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COMPUTER PROGRAM FOR THE EWMA CONTROL CHART

Nicolae EFTIMIE
"Transilvania" University of Braşov, Department of Manufacturing Engineering
e-mail: eftimien@unitbv.ro

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Abstract: The paper presents a computer program for the Exponentially Weighted Moving Average Control Chart. This type of chart is a good alternative to the Shewhart control chart when we are interested in detecting the small shifts of the process mean. The program was developed using MS Excel and uses the individual measurements for calculating: the values of EWMA, which are the points on the control chart, and the control limits. Using these values, the program plots the chart.

1. THEORETICAL CONSIDERATIONS

The paper presents a computer program for the Exponentially Weighted Moving Average Control Chart.

The EWMA control chart represents a good alternative to the Shewhart control chart, when we are interested in detecting the small shifts of the process mean.

The statistic EWMA z_i at a moment i represents the weighted sum of all the precedent measurements x_i, x_{i-1},… giving a decreasing weight for measurements depending on their age [1]:

$$z_i = \lambda x_i + (1-\lambda) z_{i-1}, \tag{1}$$

where the parameter λ is used for modulating the memory of the statistic z_i.

In general, λ takes values into the interval [0.05 ; 0.25] [1].

Usually, the starting value for EWMA, z_0, is equal to the process target μ_0. Sometimes, the average of preliminary data is used as the starting value of the EWMA. The control limits of the chart are given by the following formulas [2]:

$$UCL = \mu_0 + L\sigma\sqrt{\frac{\lambda}{2-\lambda}\left[1-(1-\lambda)^{2i}\right]}, \tag{2}$$

$$LCL = \mu_0 - L\sigma\sqrt{\frac{\lambda}{2-\lambda}\left[1-(1-\lambda)^{2i}\right]}, \tag{3}$$

The center line is equal to μ_0 [2].

The parameter L takes values into the interval [2.6 ; 2.8] when $\lambda \leq 0.1$. In the case of larger values of λ, L=3 works reasonably well [1].

Similar to the cusum chart, the EWMA chart performs well against small shifts, but does not react to large shifts as quickly as the Shewhart chart.

2. PRESENTATION OF THE PROGRAM

The program was developed using MS Excel.

The first section of the input data area is used for recording the values of μ_0, λ, L and σ. For each cell located into the input data area there were established validation rules, so the user cannot record incorrect data. Figures 1, 2 and 3 illustrate the procedure used for establishing the validation rule for the standard deviation, σ.

In the same way, there were established the validation rules for all the input data.

The second section of the input data area is used for recording the measurements (Figure 4).

