	192	1920	69.12	VA
5	and arrange the racket for drying paint	A	#	B	6	G	6	A	1	B	6	P	1	A	10	10	400	4000	144	NVA
STN 7	ASSEMBLY SECTION(FIT ROLLER GUIDE BREAKET ON FIBRE GLASS & FIT (4) SCREW SPRING WASHER)																			

1	taking guide to the roller guide station from the painting section	A	6	B	1	G	1	A	6	B	1	P	1	A	6	6	132	1320	47.52	NVA
2	and arrange the guide parallel one by one	A	1	B	6	G	6	A	1	B	6	P	1	A	1	6	132	1320	47.52	VA
3	and take the spring washer	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
4	and fit the along with spring washer on the roller guide	A	1	B	1	G	1	A	1	B	1	P	1	A	1	1	7	70	2.52	VA
5	and put the next station	A	6	B	1	G	1	A	6	B	1	P	1	A	6	6	132	1320	47.52	VA
STN 8	ASSEMBLY SECTION(FIT RUBBER STRIP ON WINDOW ONE SIDE)																			
1	taking the window frame	A	3	B	1	G	1	A	3	B	1	P	1	A	3	3	39	390	14.04	VA
2	and taking the rubber strip	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
3	and fit the rubber strip one side only (one window frame)	A	1	B	1	G	1	A	1	B	1	P	1	A	1	1	7	70	2.52	NVA
4	and put the next station	A	3	B	1	G	1	A	3	B	1	P	1	A	3	3	42	420	15.12	VA
STN 9	ASSEMBLY SECTION(DO GLASS WINDOW ASSEMBLY (USE ITEM 1 & GLASS RUBBER STRIP & WINDOW FRAME)																			
1	taking the glass rubber strip	A	3	B	6	G	1	A	3	B	6	P	1	A	0	6	120	1200	43.2	VA
2	and taking the window frame	A	3	B	6	G	1	A	3	B	6	P	1	A	0	3	30	300	10.8	VA
3	and do glass window assembly	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
4	and take glass window assemby and putting the next station	A	3	B	1	G	1	A	3	B	0	P	1	A	3	3	36	360	12.96	VA
STN 10	ASSEMBLY SECTION(FIT WALLET STRIP ON GUIDE LH USING ADHESIVE)																			
1	taking the guide from the painting section	A	#	B	6	G	1	A	6	B	6	P	1	A	10	10	400	4000	144	VA
2	and put on the table	A	1	B	1	G	1	A	3	B	0	P	1	A	0	3	21	210	7.56	VA
3	taking the wallet strip & adhesive	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
4	and fitting the wallet strip on guide LH	A	1	B	1	G	1	A	0	B	0	P	1	A	0	1	4	40	1.44	VA

	using adhesive																			
5	and taking wallet strip guide and putting the next station	A	3	B	1	G	1	A	1	B	0	P	1	A	1	3	24	240	8.64	VA
STN 11	ASSEMBLY SECTION(DRILL HOLES (8) IN WALLET ON GUIDE LH -USE CONE GRINDING WHEEL)																			
1	taking cone dril	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
2	and adjus to the dril on the wallet	A	1	B	1	G	1	A	1	B	0	P	1	A	0	1	5	50	1.8	VA
3	and dril the holes	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
4	and putting the next station	A	3	B	1	G	1	A	3	B	0	P	1	A	3	3	36	360	12.96	VA
STN 12	ASSEMBLY SECTION(FIT 8 STEEL BUSHES IN GUIDE LH)																			
1	taking the 8 steel bushes	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
2	and adjusting the guide on the table	A	1	B	1	G	1	A	1	B	0	P	0	A	1	1	5	50	1.8	VA
3	and fitting bushes in the guide	A	1	B	1	G	1	A	1	B	0	P	0	A	0	1	4	40	1.44	VA
4	and putting the next station	A	3	B	1	G	1	A	2	B	0	P	1	A	3	3	30	300	10.8	VA
STN 13	ASSEMBLY SECTION(FINAL ASSEMBLY OF BODY SIDE USING LH & RH GUIDES, LOUVER ASSY AND EQUIVILIZAR)																			
1	taking the RH and LH GUIDES	A	1	B	1	G	1	A	1	B	0	P	1	A	1	1	6	60	2.16	VA
2	and putting on the table	A	1	B	1	G	1	A	0	B	0	P	0	A	1	1	4	40	1.44	VA
3	and taking the equilizar and adjusting two guides	A	1	B	1	G	1	A	1	B	0	P	0	A	0	1	4	40	1.44	VA
4	and taking the louver assy	A	3	B	0	G	1	A	3	B	0	P	1	A	3	3	33	330	11.88	VA
5	and adjusting the louver assy	A	1	B	0	G	1	A	0	B	0	P	1	A	1	1	4	40	1.44	VA
6	and fitting the final assembly AND put the final assembly	A	1	B	6	G	1	A	1	B	0	P	3	A	1	6	78	780	28.08	VA

