Determination of Allowances for Standard Time

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Hermosillo Stamping and Assembly Plant (HSAP) use MODAPTS platform to determine the workstation load, this method generates normal times through premeditated times, not considering extra allowances because this scheme doesn’t establish it. MODAPTS dictate that each work center must examine the applicable allowances according to its own characteristic, for that reason the study was focused on determine the necessary allowances to define the standard time workloads, integrating them to normal time. Within these allowances, physical aspects of the design of the workstation station are considered as well as cognitive factors. Not contemplating these factors could generate greater physical loading and / or mental strain; affecting the performance of the employee and increasing the risk of musculoskeletal injuries.

The implementation of this strategy required a low level of investment. Regarding the necessary resources, measurement equipment was utilized as lux meter, decibel meter, pull/push gauge, etc. additional an average of 500 man hours was required for data collection during a two months period.

The ergonomist set the parameters to consider allowances such as lighting, noise, atmospheric conditions, stress levels, etc. This study is based on Mexico’s Normative Organization (NOM) and ergonomic global standards in order to establish a new time study formula. Additional to determine the allowances of this project reference tables by the International Labor office (ILO) were utilized. Although this organization does not have a formal position regarding allowances, these tables were a base to analyze and define what best suits the characteristics of Final Assembly workstations of HSAP.

Proposed allowances were measured in aspects of environmental conditions as well as stress levels in stations that required it, also were evaluated by the predictive method AAMA used for the determination of metabolic rate expenditure and the formula recommended by Rohmert in 1973 to effort levels. Once the results were obtained of each of the workstations identified, seven allowances were defined within the project to determine the standard time: Basic Fatigue Allowance, Standing Allowance, Muscular Energy (Force), Proper Illumination, Atmospheric Conditions, Noises Level and Tediumness as part of the new formula of percentage of utilization (workload metric).
Standard Time = Normal time + Allowances.

This new formula integrates to regular change management process of Industrial Engineer as criteria of workstation rebalancing; this improves the project to become self-sustained, avoiding to require an alternate or additional management. It is necessary to contemplate this is an ongoing process that could be affected by many aspects such as new model launch, engineering changes, efficiencies, etc.

This study is based on the idea to have an ergonomic process in a proactive way, considering the aspects of the design of the workstation and integrating them to regular change process (rebalancing), adhering to an internal working strategy of Ford Motor Company for all dimensions (safety, quality, flow, maintenance, environmental) focusing on inputs more than outputs.

The advantages and benefits of this project resulted: Determine the actual efficiency of workstations, improves the change management process (rebalances) it permits more input variables, decreases the risk of occupational injuries and minimize fatigue, Increases the performance of operators and the quality of the finish product.

**Keywords:** Standard time, Allowances, Ergonomic Process, Proactive, Workload.

1. Background

Ford Motor Company- Hermosillo Stamping and Assembly Plant currently works with times obtained directly from MODAPTS wht this method we obtain the workload for each workstation and affect the percentages of utilized time to work, this association has its own posture related to allowances: "MODAPTS analysis of work produces the normal time to perform work. The addition of time for allowances required by contract and/or government agencies and desired by the company is outside the sphere of the MODAPTS analysis and should be determined by the management of the company. The INTERNATIONAL MODAPTS ASSOCIATION has not adopted nor is it likely to adopt any recommendations for time allowed for allowances." IMA (2000) for that reason allowances needs to be added so standard times can be obtained.

The scope of this project is to define the process and methodology to determine allowances that need to be considered to precisely calculate standard times in Final Assembly’s workstations. This process is focused in those allowances recommended by the International Labor Organization (ILO).
1.1 Justification

The main reason to determine standard time originates from the necessity to establish adequate workloads to each workstation in order to benefit both employees and plant.

Achieving the following:

- Determine real efficiency of workstations.
- Facilitate workstations rebalances.
- Reduce and eliminate occupational injuries and fatigue from employees.
- Increase Employees’ performance and consequently an impact on Quality and Delivery.
- Cost reduction on operation.

