**Cadbury’s chocolate**

One of the production lines of Cadbury Ltd turns out 100-g bars of milk chocolate at a rate of 20,000/hour. The start of this production line is a stainless feeding pipe that delivers the molten chocolate, at about 80oC, to a battery of 10 injection nozzles. These nozzles are set to inject a little over 100 g of chocolate into flat trays which pass underneath the nozzles. Afterwards these trays move along a conveyor belt during which the chocolate cools and hardens taking the shape of the mould. In this cooling process some of the water in the chocolate evaporates in order that the net weight of the chocolate comes down to the target value of 100 g. At about the middle of the conveyor line, the moulds are turned upside down through a reverse system on the belt after which the belt vibrates slightly such that the chocolate bars are ejected from the mould. The next production stage is the packing process where the bars are first wrapped in silver foil then wrapped in waxed paper onto which is printed the product type and the net weight. The final part of this production line is where the individual bars of chocolate are packed in cardboard cartons. Immediately upstream of the start of the packing process, the bars of chocolate pass over an automatic weighing machine that measures at random the individual weights. A printout of the weights for a sample of 1,000 bars, from a production run of 115,000 units is given in the table below. The production cost for these 100 g chocolate bars is ₤0.20/unit. They are sold in retail for ₤3.50.

**Required**

From the statistical sample data presented, how would you describe this operation? What are your opinions and comments?

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 109.99 | 95.56 | 92.29 | 117.16 | 103.93 | 89.73 | 137.67 | 99.30 | 98.20 | 89.77 |
| 81.33 | 128.96 | 104.47 | 106.73 | 118.97 | 104.55 | 94.95 | 105.66 | 120.96 | 94.08 |
| 105.70 | 112.18 | 100.18 | 110.90 | 114.25 | 88.27 | 117.80 | 109.98 | 104.82 | 102.25 |
| 106.96 | 87.54 | 105.09 | 100.48 | 125.71 | 107.17 | 114.03 | 108.01 | 95.51 | 102.47 |
| 100.11 | 77.12 | 111.19 | 107.15 | 96.38 | 96.64 | 91.94 | 94.29 | 110.69 | 92.12 |
| 110.08 | 107.39 | 106.28 | 96.61 | 96.73 | 98.66 | 78.01 | 87.28 | 127.09 | 107.36 |
| 107.37 | 104.22 | 97.39 | 97.83 | 116.30 | 86.33 | 85.08 | 104.91 | 115.76 | 111.78 |
| 88.47 | 82.33 | 81.65 | 94.06 | 109.03 | 113.81 | 73.68 | 94.65 | 94.22 | 86.08 |
| 117.72 | 98.28 | 110.29 | 96.11 | 97.56 | 84.73 | 90.66 | 107.46 | 91.69 | 111.41 |
| 84.66 | 90.12 | 92.61 | 119.93 | 103.56 | 107.85 | 94.77 | 108.89 | 102.71 | 94.71 |
