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Reducing Assembly Time and Rework of Wheel Chair

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***Abstract*-Improving the productivity of the organization is the primary objective. If a wrong part assembly occurs then it leads to excess time consumption with loss of money. A new approach called Maynard Operation Sequence Technique (MOST) implementation, with an approach to Time study of an assembly workstation and reducing Non value adding activities(NVA). Poka Yoke method can be used for mistake proofing of assembly of wrong bracket on back frame of wheel Chair assembly and can also be used in defining holes during assembly of back frame, seat, mechanism, left hand rest, right hand rest. Certain devices such as fixture can be used. Automation can be applied with the help of human intervention with understanding critical points to design a Fixture and mechanical devices over the sensing devices**

Index Terms—Assembly, MOST, POKA YOKE,Time Reduction, Fixture

I. INTRODUCTION

. The industries has become more competitive and diversified. To cope up with competitive atmosphere the industries are implementing advanced technologies to overcome customer demand. There are various methods for work measurement. Fredrick W. Taylor introduced stop watch study. New studies were introduced over the period which analyze time on the basis of predetermined standards. After Motion time Analysis (MTA) (1920) , Motion time measurement (MTM) was introduced in 1948. The data of basic MTM was developed by H.B. Maynard, J L schwab, G j stegemerten(1940).MTM 2 was developed under IMD auspices in 1965. Simplified MTM - 3 was introduced in 1970. The methodology of MTM involves recording films, ratings. H B Maynard company introduced Basic MOST in 1972. The Maynard Operation Sequence Technique (MOST) can reduce upto 60 % of total time without reducing mechanical time.

TABLE 1 WORK MEASUREMENT TECHNIQUE AND TMUS PRODUCED

Work Measurement Technique	Total TMU's Produced per Analyst Hour
MTM-1	300
MTM-2	1000
MTM-3	3000
Mini-MOST	4000
Basic-MOST	12000
Maxi-MOST	25000

TABLE 2 BASIC MOST WORK MEASUREMENT TECHNIQUE

Sr.No	Activity	Sequence Model	Sub-Activity/ Parameter
1	General Move	A B G A B P A	A- Action Distance B- Body Motion G- Gain Control P – Placement
2	Controlled Move	A B G M X I A	A- Action Distance B- Body Motion G- Gain Control M - Move Control X - Process Time I - Alignment
3	Tool Use	A B G A B P _ A B P A	A- Action Distance B- Body Motion G- Gain Control P - Placement **Blank Space (_) is filled with below tool use parameter:** F-Fasten L - Loosen S - Surface Treatment M - Measure R - Record T – Think

The table can be explained such that
General Move-
Sequence
GET -|ABG|
PUT -|ABP|
RETURN-|A|
Characteristically, General Move follows a fixed sequence of sub activities identified by the following steps:
1. Reach with one or two hands a distance to the object(s), either directly or in conjunction with body motion or steps.
2. Gain control of the object.
3. Move the object by a distance to the point of placement, either directly or in conjunction with body motion or steps.
4. Place the object in a temporary or final position.
5. Return to workplace.

TABLE 3 UNIT CONVERSION TABLE

1 TMU	=	0.00001 hour	1 hour	=	100,000 TMU
1 TMU	=	0.0006 minute	1 minute	=	1667 TMU
1 TMU	=	0.036 second,	1 second	=	27.8 TMU

II. POKA YOKE

Shigeo Shingo introduced Poka-Yoke method in 1961[3], when he was one of engineers of Toyota Motor Corporation. As Poka yoke is Japanese word which means 'Mistake Proofing' and errors originating in the mistake. Shingo worked on Statistical process control (SPC) and realized that it is not the solution to improve manufacturing process. Poka yoke is implemented using simple objects like fixture, jigs, warning devices, color coding and the like to prevent people from making mistake.

In ergonomic organization manually operated assembly workstation, certainly there occurs error while assembling a particular part. Practically, when a fabric is covered over a seat lower seat (during assembly) , it is found that holes on back side of lower seat is not visible. Also some seats having multiple holes, provision that every mechanism can be assembled. But it is found that workers find it difficult to find holes. So, it is found that using certain Fixture Template would be the solution, as a error proof solution. Errors damage the fabric. Usually there are 3 brackets with different dimension but having assembly hole with same center distance. Problem of particular bracket assembled to frame. The fixture can be developed for assembly.

These objects, known as poka yoke devices, are usually used to stop the machine and alert the operator if something is about to go wrong. Poka Yoke can be applied at assembly stage. At workstation 6 template is designed implementing 3-2-1 Principal where two degrees of freedom (DOF) are restricted.

