

Weston was the Icon of Meters in Japan

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Abstract Weston Electrical Instrument Corporation was founded in 1888 and began to manufacture portable direct-current meters. At that time, the electricity power industry emerged in Japan, and in 1888, the Institute of Electrical Engineers of Japan (IEEJ) was also established. Many Weston meters were imported to Japan and used by government institutions and universities.

Japanese meter manufacturers were established around 1900 and began to manufacture meters similar to Weston's meters. It took a while for them to become able to make meters that were comparable to Weston's. On the other hand, it took a long time for Japanese users to acknowledge that the performance of domestic meters achieved the level of Weston's. In other words, Weston's meters were the icon of meters for Japanese users and maintained their superiority status for a long time in Japan.

The following meters were Weston's specialties:

- 1) Laboratory Standard Instrument (accuracy of 0.1%)
- 2) Portable Precision Instrument (accuracy of 0.25%)
- 3) Photographic Exposure Meter

Weston's superiority status in Japan continued until around 1950, after World War II. The arrival of digital instruments, however, changed the situation radically. Although the company had excellent patents, such as one for the dual-slope A/D converter, Weston Corporation passed on the opportunity to survive the competition in the meter industry.

1. Weston Electrical Instrument Corporation and Japan

Edward Weston (1850-1936) completed a portable precision electrical instrument in 1888 and founded Weston Electrical Instrument Corporation [1]. Weston products were highly valued in Japan, so the owners of the meters handled them as if they were icons. In other words, being an owner of a Weston product was something to be proud of. Such a situation continued until the 1950s, after World War II. I would like to present some examples. The following presentation shows the research results I found on my history research trip.

The first Japanese users of Weston precision electrical instruments were government institutions such as inspection bodies of electrical laboratories and telegraph offices of the Communications Ministry, as well as educational institutions such as technical colleges and universities. The precision instruments used in these places helped build a high reputation for Weston. In addition, in those days, around 1938, Weston was the world's top manufacturer for standard cells, standard resistors, and precision electrical instruments for measuring current

and voltage [2].

Many Japanese meter manufacturers were founded before and after World War I (1914 - 1918), because the war made it difficult for Japan to export and import products. In addition, it was costly and time consuming to return imported products to Europe and the U.S. through trading houses for repair every time they failed. Thus, demand for domestic products increased in Japan. Meter manufacturers founded in those days include Shimadzu Corporation (1874), Tokyo Keiki (1896), Kuwano Electric (1904), Yokogawa Electric (1915), Hokushin Electric (1918), Anritsu Electric (1895), and Hioki (1935). In addition, switchboard meters were imported along with power generators, and manufactured by each of the heavy electrical equipment manufacturers, such as Toshiba, Hitachi, and Yasukawa electric.

The manufacture and design of meters, however, require components and materials. No meters can be made if the key components of the meters such as a permanent magnet or resistor material like manganin alloy cannot be obtained. Accordingly, the study of key components, in particular, a permanent magnet was already underway at a university.

Institute for Materials Research at Tohoku University completed the KS steel for permanent magnets in 1917, which greatly contributed to the start of the meter industry in Japan. [3]

In addition, the replacement of equipment destroyed by the Great Kanto Earthquake (1923) helped boost the demand for meter manufacturers. Meters made in Japan replaced the installment base of existing imported meters.

2. Laboratory Meters were the Icon for Inspection Bodies

Weston laboratory meters were used as a secondary standard equipment at ETL (Electro Technical Laboratory) and at JEMIC (Japan Electric Meters Inspection Corporation). JEMIC's offices were located around Japan, so they had a large influence on the spread of precision meters.

Meters from Yokogawa and other Japanese manufacturers were adopted over time and assumed the role of practical standard equipment in private companies. They were the symbol of having good calibration facilities. The accuracy and stability were 0.1% or 0.2% (Fig.1, Fig.3)



Figure 1 Weston Laboratory Meter

In those days, meters of advanced companies such as Cambridge, U.K., and Siemens, Germany, were imported to Japan. However, many of the Japanese meter manufacturers adopted the structure of Weston. To do so, technologies for permanent magnets, beryllium copper springs, pivot supports, aluminum coils, knife-shaped pointers, and mirrored scale plates were required. (Fig.5)



Figure 2 Weston Portable Precision Meter



Figure 3 Japanese manufactured Laboratory Meter (0.2%)

3. Portable Meters were the Icon for Educational Institutions

Weston portable instruments, as the name indicates (Keitai; Japanese), satisfied the requirement of being able to be carried to sites at power generation plants and used at universities and other laboratories. (Fig.2)

These instruments achieved an accuracy of 0.25% or 0.5%, and were mainly used for experiments by students at educational institutions such as universities and engineering schools. As shown in the photo, (Fig.4) future electrical engineers became familiar with the instruments through experiments. This experience remained in the mind of the students and helped form a large instrument market as the students developed into electrical engineers.

