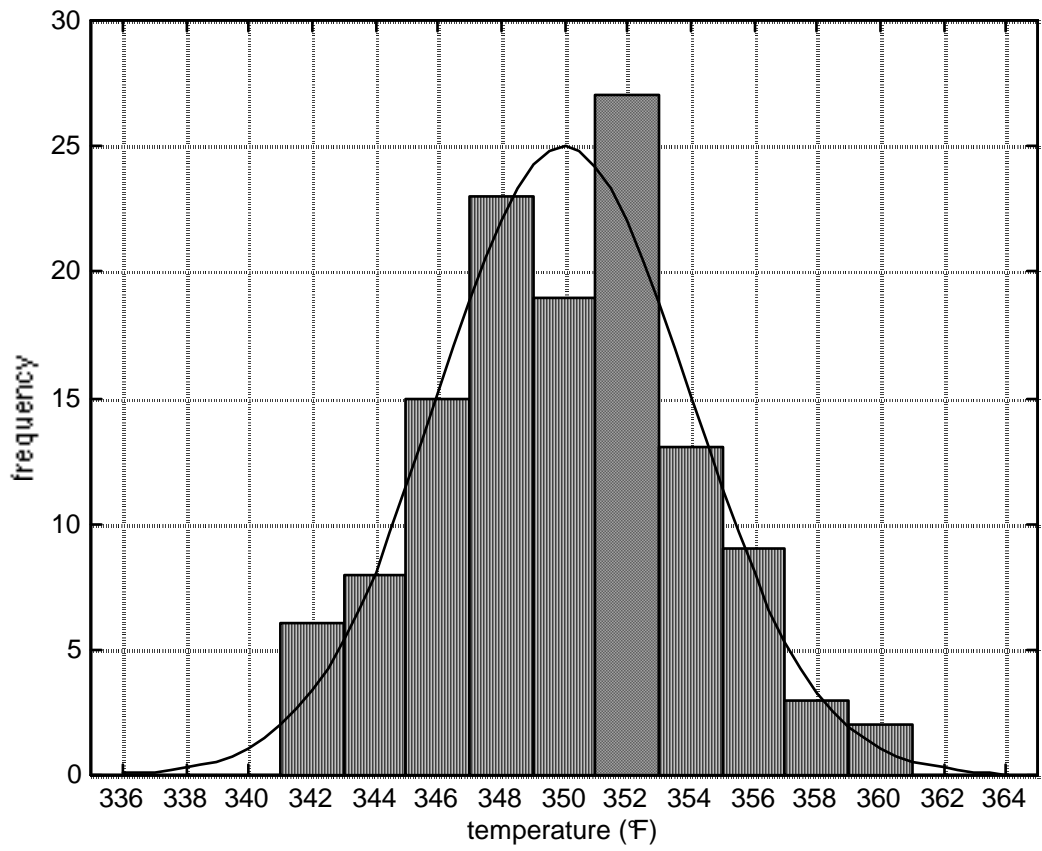
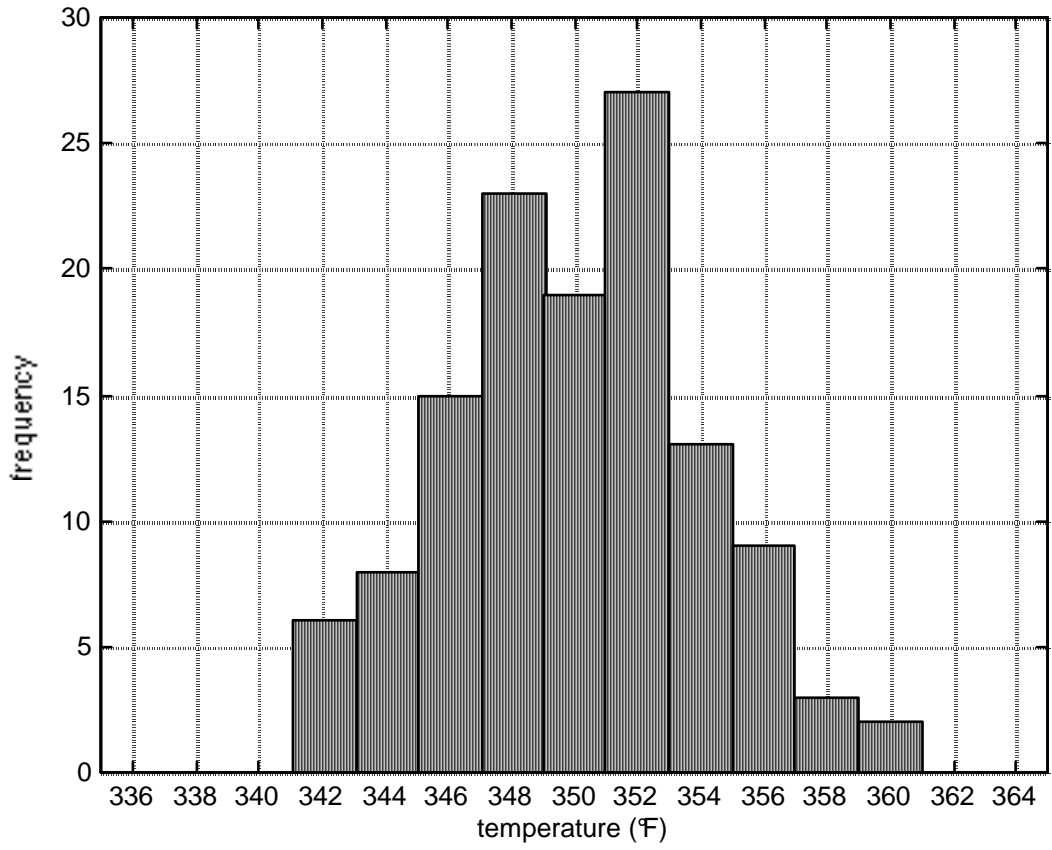