| 104.06 | 82.20 | 68.25 | 83.26 | 100.75 | 113.60 | 86.70 | 89.53 | 113.24 | 101.96 |
| 77.03 | 114.88 | 101.85 | 110.09 | 101.58 | 95.08 | 100.03 | 114.82 | 78.61 | 78.30 |
| 93.40 | 112.55 | 87.20 | 126.22 | 99.58 | 105.39 | 120.19 | 120.80 | 112.80 | 118.26 |
| 110.99 | 86.71 | 113.41 | 94.49 | 76.15 | 90.53 | 88.65 | 108.99 | 110.82 | 100.12 |
| 82.77 | 94.01 | 107.12 | 90.72 | 100.85 | 80.92 | 84.10 | 91.01 | 103.10 | 76.31 |
| 110.37 | 100.82 | 98.78 | 100.22 | 118.64 | 133.14 | 92.54 | 88.88 | 79.28 | 105.22 |
| 106.50 | 81.94 | 110.45 | 105.36 | 100.35 | 102.25 | 87.17 | 99.59 | 107.66 | 103.49 |
| 127.22 | 86.24 | 91.36 | 115.23 | 93.63 | 91.47 | 112.13 | 108.65 | 106.22 | 108.44 |
| 76.73 | 111.44 | 104.75 | 92.64 | 93.21 | 107.99 | 93.08 | 99.96 | 97.36 | 98.27 |
| 109.54 | 100.09 | 98.18 | 92.54 | 97.86 | 110.86 | 118.15 | 84.37 | 115.87 | 80.20 |
| 95.18 | 100.96 | 111.12 | 102.37 | 130.33 | 91.68 | 109.46 | 86.43 | 96.22 | 99.61 |
| 83.61 | 100.15 | 104.68 | 106.46 | 108.35 | 81.11 | 77.62 | 98.70 | 94.96 | 109.65 |
| 90.08 | 87.39 | 107.58 | 111.92 | 106.97 | 85.60 | 107.82 | 113.96 | 115.22 | 100.76 |
| 125.89 | 89.80 | 92.81 | 114.38 | 104.46 | 90.48 | 103.74 | 116.37 | 123.87 | 116.78 |
| 90.70 | 87.09 | 92.41 | 101.24 | 96.72 | 97.35 | 81.84 | 112.72 | 79.72 | 131.30 |
| 108.39 | 79.78 | 112.91 | 78.84 | 112.81 | 115.89 | 116.72 | 93.32 | 91.96 | 122.44 |
| 91.94 | 107.23 | 111.40 | 122.86 | 105.62 | 115.47 | 101.21 | 110.45 | 104.65 | 109.23 |
| 79.58 | 88.08 | 123.39 | 110.58 | 74.03 | 95.81 | 117.48 | 84.67 | 101.72 | 96.16 |
| 87.42 | 90.88 | 116.54 | 83.95 | 92.30 | 100.04 | 91.21 | 92.71 | 89.79 | 94.91 |
| 97.83 | 110.16 | 118.70 | 96.35 | 111.99 | 123.15 | 107.09 | 80.51 | 88.89 | 89.35 |
| 109.66 | 108.50 | 83.78 | 112.01 | 115.94 | 109.48 | 114.54 | 102.57 | 98.96 | 100.70 |
| 93.97 | 106.18 | 91.46 | 96.15 | 102.13 | 70.63 | 91.56 | 113.09 | 113.96 | 123.54 |
| 69.76 | 107.66 | 119.46 | 85.91 | 109.40 | 93.40 | 98.23 | 97.06 | 105.96 | 110.04 |
| 115.56 | 93.79 | 91.70 | 98.56 | 121.63 | 86.92 | 125.22 | 90.20 | 100.51 | 122.15 |
| 85.87 | 102.32 | 88.38 | 98.58 | 100.82 | 99.82 | 86.25 | 87.71 | 131.27 | 85.70 |
| 102.75 | 89.01 | 90.46 | 104.81 | 116.34 | 112.18 | 103.97 | 100.78 | 105.93 | 84.94 |
| 105.68 | 86.58 | 107.06 | 120.53 | 110.99 | 92.13 | 83.48 | 98.91 | 117.34 | 93.74 |
| 104.62 | 80.46 | 100.05 | 100.87 | 113.41 | 92.96 | 115.99 | 96.20 | 114.02 | 108.22 |
| 94.09 | 94.13 | 96.66 | 100.80 | 97.73 | 75.22 | 99.75 | 96.00 | 86.84 | 94.29 |
| 124.37 | 80.46 | 91.53 | 101.49 | 92.42 | 110.46 | 102.64 | 75.03 | 101.15 | 105.47 |