III. CASE STUDY

The Case study deals with the assembly of wheel chair at workstation. The bracket assembly is done at workstation1. At workstation2 same worker cover mesh on the back frame. The back frame is transported to workstation 3. Worker at workstation3 staple the mesh and transport back frame to workstation6. Workstation 4 and 5 work parallel to workstation 1,2 and 3. At Workstation 4 assembly of gluing of foam on seat is being performed. At workstation 5 Fabric is covered on the seat. The seat is transferred to workstation 6. The workstation 6 assemble seat with the backframe with arm rest and mechanism thereafter.

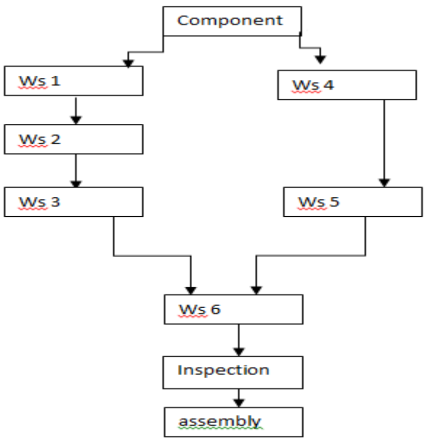

Figure1: Flow Chart Of Wheel Chair Assembly

Calculation of cycle time:
Basic Cycle Time : 2000 *0.036 = 72 s
Considering allowance of 16%
Standard Time = 72 * 1.16 = 83.52 s

TABLE 4: WORKSTATION 1 PROCESSES

Sr. No.	Method Description (Ws1)	Sequence model	TMU
1	Taking Frame in hand and adjusting on fixture	A1B0G1 A1B0P1 A0	4
2	Placing wooden brace on fixture	A1B0G1 A1B0P1 A0	4
3	Fastening Wooden brace with 4 screw by pneumatic Fastener	A1B0G1 A1B0P3 F3 A1B0P1 A1 *4	80
4	Placing bracket below frame	A1B0G1 A1B1P3 A0	7
5	Fastening bracket w/ 4 screw	A1B0G3 A1B0P1 F10 A1B0P3 A1	88
6	Pulling Lever	A1B0G1 A1B0P3 A0	6
7	Transfer the Frame to the WS2	A1B0G1 A3B0P3 A3	11
8		Total TMU	200*10=2000

TABLE 5: WORKSTATION 2 PROCESSES

Sr. no.	Method Description (ws2)	TMU
1	Taking a Mesh in Hand	2
2	Cutting the Corners of the Mesh	16
3	Folding Cover	5
4	Placing Cover on Back frame	6
5	Pulling cover on Back frame	9
6	Sliding Cover over Back frame	100
	Total	138*10 =1380

TABLE 6 : WORKSTATION 3 PROCESSES

Sr. no.	Method Description	TMU
1	Pulling Mesh Tightly on frame	7
2	2 cut Mesh at the end centre	20
3	Folding one part of mesh inside	18
4	Corner Staple on Ply	12
5	Cut bracket sized Mesh	20
6	Tightly Stretching Mesh	12
7	Staple at back of bracket on Mesh	24
8	Staple 10 staple on one corner *2	120
9	Pull cover on the upper side of bracket	7
10	Cut Mesh on two sides of Bracket	30
11	Fold extra Part Behind bracket inside	10
12	Staple at side of bracket	10
13	Adjusting Mesh near Bracket	10
14	Staple at the extreme corner of Mesh	26
15	10 staple on ply *2	160
16	Transfer Seat at ws 6	37
	Total	503 *10 =5030

TABLE 7 : WORKSTATION 4 PROCESSES

Sr. no.	Method Description (WS4)	TMU
1	Taking a seat foam and extra strip	14
2	Placing 2 plates ON Ply	17
3	Placing Centre Punch on Plate	5
4	Fastening 4 Screws with hand	52
5	Fastening the screws	92
6	Dissembling Centre Punch	5
7	Spraying glue on seat	130
8	Placing AND Adjusting foam on seat	108
9	Spray glue on seat	48
10	Placing extra foam on seat	24
11	Place seat on inventory	7
	Total	502 * 10 = 5020