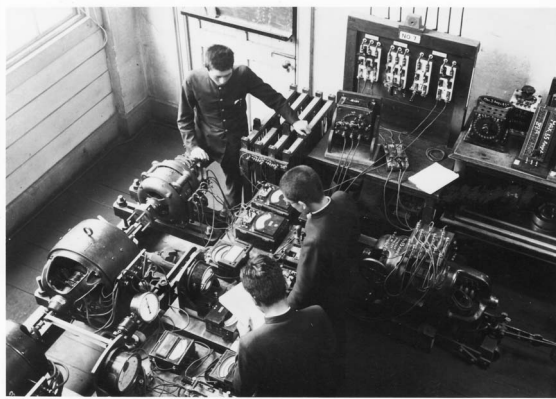


Figure 4 Electrical Engineering Experiment and Portable Instruments
(Engineering Dep. Waseda University n 1930s)

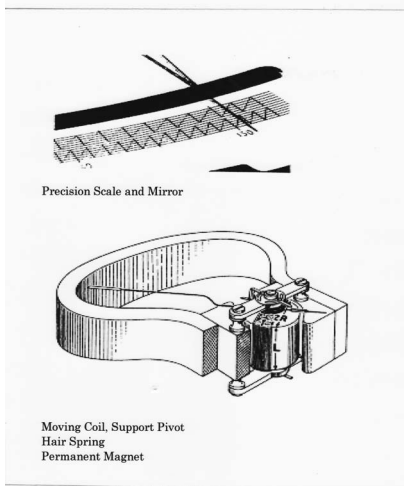


Figure 5 Weston's Electrical Meter
(Precision Scale, Mirror, Spring, Permanent Magnet)

As shown in the photo, until around the 1970s, products from more than 10 manufacturers were available in the market, including Weston Electric, Thomson, GE, Westinghouse, Hartmann Brown, Siemens, Kuwano Electric, Hitachi Ltd., Kyoritsu Electric, Anritsu Instruments, Shimadzu Corporation, Yokogawa Electric, Fuji Electric, Nissin Electric, Shimizu Electric, FEC, and NEIC. The external dimensions and appearance of these meters were basically identical. (Fig. 7)

These meters were used for student experiments; however, there was a problem with how to deal with damage resulting from use. Some schools stored their Weston meters literally as if they were an icon and had students use Japanese meters instead in order to prevent Weston meters from being damaged by use.

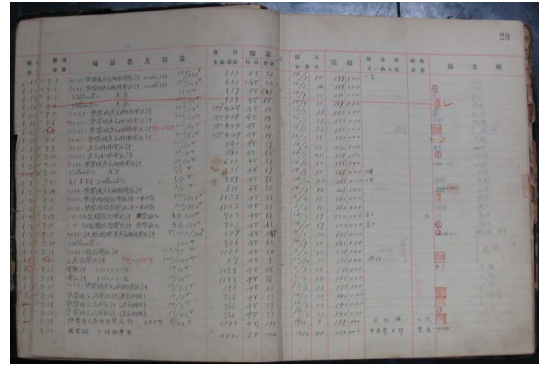


Figure 6 Instrument Ledger Listing Both Weston and Japanese Meters
(Tokyo Institute of Technology)



Figure 7 Precision Portable Meters made by Eleven Companies. (at the Market 1960s)

The price for Weston products in those days was approximately 200¥, double the price for Japanese meters. As shown in the ledger, Weston products were constantly purchased and stored as the icon for the electrical engineering course. (Fig.6, 1940s)

4. Weston Meters are also Showcased in Europe

Weston precision instruments are showcased in places in Europe such as the inspection body PTB (Physikalisch-Technische Bundesanstalt) in Germany and Ampere's Museum in Lyon, France.

In the early 20th century in the US, when users required that meters with the authorized inspection certificates, Weston exported the precision instruments to Germany to have them undergo an inspection at the Physikalisch-Technische Reichsanstalt, or PTR (currently PTB), and then re-exported them accompanied by the inspection certificate to the U.S.



Figure 8 Weston Instruments and Staff at PTB, Braunschweig Germany, (2003)

However, the fact was that PTL used Weston meters for their in house use.

Dr. Arthur Kennelly of the professor at Harvard University revealed the fact in Congress in 1900, so the establishment of National Standardizing Laboratory (NBS currently NIST), was advanced and it had to set its electrical standard department and inspection department [4].

From the beginning PTB valued highly Weston meters and permanent magnets. There was a Weston plant in Berlin for some period of time. I was, therefore, able to see Weston meters and meet former admirers at PTB.

5. Weston Exposure Meter was the Icon for Professional Photographers

In the mid-1930s, Weston manufactured handheld exposure meters for photographers. The combination of a selenium photocell and a small meter were used to control the F-stop and shutter speed.