![Final Assembly Production Line](image)

2. Methodology

Y = Determination of Allowances for Standard Time

\[ X_1 = \text{Basic Fatigue} \]

\[ X_2 = \text{Standing Position/ Foot} \]

\[ X_3 = \text{Muscular Strength} \]

\[ X_4 = \text{Lighting} \]

\[ X_5 = \text{Atmospheric Conditions (heat and humidity)} \]
Definition of this project requires the following steps in order to structure the new formula of standard time:

1. - Identify Final Assembly's workstations that have a workload superior to 85%.
2. - Identify factors that have an influence or impact in each workstation.
3. - Gather analysis done at Ford Motor Co. about normal times and necessary factors to be considered.
4. - Identify and calculate factors that are not considered or established by Ford Motor Co.
5. - Determine proper allowances for each Workstation.
6. - Determine standard time for each Workstation.
7. - Verification test needs to be done to validate results.

The following layout shows Final Assembly's view where workstations are located and indicating which ones (red colored) has a workload superior to 85%. As an initial stage it is intended to focus in these workstations since these are the ones that can be improperly evaluated without allowances correctly identified and considered.
In order to determine allowances that apply to each Workstation, this is based in allowances that are recommended by International Labor Organization (ILO). This information in presented in the following tables:

<table>
<thead>
<tr>
<th>Table: ILO Recommended Allowances</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Constant allowances:</td>
</tr>
<tr>
<td>1. Personal allowance: 6</td>
</tr>
<tr>
<td>2. Basic fatigue allowance: 4</td>
</tr>
<tr>
<td>B. Variable allowances:</td>
</tr>
<tr>
<td>1. Standing allowance: 2</td>
</tr>
<tr>
<td>2. Abnormal position allowance:</td>
</tr>
<tr>
<td>a. Slightly awkward: 0</td>
</tr>
<tr>
<td>b. Awkward (bending): 2</td>
</tr>
<tr>
<td>c. Very awkward (sitting, stretching): 7</td>
</tr>
<tr>
<td>3. Use of force, or muscular energy (lifting, pulling, or pushing): Weight lifted, points: 5</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>45</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>70</td>
</tr>
</tbody>
</table>

3. Allowances

An assessment was made to each of the above points, to see whether they apply to stations that we are analyzing.

3.1 Constant allowances

3.1.1 Personnel fatigue

The allowances for personnel fatigue do not apply to any of the stations because, that time is considered in the breaks that already has established for Ford Motor Company.

3.1.2 Basic fatigue

On the other side allowance for basic fatigue is a constant that takes into account the energy used to perform the work and relieve the monotony. This allowance is considered in the study due the nature of final assembly workstations.
3.2 Variable allowances

3.2.1 Standing Allowance

This allowance considers if the operator is in a standing or abnormal position. If the position the operator has in a workstation is abnormal, further studies are required in order to indicate which percentage will be use to evaluate.

3.2.2 Use of force or muscular energy

When a workstation has a task where a part or tool is lifted, the number or serial of the part or tool has to be documented in order to consult its weight.

In a case where a clip, pin or other part that is installed with pressure, a study has to be perform which consist in going to the workstation and have a study done regarding the insertion force that is required to perform the task. These results need to be analyzed to determine that there is not a variability of data.

Once the data is approved, the average of these is compared to the approved standard depending on the part of the hand on which the force is applied. Una vez ya aprobados los datos se compara el promedio de cada clip o tapón con el estándar permitido según la parte de la mano con la que la pone.

For this case the average is 3.3 y and the maximum force is 10 lb, therefore there is an average allowance of 0%.

For the scenario where the average force of the studies performed, the results outcome is above the established limits by Ford, the following equation will be used proposed by Romhert:

\[
HD = 1800 \times \left(\frac{t}{T}\right)^{1.4} \times \left(\frac{f}{F - 0.15}\right)^{0.5}
\]

\[
t = \text{sustenance duration (min)}
\]

\[
f = \text{sustenance force (lb)}
\]

\[
F = \text{Maximum sustenance force (lb)}
\]

\[
T = 1.2 / \left(\frac{f}{F - 0.15}\right)^{0.618} - 1.21
\]
3.2.3 **Bad illumination**

To determine illumination/ lighting, a R&R gauge was made, once approved, a illumination analysis and study of each workstation was done and finally it was compared to the established in NOM-025-STPS-2008 (Mexican Norm).