TABLE 8 : WORKSTATION 5 PROCESSES

Sr. no.	**Method Description (ws5)**	**TMU**
1	Taking a seat	12
2	Cover fabric on seat	10
3	Pulling fabric	36
4	2 Staple	126
5	Adjusting fabric	162
6	Adjusting Folding Corners	56
7	2 Staple Corners	20
8	Adjustment of fabric	81
9	Stapling single line	126
10	Placing a back Cover on seat	4
11	Stapling 6 staple	12
12	Stapling single line	112
	Total	697 *10 = 670

TABLE 9: WORKSTATION 6 PROCESSES

Sr. no.	Method Description	TMU
1	Placing seat on assembly seat	11
2	Finding holes on seat	154
3	Taking a left hand arm rest parts	8
4	Placing LH on seat (Same for RH)	32
5	Taking RH arm rest AND SCREWS (Same for LH)	16
6	Assembling RH arm rest with fastener (Same for LH)	88
8	Placing Screw on holes (Same for LH and RH)	16
10	Placing Washer on seat	7
11	Placing Mechanism on washer	10
12	Place screw on mechanism holes	7
13	Fasten the screws	80
14	Placing back frame on seat	25
15	Placing the screws on bracket and assembly	10
16	Fastening the screws on bracket and mechanism	80
		544 *10 =5440

Adding TMUs of all workstation, and converting into time, the standard time becomes 1063.6s.

IV. BOTTLENECK IDENTIFICATION

Though bottleneck identification in MOST reduce time of the activities consume higher time. In our study it is found that workstation(ws) 1,2 and 3 forms a cycle of assembling back frame. Workstation 4, 5 forms other cycle which consumes more time as compared to ws 1,2,3. So we need to reduce time at ws4 and 5.

At ws4- Adjusting and placing foam on seat forms bottleneck activity as it is combined with gluing extra strip.

At ws5 – Adjusting fabric is the bottleneck activity.

At ws6 – Finding holes on seat also consume time

A. POKA YOKE

To 'mistake proof' assembly , implementing Poka Yoke at ws1. So work basis study is done. Understood the existing process. At ws1 bracket assembly is performed. There are 3 types of different brackets assembled on backframe, every bracket further responsible for mechanism assembly at workstation 6.

Three types of bracket and their respective geometry:

Figure2: Synchronous single point mechanism bracket profile

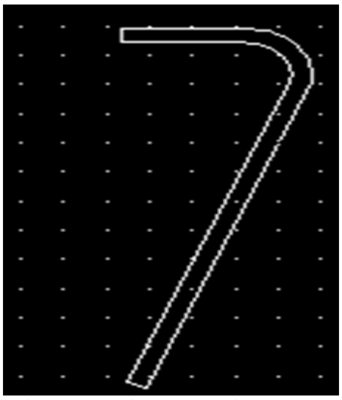

Figure3. Synchronous Multipoint Mechanism Bracket Profile

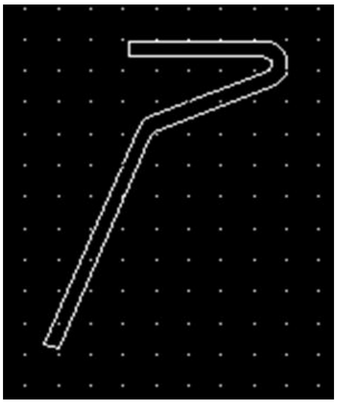

Figure4. Centre Tilt Mechanism

Every bracket has the individual angular tilt and width. Taking the advantage of that and existing fixture dimension . Every bracket has different resting position. Bracket have different length. Obviously Sensors can be the option for such situation to 'Mistake Proofing' but it just a feedback mechanism. Also certain gauges could be implemented while assembling . We are applying both the concepts of Sensors and gauges We are going to 'fail safing' the bracket assembly. So we need the design solution. Also the contact type method is applicable. The fixture block can be placed at the space shown. Diagram shows the existing fixture.

