Criteria for selection of a weighing instrument

Most of manufacturers of laboratory balances specify in their product folders below data:
1. weighing range /maximal capacity Max/
2. readability /reading unit/
3. repeatability
4. linearity
5. stabilization time
6. pan size
7. working temperature
8. class of a balance (if such a balance is classified, i.e. it meets the requirements of 90/384/EEC Directive on verification in specific circumstances, defined in this directive).

Weighing range is specified by the manufacturer of a balance and it has to be rigorously observed by the operator. Weighing loads above Max causes permanent damage of a balance.

Readability, is a parameter referring to maximal capacity of a balance. Operator should pay attention to mass of measured sample, and accuracy in which this sample is going to be measured. In case an analysis in performed imprecisely, it can cause a situation, where none of the manufacturers can meet operator expectations.

Most of the controversies and questions from operators refer to parameter described in commercial materials as “repeatability” in relation to analytical balances. During analysis of commercial and informative materials from competitive manufacturers, it is observed, that “repeatability” is expressed by parameter of standard deviation of a specific type of balance.
Standard deviation is a numeric value and it is much lower from the difference between maximal and minimal indication of a balance from a series of measurements (dispersion of indications as described in PN-EN 45501) for instance: a balance with reading unit *d* = 0,01 mg and difference between maximal and minimal indication has 76 units dispersion (0,07 mg) and standard deviation in such situation (depending on distribution) can equal 0,02 mg. the lower the difference between maximal and minimal indication, the lower is the standard deviation.

Linearity is characterized by an error of a balance in its full weighing range. If balance is utilized in a very limited weighing range, calibration should be done at the point of weighing. It is very important, as the error is set for the whole weighing range and rounded to the maximal one, as tested during measurements (in practice, maximal error most likely occurs in maximal load, and in lower loads, this error is smaller).

Stabilization time is a period of time in which a balance reaches stable result of a measurement.

Working temperature, is a range of temperatures in which a manufacturer of balance guarantees its proper indications. In case, on workstation temperature conditions are different, a balance should be calibrated according to ambient conditions on workstation, and consider possible error of indications.

Accuracy class is characterized by maximal permissible errors with reference to verifying unit *e*. in some application a balance may require supervision from legal metrology, also known as verification. Presently, balances undergo conformity evaluation and EC verification processes. Both processes can be performed by a notified body (in Poland it is Glowny Urzad Miar) on basis of type approval documents or manufacturer who has confirmed and certified quality management system compatible to Directive 90/384/EEC.

Comparison of balances due to differences in construction

Components of electronic balance construction, as presented on schema of laboratory balances, are generally present in all solutions accessible on the market. Each of the manufacturers uses some specific solutions. So, what the influence of such unique solutions onto balance operation and its price may be, and which criteria should be considered as valid on making a decision of balance purchase.

Weighing pan

Its dimensions should be adequate to the size of measured samples, as the bigger the weighing pan, the higher is price of a balance. As standard, weighing pan are offered in stainless steel (non-magnetic) technology. Anti-draft shield are in most cases made of plastics, which should be resistant to electrostatic charges.

Casing

In most cases of laboratory balances (balances verified in class II), casing is made of aluminum cast and powder coated with lacquer resistant to external factors. In case of less expensive solutions, the casing is offered in plastic, which is not resistant to chemical substances weighed in laboratories.

Anti-draft shield

Analytical balances (verified in class I) are equipped with an anti-draft shield protecting weighed sample from ambient conditions, like movement of air around the balance. The size of an anti-draft shield differs according to balance application. In most cases it is worth to consider purchasing a balance with bigger anti-draft shield, as it is hard to anticipate the size of samples that a balance will weigh.

Analytical balances also differ in place of weighing mechanism location (under the weighing pan or behind it). In most cases, a balance with weighing mechanism located under the weighing pan is less expensive, and today, in case of resolution d = 0,1 mg as accurate as balances with mechanism located at the back part of balance casing.

It is, however, possible that error may occur if magnetic elements are weighed. In such cases, it is much better to choose a balance with weighing mechanism located in a bigger distance from weighing pan, i.e. at the back part of balance casing.

Force-motor

A force-motor is the main measuring part of a balance, which is responsible for very precise conversion of force into proportional electric signal. A force-motor is also responsible for stability during measuring process and decides on balance compliance to errors sourcing from ambient temperature. When selecting a type of a balance, an operator make check if the instrument has type approval document. During verification process, certifying units check whether a balance has proper metrological characteristics and temperature errors. In some cases, temperature error is specified in commercial materials of a balance.

Mechanism of a monoblock?

Manufacturers of laboratory balances have been divided into two groups, and each of them prizes advantages of their solutions, and omits its drawbacks. If both designs are compared, an operator should take into consideration below aspects:

- **weighing accuracy** – a traditional mechanism is equipped with better quality spring elements in lever bearing of straight-line mechanism (R_R factor of aluminum is lower than R_R factor of bronze or steel) which provides better resistance to overloading and lower hysteresis errors. As an effect of long lasting construction works, manufacturers were able to design proper quality aluminum elements of monoblocks for average resolutions. In case of very high resolutions, traditional mechanism are applicable.

- **durability to defects** – aluminum monoblock, due to material used for its construction, is less durable than a traditional mechanism (lower R_R factor). Thus, it requires application of additional construction elements which protect it from damage. Those elements are not always effective in operation. A steel monoblock is more durable than an aluminum one, but it is also more expensive. Additionally, with steel monoblock it is difficult to design a high resolution balance.

- **weighing speed** – as a rule of operation of a compensatory set, elements of a mechnism do not relocate, and so their mass does not have fundamental influence on weoighing speed. What is important, is the proper operation of electronic controlling elements of a balance.

- **resistance to ground vibrations during weighing process** – a monoblock is more resistant, due to a possibility of obtaining lower mechanical masses of moveable elements. Presently, manufacturers use set of digital filters, and minimize traditional design of mechanism to eliminate this drawback.

- **service and repairs** – a balance, that is based on monoblock, if damaged, is not repairable. Its repair cost is practically equal to purchase cost of a new balance. A traditional mechanism can be repaired for several times by an authorized service point of the manufacturer.

Above analysis and comparison of balance features does not give straightforward answer to an operator which balance design is better: a monoblock or a mechanism. As for the operator parameters like errors in weighing process, weighing speed, resistance to defects and working conditions are similar, and in case of service they are much worse for a monoblock. Then why some of the manufacturers have introduced as monoblock to serial production, and they claim that their design is better? The answer is related to assembly cost. In Europe, where labour cost is very high, manufacturers have searched for a technology that is less labour-consuming. After approximately 20 years of continuous research and gigantic capital investments, obtained results are satisfactory. A presently offered product has quality that allows for its sales in the market. However, within this 20 years period, situation in the world has changed. Globalization process made it possible to countries with low production cost (Eastern Europe, Asia) to compete on same rights. Those countries have started to manufacture laboratory balances with traditional mechanism and lower labour cost. Additionally, new technologies for processing of traditional mechanism materials have appeared.

Today, an operator may either be affected by a commercial campaign, which stresses the superiority of new monoblock technologies or take a look or price, and purchase the same quality balance equipped with traditional mechanism.