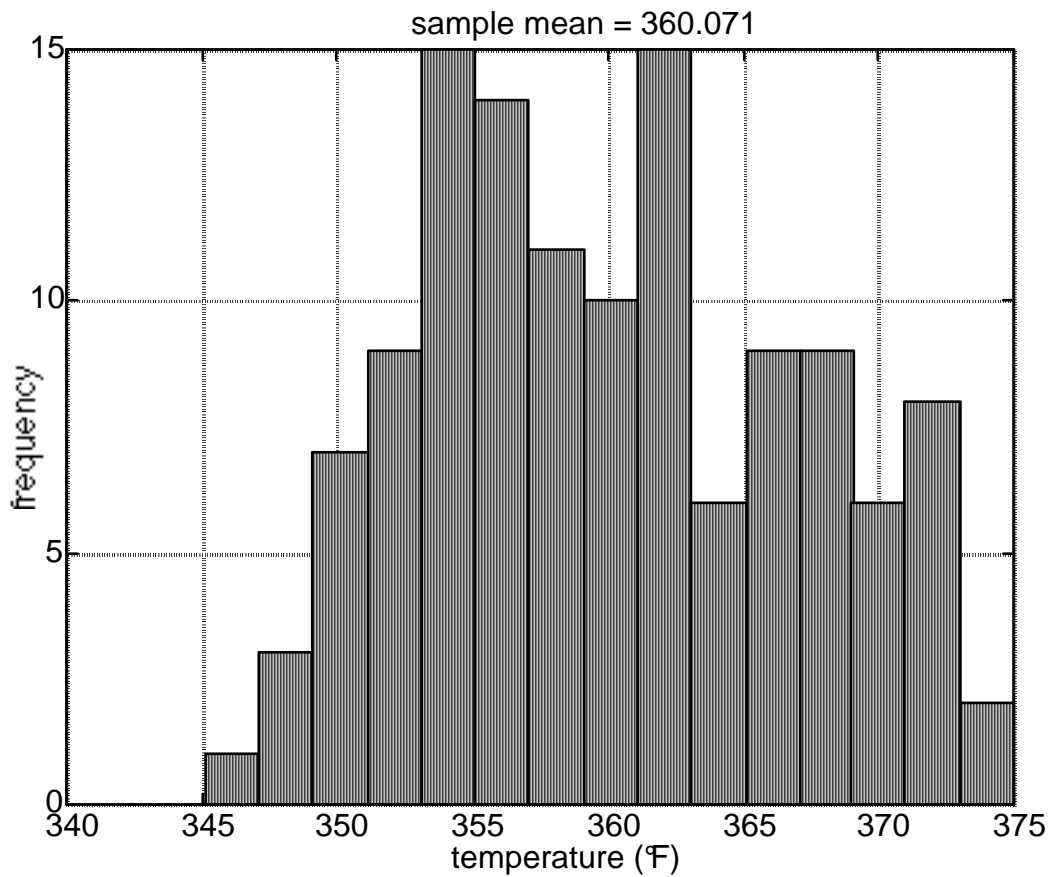