Young persons in the digital age may have no idea what kind of tool an exposure meter is. They also may have no idea of the photographic term "proper exposure." In addition, in the pioneer days of color photography, the tolerance of exposure was narrow, so over and under exposure resulted in poor photos. Edward Faraday Weston (1878-1971) obtained the first patent for an exposure meter and Weston Corporation began to manufacture exposure meters in the 1930s.



Figure 9 Weston Master 4050 Exposure Meter
Weston Euro Master, Weston Master V, Sekonic-Master

According to the patent, the invention came about as a result of the love for photography of Weston II. [US Pat:2,0166,469 (1935)]

Exposure meters need a photosensitive element (for which, at first, a selenium was used, and then a CDS cell), which, at first, was an accessory for electrical meters.

An exposure meter called Weston Master caught the heart of Japanese professional photographers. For engineers who worked for a department that involved taking photos, being allowed to use a Weston Master was the proof of being recognized as a professional photographer. Weston Corporation, UK, licensed the technology to Sekonic, Japan, for some period of time.

The turning point came soon. It was the integration of an exposure meter into a camera; to be exact, the arrival of a camera with a built-in through-the-lens (TTL) exposure meter. In the period between the 1960s and 1970s, amateur photographers using this new camera became they were able to take the same photos as professional photographers using the Weston Master.

However, a real exposure meter needs to measure the incident light, reflected light, and stroboscopic light (flash light). Professional photographers for wedding photography and portrait photography in the U.S may stick with film for as long as they live. For example, Mr. Sato has been working as a zoo photographer for the past 20 years. Even though this field is entering the digital world, he has no intention of giving up his Weston Master. (Fig.10)



Figure 10 Weston Master and Professional Photographer, Mr. Sato

6. Arrival of Digital Meters and Value of Laboratory Meters

After World War II, people expected for panel meters to have an accuracy of percentage readouts, and the potentiometer method was developed instead for tasks requiring high accuracy. A self-balancing instrument arrived, it was used for precision measurement though it needed a long time for balancing. In addition, the arrival of a digital meter enabled the numeric display of high resolution measured values. The era of high-accuracy laboratory indicating meters was gone. In October 1954, Weston Corporation was absorbed by Daystrom and in 1962, Daystrom was taken over by Schlumberger. In 1988, Weston Corporation ceased production and brought an end to its history that lasted one century.[2]

If you take a close look at the history of the company, however, you will find that Weston Corporation had the technical potential of pulling a successful transition to digital meters. In 1957, Weston's R&D chief, Roswell Gilbert, applied for a patent for an invention called a dual-slope analog-to-digital converter. His invention was outstanding, so many competitors including meter manufacturers felt threatened. However, Gilbert's A/D converter did not sell well. According to Gilbert's paper, the reason was the absence of support technology in those days. In other words, they had to use of vacuum tubes resulted in a large box casing, so the A/D converter failed to generate demand. The market for this circuit expanded after it was miniaturized into an integrated circuit by the semiconductor manufacturer Fairchild. [5], [US Pat.3,051,939 (1957)]

Aug. 28, 1962 R. W. GILBERT 3,051,939
 FILED May 9, 1957 ANALOG-TO-DIGITAL CONVERTER 2 Sheets-Sheet 1

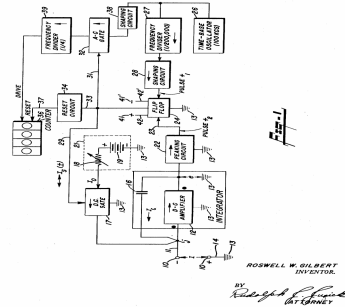


Figure 11 A/D Converter Circuit,
 R. W. Gilbert; Patent Filed (1957), Patented(1962)

Why did Gilbert invent an A/D converter? My theory is he attempted to use the integration to handle very small current values of the exposure meter. Integration values are relevant to exposure. Weston Corporation had the technology to maintain its icon status in the industry, but Weston management passed on the opportunity. The IC technology enabled another player to acquire the status of the new icon of the industry. [6]



Figure 12 Weston's Digital Mutimeter
 (Daystrom-Weston, 1970s)

7. Weston's precision products

Weston Electrical Instrument Corporation developed a succession of excellent products, such as precision electrical instruments, power shunt resistors, stable resistor materials, and electrical exposure meters, over a period of 100 years

It's products were exported to countries around the world and cherished as an icon in Japan. Many users became familiar with Weston products through the student works and the experience remained in their mind for

a long time. However, Weston Corporation passed on the opportunity to take advantage of its excellent invention in the period of transition to digital technology.

As the next step of my study, I would like to focus on the question of why Weston Corporation passed on the opportunity, not only from the standpoint of management, but also from that of technological history, and report the results of the study.[7]

Acknowledgement

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