| 126.44 | 105.65 | 120.84 | 111.79 | 109.08 | 119.04 | 112.62 | 118.08 | 102.80 | 93.42 |
| 99.15 | 111.19 | 111.35 | 104.32 | 101.15 | 107.82 | 131.00 | 89.15 | 111.87 | 99.05 |
| 76.55 | 118.01 | 104.89 | 104.34 | 95.76 | 98.66 | 84.72 | 124.61 | 100.82 | 117.34 |
| 103.06 | 88.58 | 102.46 | 71.23 | 103.30 | 85.94 | 100.85 | 104.59 | 93.75 | 102.43 |
| 89.16 | 87.54 | 100.76 | 84.81 | 105.23 | 103.23 | 113.82 | 92.61 | 99.83 | 83.20 |
| 98.47 | 97.58 | 95.74 | 97.12 | 75.73 | 98.74 | 101.79 | 96.19 | 106.64 | 94.00 |
| 99.67 | 106.74 | 100.36 | 107.74 | 94.16 | 121.43 | 112.87 | 99.19 | 113.85 | 104.54 |
| 87.03 | 107.22 | 128.15 | 101.96 | 95.28 | 114.46 | 100.17 | 91.39 | 87.03 | 92.03 |
| 115.58 | 96.56 | 107.22 | 108.70 | 123.61 | 78.08 | 105.65 | 86.94 | 69.47 | 88.40 |
| 105.53 | 105.78 | 100.39 | 93.56 | 98.10 | 96.59 | 107.41 | 102.82 | 111.18 | 93.81 |
| 122.64 | 101.94 | 98.80 | 103.18 | 74.65 | 93.82 | 102.75 | 122.86 | 97.53 | 108.53 |
| 72.33 | 93.40 | 88.61 | 112.02 | 101.06 | 85.77 | 110.74 | 79.13 | 98.69 | 111.28 |
| 89.72 | 84.26 | 114.09 | 98.53 | 107.80 | 101.85 | 94.06 | 116.99 | 103.03 | 109.48 |
| 109.64 | 94.41 | 106.91 | 115.02 | 106.62 | 130.32 | 92.96 | 115.74 | 85.03 | 118.97 |
| 79.53 | 96.89 | 74.95 | 107.34 | 111.82 | 85.01 | 113.15 | 100.49 | 88.89 | 89.35 |
| 97.41 | 104.09 | 84.20 | 97.75 | 106.11 | 108.26 | 98.33 | 116.27 | 104.37 | 132.20 |
| 105.22 | 116.57 | 102.50 | 93.75 | 122.28 | 93.06 | 85.72 | 88.30 | 115.09 | 96.59 |
| 93.58 | 97.92 | 104.43 | 108.59 | 98.57 | 111.71 | 76.00 | 88.22 | 122.84 | 107.31 |
| 84.93 | 108.27 | 105.92 | 98.32 | 101.58 | 91.72 | 87.44 | 89.97 | 100.80 | 103.96 |
| 103.15 | 81.68 | 115.27 | 105.86 | 100.33 | 110.56 | 97.16 | 113.09 | 109.75 | 116.14 |
| 108.35 | 85.48 | 110.16 | 96.91 | 96.26 | 109.91 | 104.85 | 97.13 | 101.72 | 109.02 |
| 110.02 | 100.71 | 92.17 | 109.47 | 98.38 | 124.46 | 87.58 | 109.23 | 95.87 | 113.11 |
| 72.25 | 105.48 | 105.97 | 99.82 | 104.22 | 93.66 | 90.59 | 112.85 | 87.10 | 110.99 |
| 118.28 | 105.78 | 96.00 | 93.23 | 101.84 | 112.44 | 114.84 | 101.73 | 87.78 | 95.28 |
| 93.70 | 92.57 | 115.12 | 106.43 | 90.42 | 82.52 | 104.80 | 90.70 | 113.83 | 113.31 |
| 97.15 | 103.23 | 90.64 | 113.09 | 109.95 | 110.22 | 93.42 | 74.92 | 102.61 | 102.97 |
| 87.92 | 91.97 | 86.28 | 97.84 | 94.52 | 94.13 | 113.85 | 101.91 | 98.08 | 111.08 |
| 120.77 | 97.15 | 98.11 | 108.47 | 97.61 | 94.78 | 88.52 | 112.29 | 100.67 | 103.23 |
| 101.18 | 101.05 | 105.53 | 86.92 | 106.76 | 85.76 | 98.48 | 96.49 | 124.08 | 89.59 |
| 86.13 | 99.46 | 105.28 | 92.39 | 94.52 | 113.24 | 101.07 | 106.23 | 86.39 | 117.77 |
