controls represent one component of a manufacturer's specification and are a way of achieving reliable quality assurance. The actual value of the measurements depends upon how the data are obtained and used. As already mentioned, several methods exist to quantify process data and draw meaningful qualitative solutions.

24.2 Production measurement technology – in-/on-line, off-line

There is a huge number of instruments and it is impossible to cover them all within a single chapter. The following sections are therefore limited to selected methods of measurement using examples that are important to the confectionery industry. The following applications are often part of control systems.

24.2.1 Recording time

When monitoring product throughput for example counting packed bars, the elapsed time is measured. In this way machine operating hours can be specified for specific lot sizes. Determining the useful life of individual refiner roll is another example. A time period is obtained for which desired product features or machine settings can be maintained. Time measurements can be obtained automatically, for example in the case of synchronised measurements based on trigger signals and can be saved in machine-readable form. Typical examples of time-dependent measurements are shown in Table 24.1.

24.2.2 Recording position (location)

Over the past 10 years radio frequency identification (RFID) technology has revolutionised the use of chocolate moulds. A data carrier and transmitter mounted within the mould front (see Figure 24.1) individualises each mould and permits data transfer each time it passes one of the fixed on-line detection points. This opens up new opportunities for chocolate manufacturers, for example:

- Full traceability and documentation of individual moulds.
- "Mould lifecycle management" is possible as the entire life cycle of each mould is recorded.
- The expected maximum lifetime can be predicted with greater accuracy and maintenance planning improved.
- Wash cycles, conditions and mould run time length between wash cycles can be optimised. This can help to improve food safety.
- Environmental conditions can be monitored in operating cooling tunnels.
- Data is available in real time at any time, so all the moulds on a moulding line can be sorted according to required criteria such as age or operating hours.

Currently some limitations exist due to the restricted data capacity of the sensors.

Table 24.1 Typical time-dependent measurements.

	Dimension as an example	Typical examples
Time as basic variable		
Day:Hour:Minute:Second	dd:hh:min:s	Start of a cycle time, e.g. a fill, Time stamp from a database,
Second	s	Time interval
Frequency		
Hertz	Hz = 1/s	Line frequency, Scanning rate of a scanner
Number	units	Quantity produced.
	bars/min	Output of packaging machine.
	moulds/min	Output of a moulding plant
Revolutions/time	rev./min	Speed of a motor
Velocity, speed	m/s	Belt speed, Air velocity in a cooling tunnel, Flowpack – packaging rate
Angular velocity	rad/s	Feature of a stepping motor
Acceleration	m/s^2	When re-starting packaging equipment
Angular acceleration	rad/s^2	Feature of a stepping motor
Volumetric flow rate	m^3/h	Cooling water flow rate, Volumetric air flow from a fan

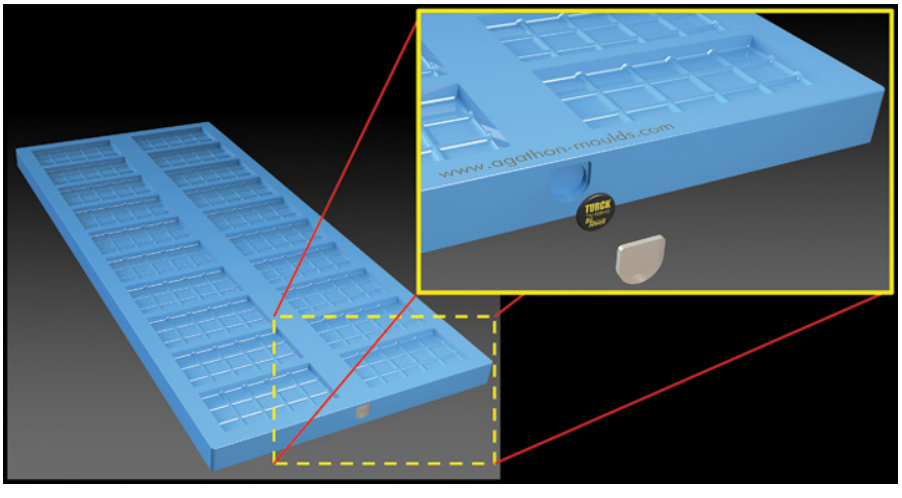

Figure 24.1 Mould with built in RFID sensor. Reproduced with permission of Agathon, Germany, and Turck, Germany.

A further example involves the position of the individual products along a feed conveyor. This can be used, for instance, to control the feeding of several packaging machines and storage units. The handle position on directional control valves indicates the current port size in relation to the fully open port. The change