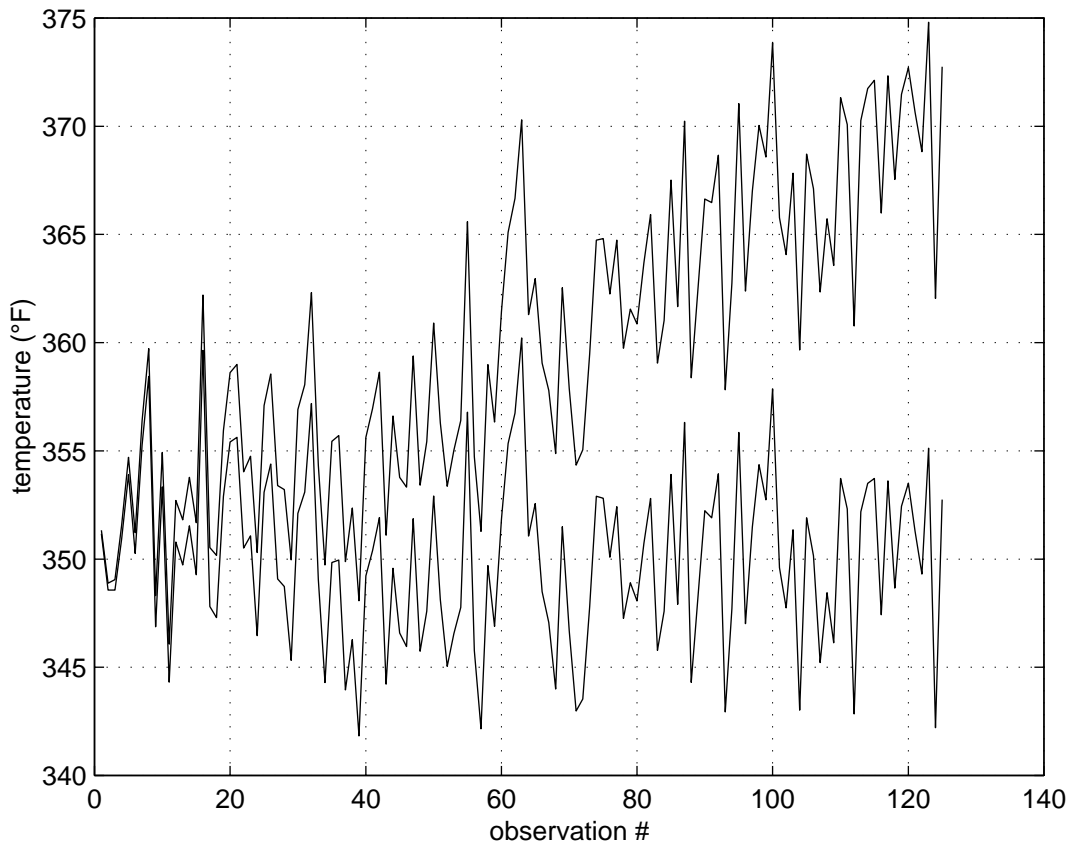
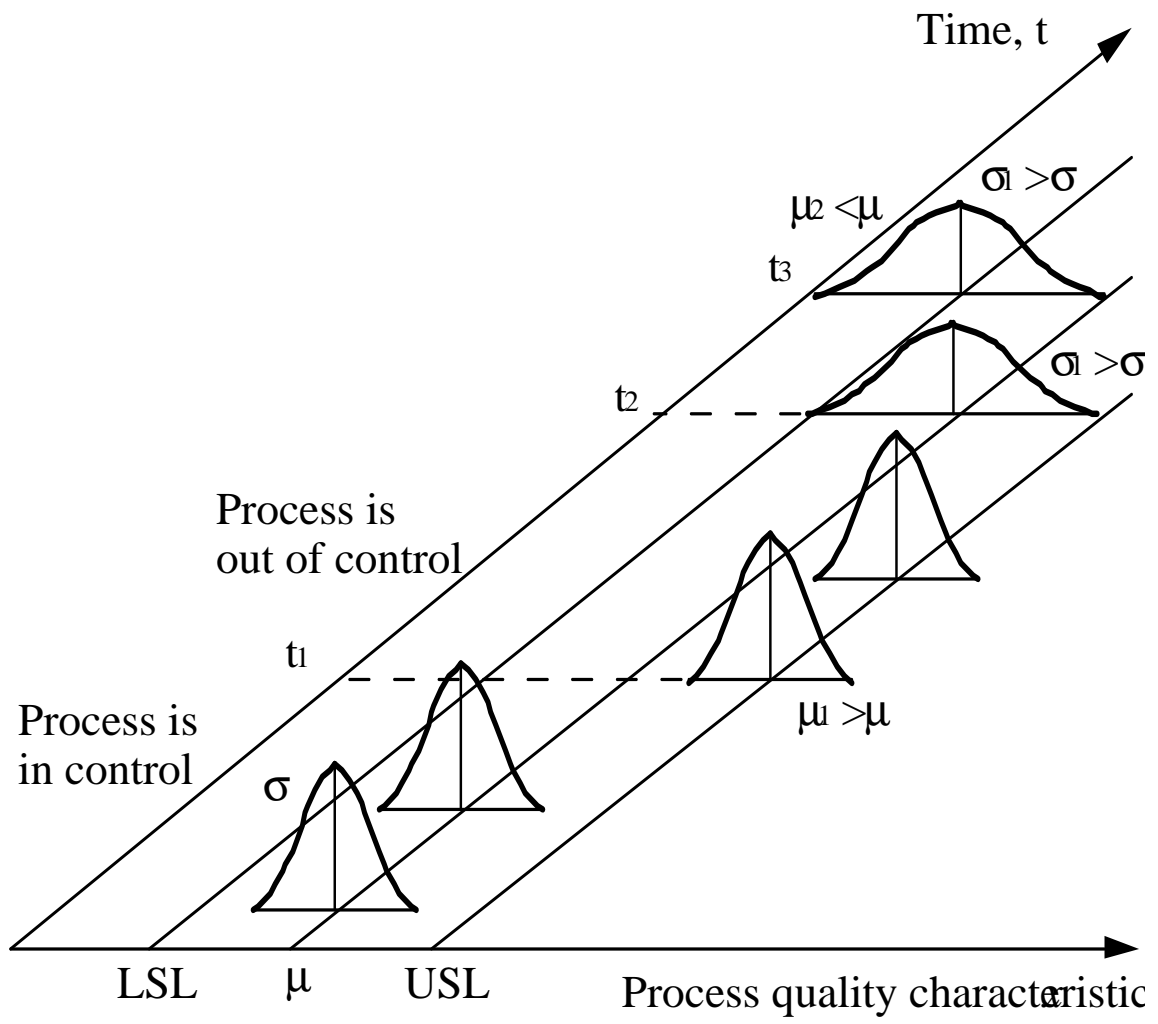

Tabella: Misure di temperatura nell'autoclave

| Sample # | °F | Sample # | °F | Sample # | °F |
|-----------------|-----------|-----------------|-----------|-----------------|-----------|
| 1 | 351,17 | 9 | 344,22 | 17 | 353,91 |
| 1 | 348,57 | 9 | 349,57 | 18 | 347,91 |
| 1 | 348,57 | 9 | 346,58 | 18 | 356,31 |
| 1 | 350,92 | 10 | 345,96 | 18 | 344,3 |
| 1 | 353,9 | 10 | 351,87 | 18 | 348,34 |
| 2 | 350,26 | 10 | 345,74 | 18 | 352,24 |
| 2 | 355,26 | 10 | 347,59 | 19 | 351,91 |
| 2 | 358,44 | 10 | 352,91 | 19 | 353,94 |
| 2 | 346,87 | 11 | 348,13 | 19 | 342,94 |
| 2 | 353,33 | 11 | 345,04 | 19 | 347,71 |
| 3 | 344,31 | 11 | 346,55 | 19 | 355,85 |
| 3 | 350,79 | 11 | 347,77 | 20 | 347,02 |
| 3 | 349,73 | 11 | 356,79 | 20 | 351,49 |
| 3 | 351,54 | 12 | 345,77 | 20 | 354,36 |
| 3 | 349,28 | 12 | 342,16 | 20 | 352,74 |
| 4 | 359,64 | 12 | 349,7 | 20 | 357,86 |
| 4 | 347,81 | 12 | 346,89 | 21 | 349,61 |
| 4 | 347,29 | 12 | 351,83 | 21 | 347,75 |
| 4 | 352,89 | 13 | 355,34 | 21 | 351,35 |
| 4 | 355,41 | 13 | 356,75 | 21 | 343,02 |
| 5 | 355,63 | 13 | 360,22 | 21 | 351,91 |
| 5 | 350,51 | 13 | 351,06 | 22 | 350,15 |
| 5 | 351,07 | 13 | 352,56 | 22 | 345,22 |
| 5 | 346,46 | 14 | 348,5 | 22 | 348,44 |
| 5 | 353,09 | 14 | 347,07 | 22 | 346,13 |
| 6 | 354,4 | 14 | 344 | 22 | 353,72 |
| 6 | 349,08 | 14 | 351,5 | 23 | 352,32 |
| 6 | 348,73 | 14 | 346,69 | 23 | 342,85 |
| 6 | 345,32 | 15 | 342,98 | 23 | 352,18 |
| 6 | 352,11 | 15 | 343,53 | 23 | 353,5 |
| 7 | 353,1 | 15 | 347,8 | 23 | 353,72 |
| 7 | 357,19 | 15 | 352,9 | 24 | 347,43 |
| 7 | 349,07 | 15 | 352,81 | 24 | 353,61 |
| 7 | 344,29 | 16 | 350,09 | 24 | 348,66 |
| 7 | 349,84 | 16 | 352,42 | 24 | 352,44 |
| 8 | 349,95 | 16 | 347,26 | 24 | 353,51 |
| 8 | 343,96 | 16 | 348,91 | 25 | 351,29 |
| 8 | 346,28 | 16 | 348,06 | 25 | 349,31 |
| 8 | 341,83 | 17 | 350,73 | 25 | 355,12 |
| 8 | 349,23 | 17 | 352,8 | 25 | 342,21 |
| 9 | 350,39 | 17 | 345,78 | 25 | 352,75 |
| 9 | 351,92 | 17 | 347,59 | | |



Esempio: trend nei dati





Esempio: Autoclave

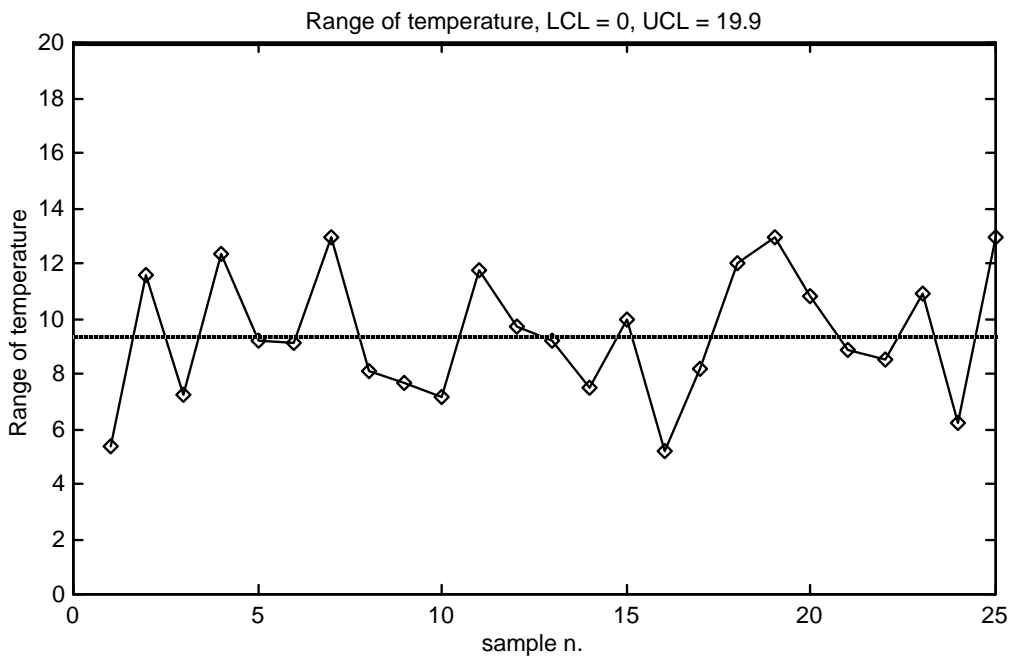
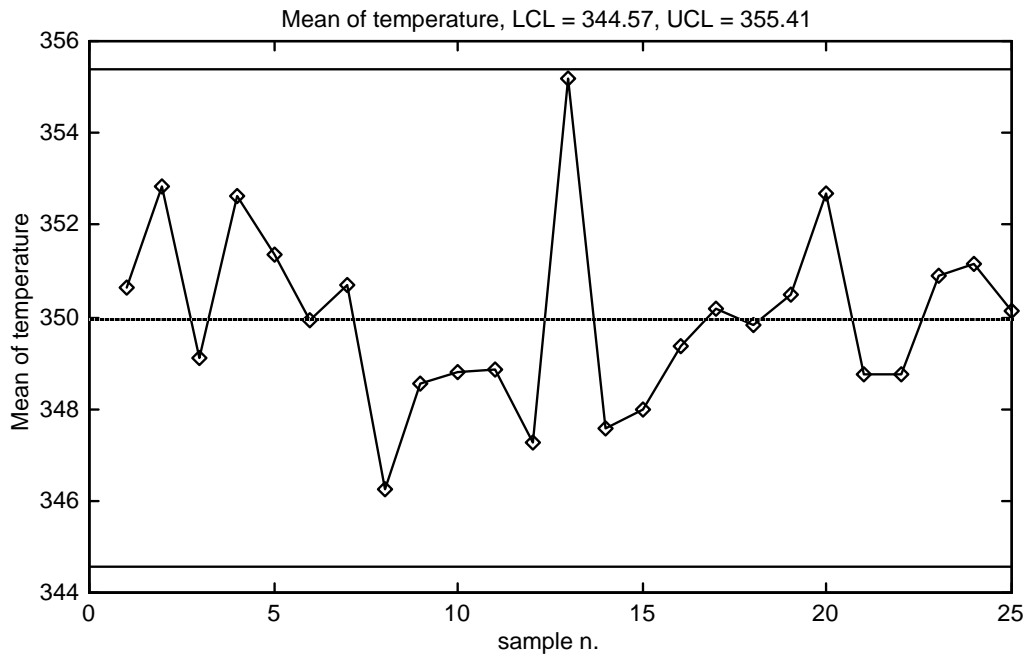
Tabella: Misure di temperatura nell'autoclave con media e range calcolate per ogni sottogruppo

| <i>Sottogruppo</i> | temperature | | | | | \bar{X} | Range |
|--------------------|-------------|--------|--------|--------|--------|---------------|--------------|
| 1 | 351.17 | 348.57 | 348.57 | 350.92 | 353.90 | 350.62 | 5.33 |
| 2 | 350.26 | 355.26 | 358.44 | 346.87 | 353.33 | 352.83 | 11.57 |
| 3 | 344.31 | 350.79 | 349.73 | 351.54 | 349.28 | 349.13 | 7.23 |
| 4 | 359.64 | 347.81 | 347.29 | 352.89 | 355.41 | 352.60 | 12.35 |
| 5 | 355.63 | 350.51 | 351.07 | 346.46 | 353.09 | 351.35 | 9.17 |
| 6 | 354.40 | 349.08 | 348.73 | 345.32 | 352.11 | 349.92 | 9.08 |
| 7 | 353.10 | 357.19 | 349.07 | 344.29 | 349.84 | 350.69 | 12.90 |
| 8 | 349.95 | 343.96 | 346.28 | 341.83 | 349.23 | 346.25 | 8.12 |
| 9 | 350.39 | 351.92 | 344.22 | 349.57 | 346.58 | 348.53 | 7.70 |
| 10 | 345.96 | 351.87 | 345.74 | 347.59 | 352.91 | 348.81 | 7.17 |
