Figure 24.6 Example of a 3-D scan. Reproduced with permission of Rohwedder AG, Germany.
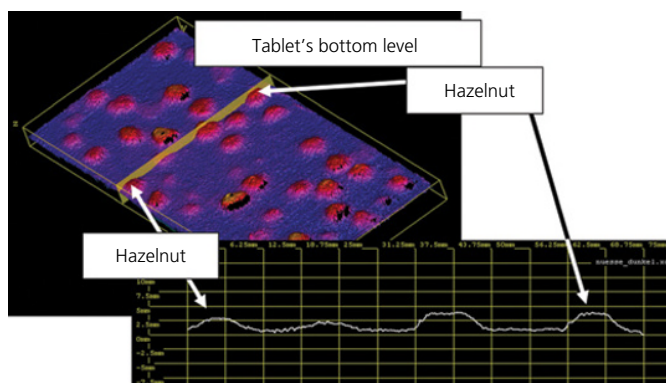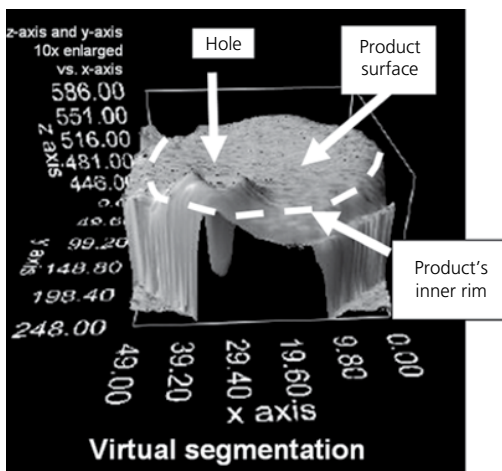

Figure 24.7 Nut distribution in a bar. Reproduced with permission of 3-D Shape, Erlangen, Germany.

24.2.3 Recording by numbers

Counting can be relatively simple. A few applications are as follows:

- Rotary motion is recorded using the individual segments of a disc with a specially manufactured edge. A predetermined number of teeth produce counting pulses in a sensor during rotation (see Figure 24.2).
- For deliveries, the number of tankers, pallets, big bags and so on are counted.
- Determining the number of loaded conching units, when producing the masses in batches.
- Counting the number of unpackaged products entering and leaving a storage unit.
- Calculating the number of finished products in final stock department by weighing the container (stock keeping unit; SKU), five-count package, filled box of chocolate, multipacks and so on.
- Guaranteeing components in the overall recipe.

24.2.4 Recording "patterns"

This involves recording a more complex measurement parameter. The term "pattern" covers the results of measurements such as intensity diagrams of spectra, or the reproduction of product images as grey-scale distributions and their comparison with a specified range for such a pattern. Principles of pattern recognition are used to recognise foreign matter, to identify defined defects, to read alphanumeric characters (e.g. best before date coding), to read a bar code or codes invisible to the human eye, to distinguish for example between products with identical shape but with different fillings (Loeser, 2009). Many different methods of data analysis are used here, including mathematical statistics and artificial intelligence.

24.2.5 Recording the degree of filling (fill level)

The term "degree of filling" (fill level) applies to many situations. It is usually recorded as a percentage or often refers to a volume. Some examples are as follows:

- In a silo for bulk goods: comparison of the measured amount added to and leaving the silo;
- In a tank for liquids: level in a sight glass, weighing before and after filling, ultrasound probes;
- In a tank or hopper for tempered masse: dropping below the minimum sensor or rising above the maximum sensor;
- In a hopper of a pre-refiner/refiner;
- In a cooling tunnel, before emptying after a break down;
- Within a storage unit for chocolate bars, prior to feeding the packaging machine: tracking the difference between entering and exiting items;
- On a feeding conveyor inside a packaging system: tracking the difference between items entering on the feeding conveyor and those leaving it;
- Ball mills: volume occupied by the balls inside the milling chamber;
- In a gas bottle filled with N_2 for aerating of the filling masse: by determination of total weight, for example at the start and at the end of a shift or by means of a consumption sensor.

24.2.6 Recording by weighing

In addition to counting and temperature measurement, determining the weight or mass is one of the most common measurement tasks (examples of operations based on mass and force are given in Table 24.3). The weight of bulk goods such as sugar, milk powder or fractured cocoa nibs is determined using bulk material scales or belt conveyor scales. Mixers are connected directly to weighing systems. This takes place in a continuous or semi-continuous manner. Automatic weighing systems can be employed throughout, from cocoa processing to final bar. For example, they can be located downstream from a conventional winnower in order to check and track level of shell (Chapter 3). All further weight measurements, for instance, when adding other ingredients such as nuts, and