For illumination cataloged as too low, low or inadequate a study by Bennett (1977)

3.3.4 **Atmospheric conditions**

NIOSH (1986) proposes a formula to determine the percentage of allowance in accordance to atmospheric conditions, which is presented as the following:

\[
HD = e^{(-41.5 + 0.0161W + 0.497TGBH)}
\]

Where \( W \): is the consumed energy in Kcal/hr.

\( TGBH \): Global temperatura of Wet Bulb °F

The following data was provided by Ford. \( W=240 \text{ kcal/hr} \) and \( TGBH= 78.8 \text{ °F} \).

3.3.5 **Noise Level**

Ford complies with NOM-011-STPS-2001 (90 dB below at a 8 hrs shift).

3.3.6 **Tediousness**

It consists in determining if a workstation performs the same tasks if it varies between options. This allowance applies to elements where there is a repetitive use of body extremities, such as fingers, hands, or legs. “A method studies use to simplify work and do it more efficiently, also becomes tedious or repetitive to qualified operators, and it becomes more probable that operators become more likely to suffer from a muscle-skeletal disorder relate to work.” NIEBEL (2009)

4. **Allowance Calculation**

Once all studies to determine allowances are done, the resulting allowances must be added, only those that have an impact in each workstation.
Example. Workstation 729- Installation of Rocker Molding.

\[
\text{Total Allowance} = \text{TS} = \text{TN} \times (1 + \text{Allowance})
\]

<table>
<thead>
<tr>
<th>Constant Allowances</th>
<th>4.0 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable Allowances:</td>
<td></td>
</tr>
<tr>
<td>Standing Position</td>
<td>2.0 %</td>
</tr>
<tr>
<td>Atmospheric Conditions</td>
<td>3.57%</td>
</tr>
<tr>
<td>Tediumness</td>
<td>5.0 %</td>
</tr>
<tr>
<td>Total</td>
<td>14.57%</td>
</tr>
</tbody>
</table>

\[
\text{TS} = 42.07 \times (1.1457) = 48.19 \text{seg}
\]

\[
\text{Workload\%} = 97.70\%
\]

Posterior, time standard is calculated and workload percentage in each workstation:

<table>
<thead>
<tr>
<th>LINEA</th>
<th>We</th>
<th>Description</th>
<th>Normal Time Workload%</th>
<th>Basic Fatigue</th>
<th>Standing</th>
<th>Muscular Force</th>
<th>Bad Illumination</th>
<th>Atmospheric Condition</th>
<th>Noise Level</th>
<th>Tediumness</th>
<th>TOTAL DF DE HOGURA</th>
<th>Standard Time % Workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>101 L</td>
<td>Dash panel harness</td>
<td>90.9%</td>
<td>4%</td>
<td>2%</td>
<td>1%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>5%</td>
<td>15.57%</td>
<td>105.57%</td>
<td></td>
</tr>
<tr>
<td>108 L</td>
<td>Gas tube installation</td>
<td>98.5%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>5%</td>
<td>14.57%</td>
<td>113.17%</td>
<td></td>
</tr>
<tr>
<td>109 L</td>
<td>Seat bracket installation</td>
<td>90.5%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>14.57%</td>
<td>111.07%</td>
<td></td>
</tr>
<tr>
<td>120 L</td>
<td>Hood bracket installation</td>
<td>84.1%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>14.57%</td>
<td>98.08%</td>
<td></td>
</tr>
<tr>
<td>124 L</td>
<td>Brake pedal</td>
<td>95.6%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>14.57%</td>
<td>110.97%</td>
<td></td>
</tr>
<tr>
<td>122 R</td>
<td>Gatefold harness</td>
<td>88.1%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>14.57%</td>
<td>103.37%</td>
<td></td>
</tr>
<tr>
<td>124 R</td>
<td>Side curtain airbags</td>
<td>90.4%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>14.57%</td>
<td>105.02%</td>
<td></td>
</tr>
<tr>
<td>128 R</td>
<td>Headliner selection and installation</td>
<td>90.7%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>3.57%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>14.57%</td>
<td>105.34%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. Line 100 Workstation time standard calculation.

5. Conclusion

- A study to determine all workstations’ standard times was done in Final Assembly.
- With the previous information, rebalances were done with more precise data.
- Some of the variables and factors considering the previous information are:
  - Illumination
  - Atmospheric Conditions (temperature, energy consumption while working)
  - Strength

6. References