IV. **RESULT AND DESCUSSION**

Following are the Non-Value Added activities found from the study.

1. Pouring the Resin in Big Drum

Time require for Mixing of resin with powder before change the mixing drum size 24 min 46 second (1 big drum = 4 small drum).
Time require on SMC machine 8 minute 30 second.
Due to higher time taking from mixing machine, SMC machine would be stop for 16 minute 16 second.
For the continuous production of the SMC sheet, it is require to change the drum size,
So we decided to change the big drum to small drum of the mixing the resin with powder.
it is approximately 8 minute for mixing machine.
Therefore the SMC machine is continuously working in current condition.

2. Take the cutting sheet from the SMC section to the Moulding Operation

SMC Sheet is made by SMC section but they are not cutting the sheet,For the next operation of moulding machine, sheet is require to cut according to moulding die. So moulding operators are wasting a time for cutting the sheet.Actually mixture machine take the time for mixing the powder for 8 minute. So at that time operators are free. Therefore, we decided that SMC section operators would be cut the sheet and send to the moulding operation.Thus the free of time of SMC operators are to be utilized.

3. Arrange the racket for drying paint

They are using Ossian paint for painting the product that was require 15 minute for drying. It is require to arrange the product in racket.
So we decided to use oil paint to painting the product. It is require less time compare to the Ossian paint.(approx.. 5 min.)And also it is not require to arrange the product in racket.

4. Taking guide to the roller guide station from the painting section

Painting section to the roller guide station travelling distance is 10 miter.Side of painting section space is free, so space utilization and it required.So replace the guide station near to the painting section, and that distance is 6 miter. So we decided.

5. Fit the rubber strip one side only (one window frame)

I observed that one product to fit the rubber strip time is the 1 minute, so it is very high time and arrange the window frame and fitting rubber strip that time is the only 20 sec for one product.So we decided to arrange the product and fitting the rubber strip.

Table 4 Cycle time and Manpower (After)

Sr.No.	Work Station description	Cycle Time	Manpower/Day
1	Mixture M/C	46.08	2
2	SMC M/C	60.48	5
3	Moulding M/C (Louver)	25.56	2
4	Moulding M/C (Guide)	32.76	2
5	Finishing	44.64	6
6	Painting	121.32	3
7	ASSEMBLY SECTION(FIT ROLLER GUIDE BREAKET ON FIBRE GLASS & FIT (4) SCREW SPRING WASHER)	99.72	6
8	ASSEMBLY SECTION(FIT RUBBER STRIP ON WINDOW ONE SIDE)	31.32	2
9	ASSEMBLY SECTION(DO GLASS WINDOW ASSEMBLY (USE ITEM 1 & GLASS RUBBER STRIP & WINDOW FRAME)	25.92	2
10	ASSEMBLY SECTION(FIT WALLET STRIP ON GUIDE LH USING ADHESIVE)	163.8	2
11	ASSEMBLY SECTION(DRILL HOLES (8) IN WALLET ON GUIDE LH -USE CONE GRINDING WHEEL)	19.08	2
12	ASSEMBLY SECTION(FIT 8 STEEL BUSHES IN GUIDE LH)	16.2	2
13	ASSEMBLY SECTION(FINAL ASSEMBLY OF BODY SIDE USING LH & RH GUIDES, LOUVER ASSY AND EQUIVILIZAR)	46.44	2
	TOTAL	733.32	38

V. CONCLUSION

After the Analysis of assembly of body size window unit, it was found that most of works are Some operation sequences are not proper that cause time loss. And reduced the Non-Value Added activities and space utilization, reduce the travelling distance.

Before the implementation of MOST Analysis technique 996.12 sec is require to manufacture the product then after implementing it is require 733.32 sec. and total time reduced is 262.8.

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