| 11 | 348.13 | 345.04 | 346.55 | 347.77 | 356.79 | 348.85 | 11.75 |
| 12 | 345.77 | 342.16 | 349.70 | 346.89 | 351.83 | 347.27 | 9.67 |
| 13 | 355.34 | 356.75 | 360.22 | 351.06 | 352.56 | 355.18 | 9.16 |
| 14 | 348.50 | 347.07 | 344.00 | 351.50 | 346.69 | 347.55 | 7.50 |
| 15 | 342.98 | 343.53 | 347.80 | 352.90 | 352.81 | 348.00 | 9.92 |
| 16 | 350.09 | 352.42 | 347.26 | 348.91 | 348.06 | 349.34 | 5.16 |
| 17 | 350.73 | 352.80 | 345.78 | 347.59 | 353.91 | 350.16 | 8.13 |
| 18 | 347.91 | 356.31 | 344.30 | 348.34 | 352.24 | 349.82 | 12.01 |
| 19 | 351.91 | 353.94 | 342.94 | 347.71 | 355.85 | 350.47 | 12.91 |
| 20 | 347.02 | 351.49 | 354.36 | 352.74 | 357.86 | 352.69 | 10.84 |
| 21 | 349.61 | 347.75 | 351.35 | 343.02 | 351.91 | 348.72 | 8.89 |
| 22 | 350.15 | 345.22 | 348.44 | 346.13 | 353.72 | 348.73 | 8.50 |
| 23 | 352.32 | 342.85 | 352.18 | 353.50 | 353.72 | 350.91 | 10.87 |
| 24 | 347.43 | 353.61 | 348.66 | 352.44 | 353.51 | 351.13 | 6.18 |
| 25 | 351.29 | 349.31 | 355.12 | 342.21 | 352.75 | 350.13 | 12.91 |