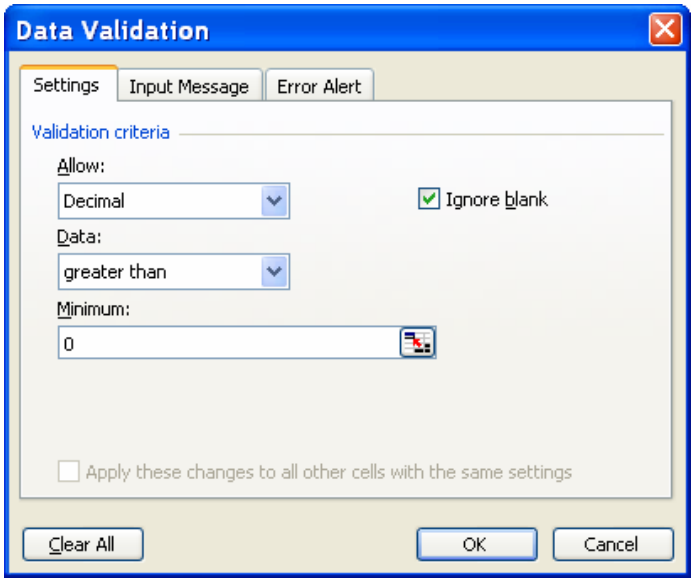

Figure 1. The Data validation dialog box – Section: Settings

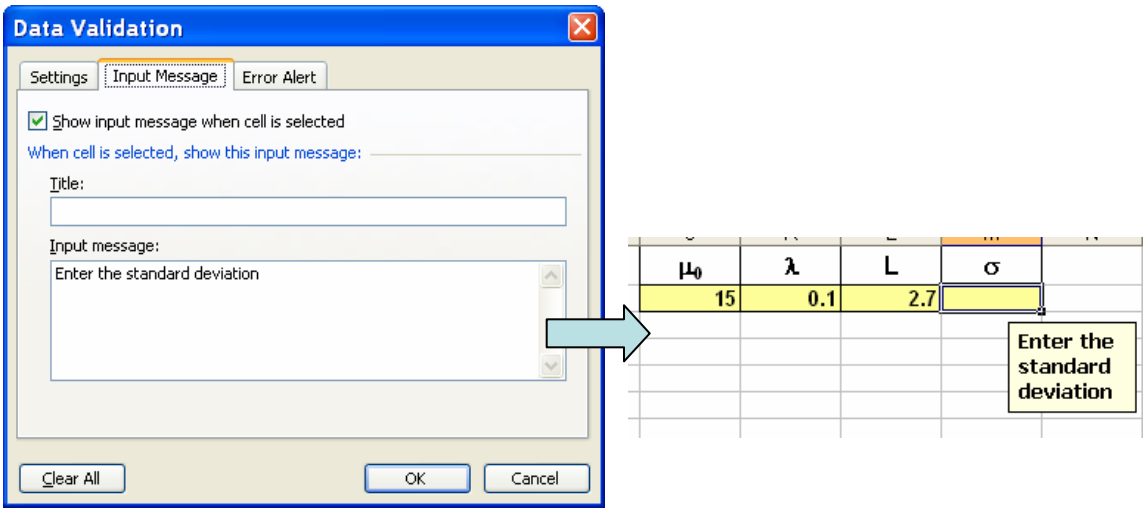

Figure 2. The Data validation dialog box – Section: Input Message

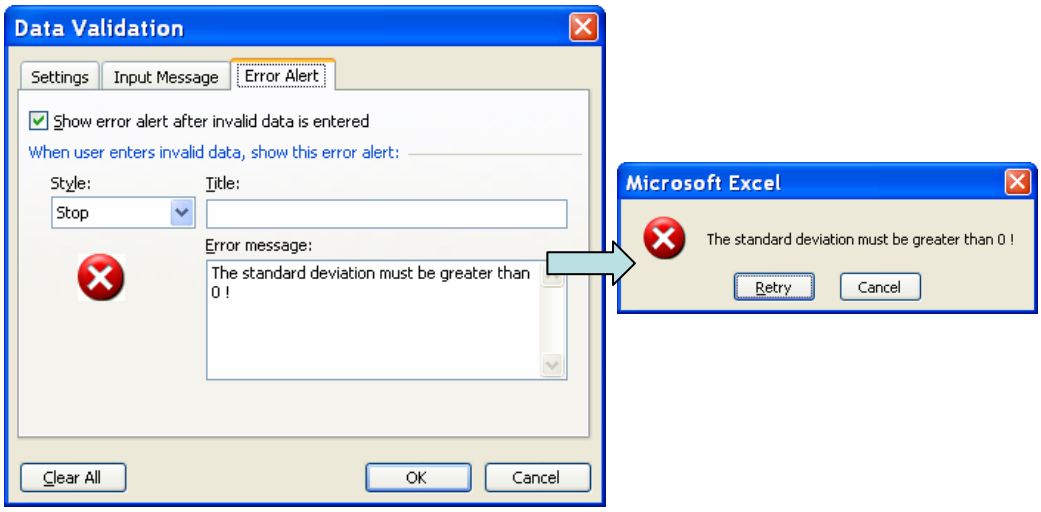

Figure 3. The Data validation dialog box – Section: Error Alert

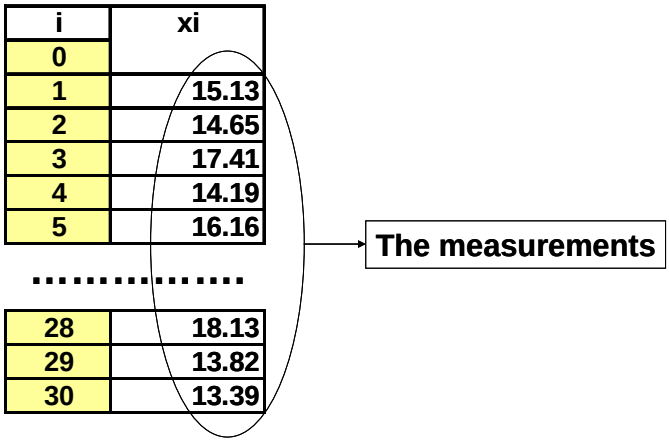

Figure 4. The Input data area – The measurements

Using the measurements, the program calculates the values of the statistic EWMA, z_i (Figure 5).

- The starting value is the process target:

$$z_0 = \mu_0 , \tag{4}$$

- The values of the statistic z_i for $i \geq 1$ are calculated by the program by means of the relation (1).

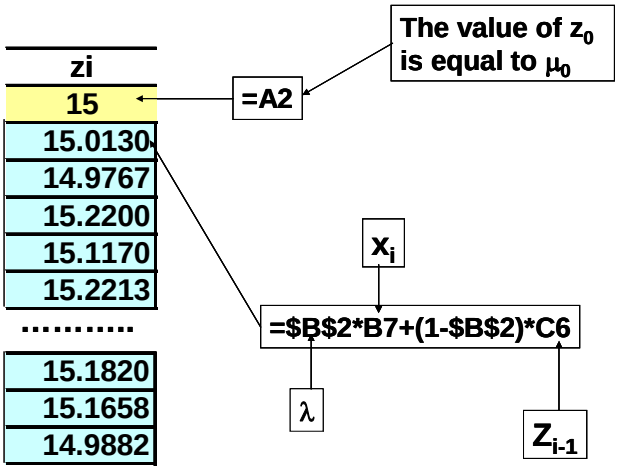

Figure 5. The values of the statistic EWMA

The control limits are calculated by means of the relations (2) and (3) and the center line is equal to the process target μ_0 (Figure 6).

Using values of the statistic EWMA, the control limits and the central line, the program plots the EWMA chart (Figure 7).

The next operation, which must be accomplished by the program's user, is the control chart analysis.

In the presented example, it can be seen that the process wasn't influenced by special causes of variation (Figure 7).

3. CONCLUSIONS

The presented program can be used as a Computer Aided Quality tool, at the Statistical Process Control.

The program calculates the values of the statistic EWMA, which are the points on the control chart, the control limits and the central line. Using these values, the program plots the control chart.