| 91.01 | 98.00 | 105.70 | 114.91 | 118.27 | 112.31 | 111.56 | 74.23 | 93.76 | 94.83 |
| 101.59 | 129.89 | 99.70 | 84.06 | 105.70 | 91.04 | 102.12 | 87.74 | 102.60 | 96.53 |
| 87.54 | 94.44 | 95.50 | 107.41 | 103.78 | 87.14 | 86.56 | 94.16 | 100.68 | 93.12 |
| 99.68 | 124.37 | 84.63 | 128.39 | 114.25 | 104.27 | 64.48 | 113.58 | 92.58 | 114.63 |
| 97.72 | 95.06 | 80.25 | 113.94 | 90.48 | 92.83 | 85.32 | 82.21 | 86.13 | 102.19 |
| 104.72 | 88.06 | 98.27 | 100.55 | 103.04 | 101.62 | 83.50 | 118.85 | 90.36 | 72.94 |
| 114.48 | 86.68 | 117.77 | 76.94 | 77.25 | 114.89 | 93.57 | 105.11 | 99.00 | 117.92 |
| 80.75 | 106.39 | 114.61 | 98.57 | 84.24 | 98.66 | 99.65 | 89.68 | 84.72 | 99.68 |
| 99.38 | 101.92 | 109.34 | 110.26 | 84.38 | 78.99 | 103.79 | 72.33 | 104.69 | 102.89 |
| 84.99 | 93.90 | 106.92 | 96.53 | 100.53 | 100.80 | 112.18 | 92.37 | 103.46 | 94.40 |
| 91.32 | 114.90 | 95.86 | 95.88 | 101.66 | 100.41 | 106.12 | 112.15 | 91.74 | 93.69 |
| 93.53 | 79.31 | 90.20 | 108.82 | 98.27 | 110.21 | 107.67 | 107.36 | 102.31 | 105.89 |
| 101.95 | 101.77 | 128.61 | 88.56 | 104.56 | 115.18 | 114.19 | 81.22 | 94.47 | 118.35 |
| 93.91 | 104.75 | 101.42 | 96.85 | 110.45 | 109.30 | 102.65 | 91.28 | 96.53 | 92.34 |
| 84.35 | 84.59 | 84.46 | 98.85 | 113.25 | 93.16 | 104.71 | 91.55 | 86.53 | 101.49 |
| 116.09 | 97.42 | 86.59 | 112.56 | 124.65 | 89.42 | 113.61 | 107.15 | 87.79 | 99.23 |
| 125.83 | 105.65 | 118.83 | 97.00 | 78.92 | 107.13 | 96.54 | 96.27 | 107.66 | 94.27 |
| 105.43 | 84.18 | 94.67 | 99.88 | 69.91 | 104.42 | 109.96 | 111.84 | 96.00 | 102.08 |
| 96.00 | 99.56 | 101.01 | 101.25 | 79.24 | 98.06 | 101.96 | 84.91 | 91.40 | 93.12 |
| 104.58 | 99.72 | 105.64 | 103.42 | 113.30 | 116.15 | 94.42 | 98.61 | 105.44 | 81.72 |
| 119.27 | 108.80 | 109.19 | 100.85 | 97.70 | 114.42 | 134.78 | 106.44 | 123.01 | 80.60 |
| 109.68 | 96.30 | 114.11 | 118.06 | 123.57 | 111.82 | 90.50 | 103.37 | 110.63 | 124.73 |
| 135.40 | 136.89 | 111.58 | 110.97 | 96.37 | 97.72 | 110.05 | 94.75 | 82.73 | 83.65 |
| 82.08 | 99.27 | 85.42 | 83.71 | 88.87 | 88.72 | 91.08 | 115.13 | 111.54 | 104.20 |
| 116.02 | 85.62 | 87.85 | 90.56 | 110.26 | 90.45 | 119.81 | 98.53 | 116.15 | 94.91 |
| 118.86 | 101.61 | 92.91 | 87.22 | 93.32 | 99.10 | 112.63 | 106.08 | 96.40 | 91.15 |
| 113.20 | 108.29 | 109.15 | 92.48 | 118.07 | 95.72 | 88.35 | 94.94 | 111.22 | 94.35 |
| 90.46 | 101.91 | 112.82 | 78.72 | 114.22 | 110.04 | 122.23 | 96.58 | 78.32 | 90.44 |
| 123.99 | 95.47 | 95.63 | 93.56 | 108.56 | 107.07 | 108.76 | 86.53 | 103.00 | 103.49 |
| 97.44 | 74.24 | 99.06 | 93.27 | 80.79 | 91.86 | 108.70 | 106.80 | 112.44 | 100.42 |