Chapter 5
Working with Random Values

In many cases, it is not possible to specify a fixed value for processing time or failure duration. Plant Simulation provides functions for including random and empirical distributions of values in the simulation.

5.1 Working with Distribution Tables

When entering times, you can choose from among the menus of a number of distribution functions. The distribution functions can, in principle, be divided into two areas:

- Empirical distributions: This includes real values—e.g. from the past—and the distribution of values can be specified.
- Probability distributions: Here, the real distribution is not known exactly. It will work with mathematical distribution functions that map the distribution of real values approximately.

A fundamental problem is data collection. You need to estimate the distribution of a large amount of data, which should be collected for a certain period. Especially for new solutions, these data are available only from comparing facilities. In any case, try to reproduce the real fluctuations of values as closely as possible in the simulation in order to achieve a realistic result.

Proceed to determine empirical distributions as follows:

1. Determine the maximum and the minimum of the values (eliminate abnormally high/low values)
2. Divide the data into a suitable number of classes (dependent on the distance from minimum and maximum, and the quantity of the data)
3. Determine the class width (class boundaries) by dividing the difference of maximum value and minimum value with the number of classes
4. Calculate the lower and upper bounds of the classes
5. Count the dates and assign the data into the classes (the class usually includes the upper bound and not the lower bound)
6. Evaluate the frequencies of the various classes by setting the number of values in each class in proportion to the total number of values
Example: Analysis of Statistical Data
The following example shows the evaluation of statistical data (frequency) using Excel, which has a number of powerful features for evaluating statistical data. You can import, via ASCII, data from different sources. As an example, the following recorded values are to be evaluated: 90, 78, 89, 67, 78, 88, 99, 78, 77, 76, 80, 81, 77, 76, 75, 72, 80, 82, 80, 91, 92, 94. Normally, the data are available in table form or as a comma-delimited text file (.csv, .txt, .asc, etc.). First, enter the data into an Excel table in one column. In the first step, determine the maximum and the minimum of the values. For this, you can use the Excel functions max(range) and min(range). In this example, the maximum is 99 and the minimum 67. The difference between the two values is 32. We must now divide this value into a sufficient number of classes. The more classes you create, the higher is the accuracy of the mapping of the variation. We divide the total range into eight classes with a class width of four (division of distance by class number). As a next step, we define the upper and lower limits of the classes (lower limit + distance = upper limit = lower limit of the next class). Fig. 5.1 shows how this could be carried out in Excel.

![Fig. 5.1 Classes in Excel](image)

In the next step, we determine the frequency of the individual values in the data. To do this, we need a matrix function of Excel. These functions work only when you perform a specific series of steps: