History of the scale – Part 2

... Scales and weighing through the ages ...

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Part 1 described the origins of the equal armed beam scale that has accompanied mankind for many thousands of years. The first part ended with the announcement: "A time journey through the ages with the equal armed beam scale". This time, we will report about this unique and major world invention in much greater detail.

The Roman steelyard with sliding weight and the equal sided beam scale. Around 500 BC

The Roman steelyard with its sliding weight is a further development of the *equal armed beam scale.* It has been established that the sliding weight beam scale had its origins in Egypt at about 1400 BC. For the ancient Romans, this scale was an important basis for their trade empire. This is how sliding weight scales gradually became known as the "Roman scale" over the course of time. The various terms used here all refer to the same scale type.

Sliding weight scales consist of a beam with a scale and two unequal lever arms. On one arm there is a balance weight and on the other a hook to suspend the item to be weighed. Many sliding weight scales even had two hooks for hanging the load. This provided two weighing ranges. The distance between the lever arms can be changed by moving the sliding weight until the suspended object comes into balance. The sliding weights normally had geometric shapes or were reproductions of commodities such as fruit, animals or human busts.

The invention of the Roman sliding weight scale of course had an immense significance in trade since it offered enormous advantages over the equal armed scale. It is much quicker and easier to weigh using a sliding weight that is several times lighter than the load depending on the relative distance between the lever arms. The same operation is much more difficult using an equal armed scale with its many weight units. But it must be clearly pointed out that the steelyard can only be used if no high demands are placed on accuracy. In fact, the Roman steelyard can be very imprecise when determining weight.

Remains of this scale or its rests have been found in all countries conquered by Rome. The scale still renders good service today. The Roman steelyard scale is still the main scale used in Mediterranean countries.

Market, mass and weight in the Middle Ages

Mass and weight have been linked to the right to hold markets from time immemorial, as quoted by Pippins (744): "... that all towns shall apply, maintain in proper order and keep statutory markets and mass units." In the cultural history of mankind, a market provides the opportunity to exchange goods in large settlements and towns. The market privileges bestowed upon local rulers normally went hand in hand with the right to mint coins, the right to levy customs duties and the right to organise public markets. These privileges also included the standardisation of mass units and weights for supervising the market. Without this, a public market would not be possible.

Remark: Weights and weighing still determine the flow of money and goods today to a great extent. Without scales it would also be impossible to maintain a properly functioning economy.

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The platform scale and the equal armed beam scale. From 1669

Platform scales belong to the group of mechanical scales and function on the principle of the *equal armed beam scale*. They are normally made for weighing ranges up to 10 kg. During the weighing operation, the platform scale compares the mass of a known object, e.g. a commercial weight (standard weight) with that of goods weighed. The weight of the goods weighed matches that of the commercial weight when *equilibrium* is attained. On a platform scale, this is recognisable when the two tongues in the middle are aligned along the same line.

The platform scale was invented in 1669.

The platform scale works on the principle of the equal armed beam scale.

The analogue signal and the equal sided beam scale

Before I deal with the invention of the binary number system, I would like to again explain the term **"analogue"**. In the meantime, this term has become lost on most people, and I can confirm this every time I meet people at seminars. It is not easy to come about a simple explanation. I hope that the explanations below are easy for reader to follow.

Analogue (Greek): proportionate, ratio, account. Freely translated, analogue means something like "similar."

A signal is referred to as **analogue** when its parameters bearing the information, e.g. momentary value, can assume continuously any *variable* value between a minimum and a maximum. This relates to almost all real processes or states.

"In Fate's balance as it sways,
Seldom is the cock at rest;
Thou must either mount, or fall,
Thou must either rule and win,
Or submissively give in,
Triumph, or else yield to clamour:
Be the anvil or the hammer."

Johann Wolfgang von Goethe, *28.08.1749, † 22.03.1832

Photo: André Zehetbauer

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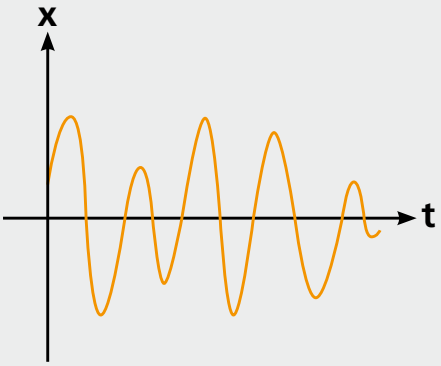
Examples of analogue conditions:
The tacho generator voltage proportional to the rotational speed or the speed of a dynamo on a bicycle (low speed = less light, high speed = bright light) is an analogue function. An office door is open slightly, open slightly more, half open or fully open (but it is either open or closed = digital). The voltage of an SG* load cell proportion to force is also an analogue signal.

Equal armed beam scales operate on the analogue principle: a proportionally greater or smaller pointer deflection results from a rising or falling weight load.



Continuous-value and continuous-time. The binary number system and the equal armed beam scale. From 1697. By and with Gottfried Wilhelm Leibniz (1646–1716)

Gottfried Wilhelm Leibniz deduced the method of calculating with the two digits 0 and 1 by dividing the weights on the **analogue** *equal armed beam scale*. As a result, he developed the binary number system that is still in use today and that is indispensable for the computer industry. He wrote about this far-reaching discovery in his New Year's letter to Duke Rudolf August in Wolfenbüttel in 1697.

8	4	2	1			Our usual numbering system today based on 10
2^3	2^2	2^1	2^0			Calculating with the two figures 0 and 1
				Binary	**Decimal**	
0	0	0	1	= 1	= 1	**Example 1**
1	0	0	0	= 8	= 8	**Bizerba a new star in the scale heavens**
0	4	2	0	= 4 + 2	= 6	
0	4	2	0	= 4 + 2	= 6	
0	0	0	1	= 1	= 1	**Example 2**
1	0	0	0	= 8	= 8	Chronos scale, the first trade-approved automatic scale in the world
1	0	0	0	= 8	= 8	
0	0	1	1	= 2 + 1	= 3	
0	1	0	0	= 4	= 4	**Example 3**
0	1	1	1	= 7	= 7	only for advanced explanation
0	0	1	1	= 2 + 1	= 3	

Examples of converting binary to decimal figures: 1866

** SG strain gauge.*

1866 "Bizerba" a new star in the scale heavens Andreas Bizer in Balingen (Photo: Bizerba Archive) The Bizerba company name today originates from the names Bizer and Balingen.

Outlook: In Part 3 of ... *Scales and weighing through the ages* ... we will first turn our attention again to Gottfried Wilhelm Leibniz and the binary number system. 1764 is the next milestone in the history of the scale. For this we go to the Swabian Alb, to Philipp Matthäus Hahn in Albstadt-Onstmettingen. He is regarded as the founder of all scale technology and manufacture in the entire region of the Zollernalb. In addition, it is thanks to his work that a new and major star rose in the scale heavens with Bizerba in 1866. ■