Nota: i dati sono organizzati in sottogruppi per poter valutare la dispersione.

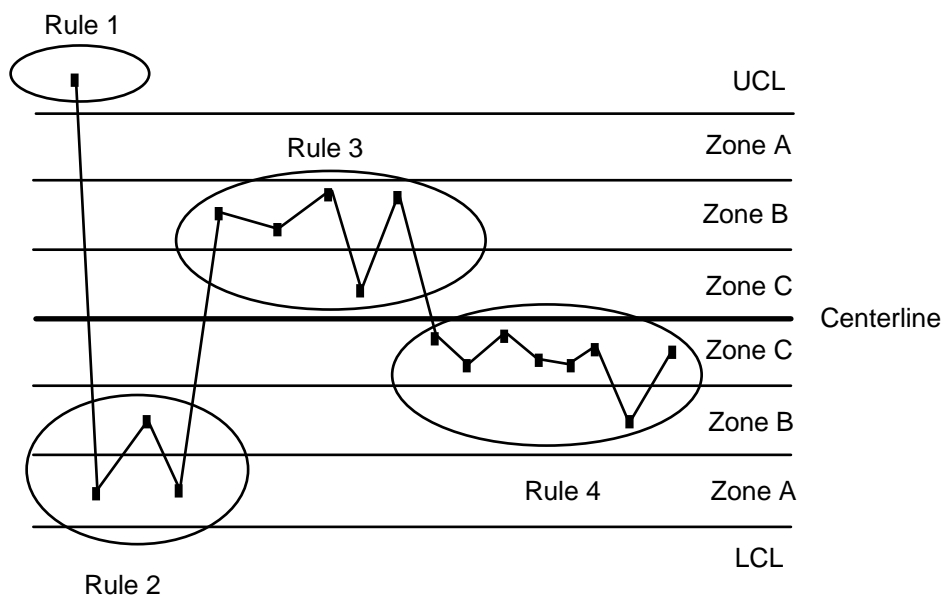
Tabella 1: Costanti per carte di controllo (ipotesi di gaussianità)

| n | A_2 | D_3 | D_4 |
|-----|-------|-------|-------|
| 1 | 2.660 | 0 | 3.267 |
| 2 | 1.880 | 0 | 3.267 |
| 3 | 1.023 | 0 | 2.574 |
| 4 | 0.729 | 0 | 2.282 |
| 5 | 0.577 | 0 | 2.114 |
| 6 | 0.483 | 0 | 2.004 |
| 7 | 0.419 | 0.076 | 1.924 |
| 8 | 0.373 | 0.136 | 1.864 |
| 9 | 0.337 | 0.184 | 1.816 |
| 10 | 0.308 | 0.223 | 1.777 |



Ricerca di pattern noncasuali: Western Electric Rules (1956)

1. uno o più punti fuori dai limiti di controllo
2. due punti su 3 consecutivi fuori dai "warning limits" ($\pm 2\sigma$)
3. quattro punti su 5 consecutivi fuori dalla banda $\pm\sigma$
4. otto punti consecutivi dallo stesso lato della centerline