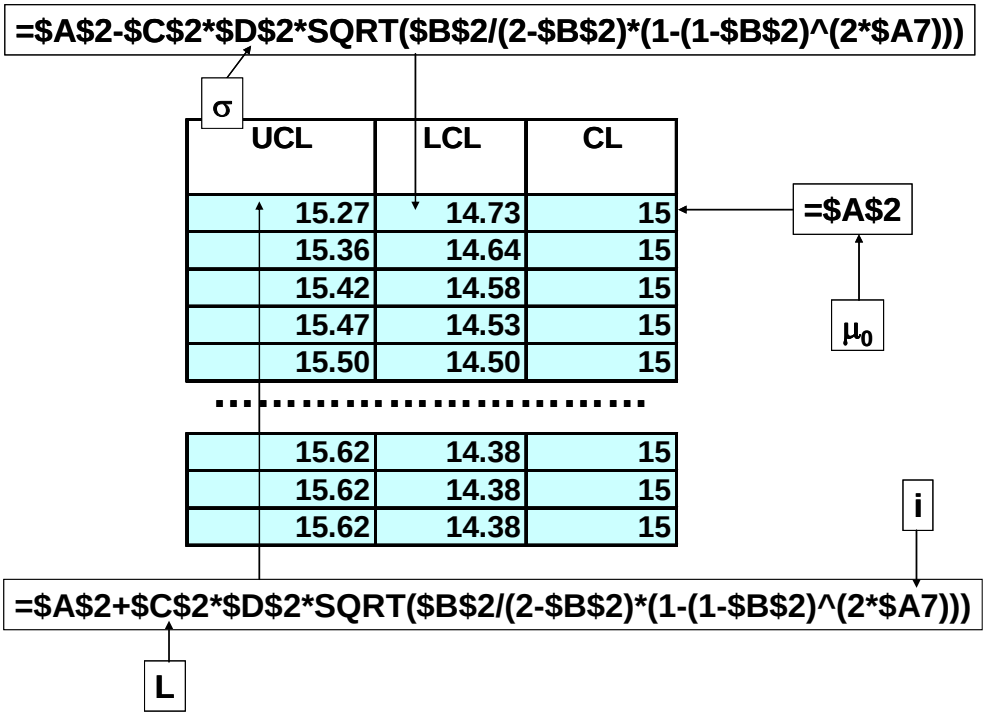

Figure 6. The control limits and the central line

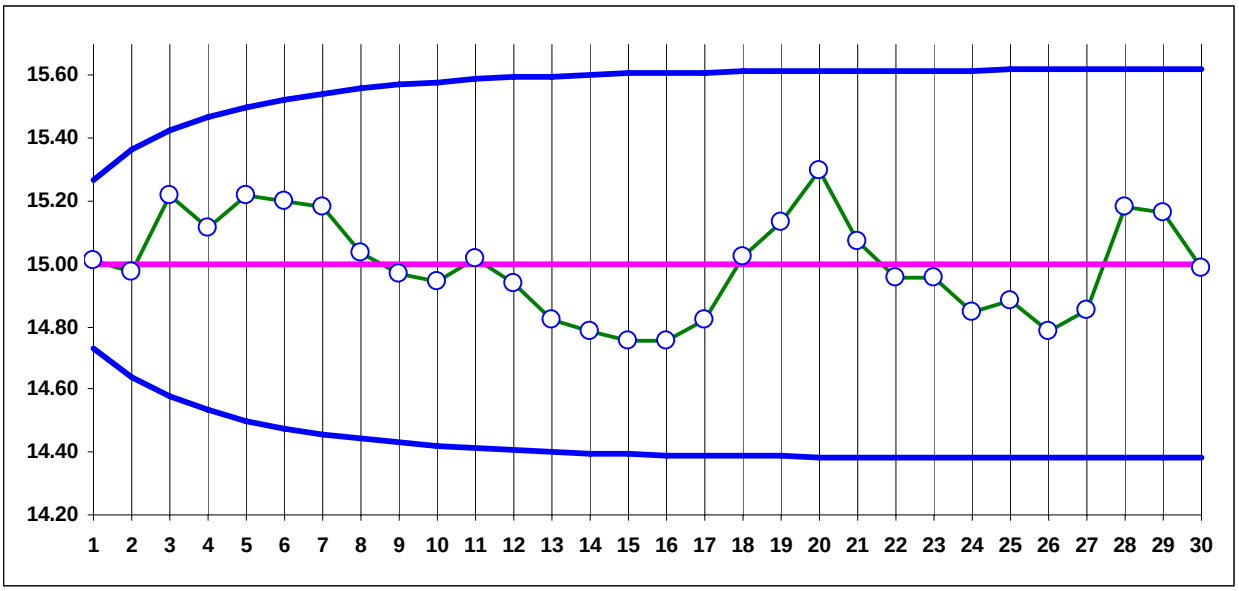

Figure 7. The EWMA control chart

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/QUA120-Chapitre3.pdf