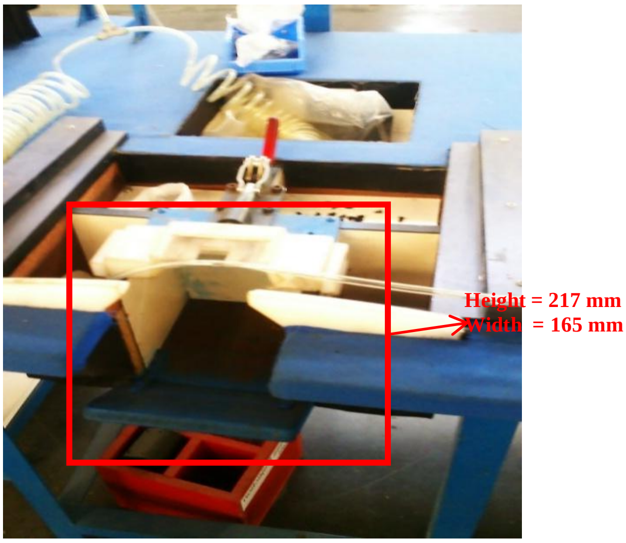

Figure5. Existing Fixture

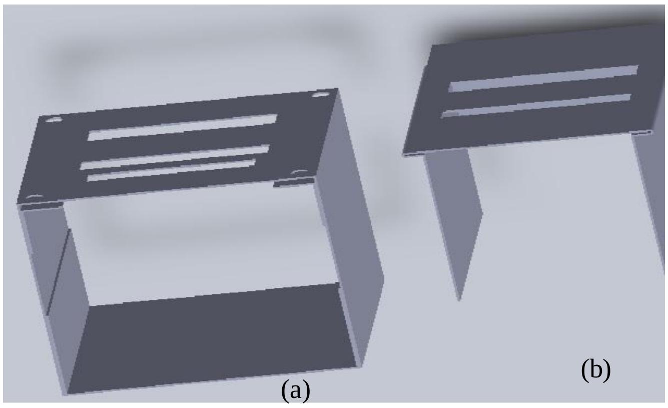

Figure6. Fixture Block : a) Fixed Block b) Slider Plate

The mechanism of the block is that slider keep open only one slot at a time. While the other slots are remain closed. The fixed block remains fixed while sliding plate moves occupying all slots.

V. RESULTS AND DISCUSSION:

To reduce time of these activities at ws4 and 5 we have to work at elemental level, so we are reducing placement indices. The adjustment of foam can be reduced by application of molded foam, which forms less elasticity as compare to existing foam and reduce placement index.

For reducing time for finding holes at ws 6, fixture template is proposed which will have the ability to assured hole defining when placed on seat.

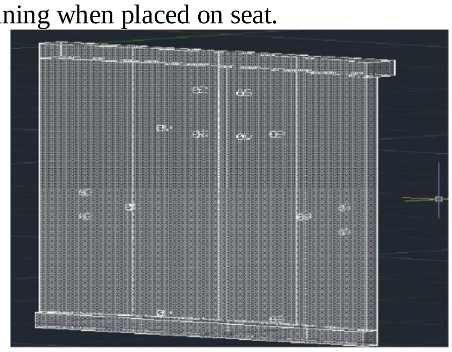
Figure7. Cad model for fixture template

Further NVA reduction at ws3 - to transfer backframe at ws6. The layout can be changed and extra distance from ws 3 to ws6 can be reduced.

TABLE10. REPRESENTATION OF REDUCTION OF ACTIVITIES TMUS

Sr.	Activities	New TMU	OLD TMU
1	Taking a extra strip	0	14
2	Placing AND Adjusting foam on seat	60	108
3	Adjusting fabric	90	162
4	Adjustment of fabric	45	81
5	Placing extra strip of foam on seat	0	24
6	Placing back frame in mechanism	10	25
7	Placing Template on seat	7	-
8	Finding holes	22	154
9	Spraying glue on seat	0	36
10	Transfer seat to ws 6	5	37
	Total	252*10=2520	602*10=6020

New Time: 2520 *0.036 = 90.72 s

Old Time: 6020 * 0.036 =216.72s

Percentage time reduction on existing processes: $\frac{216.72-90.72}{216.72}$ * 100 = 58.13 %

TABLE11. NEW MOST COMPARISON

Workstation	Old MOST Time	New MOST Time
WS1	83.52	83.52
ws2	57.62	57.62
ws3	201.05	194.6
ws4	209.63	165.71
ws5	291.06	252.18
ws6	227.17	182.17
Total	**1070.05**	**935.8**

Overall time reduction = $\frac{1070.05-935.8}{1070.05}$ * 100= 12.5 %

The Overall time reduction of 12.5 % found on existing time after implementing proposed changes.

COMPARISON FOR IMPROVEMENT

VI. CONCLUSION

After analysis, bottlenecks were found at WS4,WS5. The cycle consumes more time as compared to WS1,WS2,WS3. Modifying the processes and reducing certain non value added activities, it is found that overall time reduction is 12.5% ,leads to 50% time reduction on existing processes . This contribute towards assembling more chairs. Also the assembly process can be 'Mistake Proofed' by Poka yoke. Cardboard model was practiced and it worked satisfactorily. The productivity is improved.

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