Con le WER aumenta la probabilità di falsi allarmi

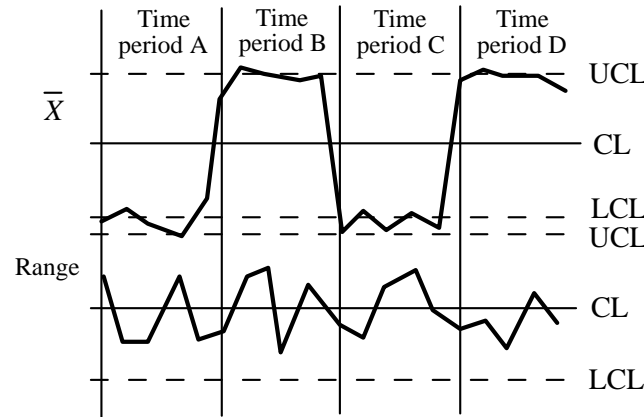
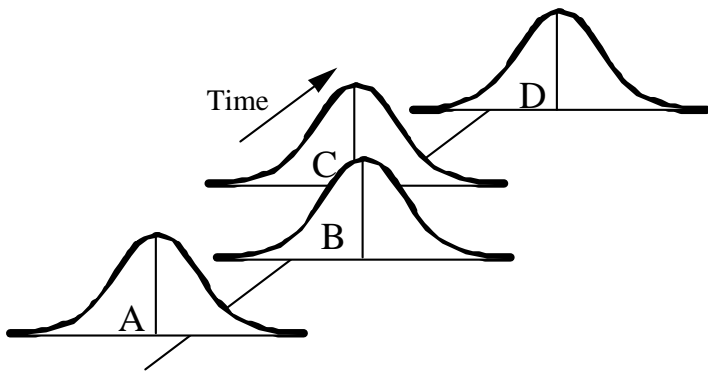
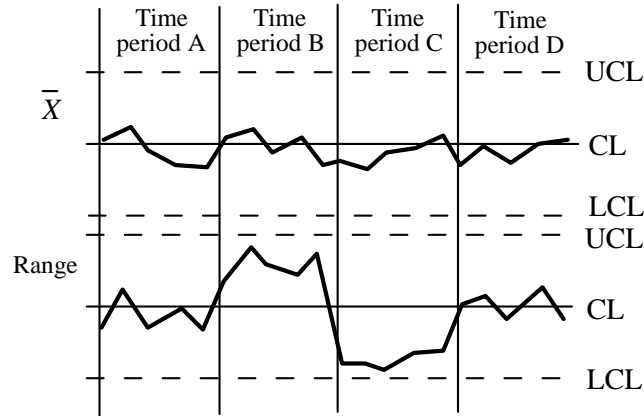
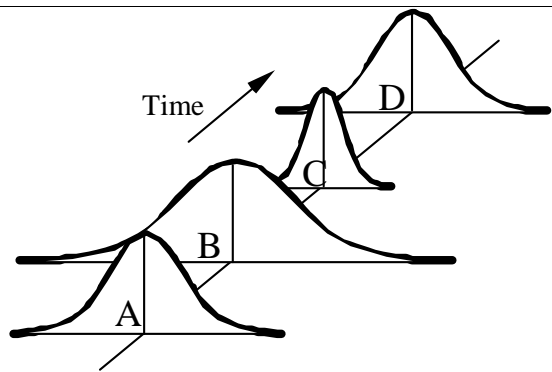


Tabella 2: Scarti in base al valore di C_p

(se il processo è in controllo, gaussiano, centrato)

| C_p | <i>Scarto previsto</i> | |
|-------|------------------------|-----|
| 0.5 | 133 620 | ppm |
| 0.6 | 71 860 | |
| 0.7 | 35 730 | |
| 0.8 | 16 396 | |
| 0.9 | 6 934 | |
| 1.0 | 2 700 | |
| 1.1 | 966 | |
| 1.2 | 318 | |
| 1.3 | 96 | |
| 1.4 | 26 | |
| 1.5 | 7 | |
| 1.6 | 2 | |
| 1.7 | 340 | ppb |
| 1.8 | 60 | |
| 1.9 | 12 | |
| 2.0 | 2 | |

ppm = parti per milione

ppb = parti per bilione

(10,000 ppb = 1%)

Relazioni tra C_p e C_{pk} : esempi

