Metrology: From Antiquity to the Modern Age, with a Look at the New Frontiers

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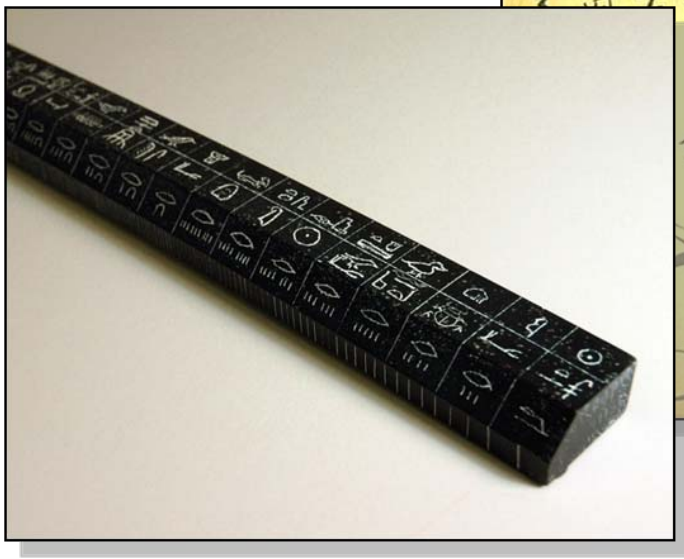
Metrology: the World's Premier Measurements Community

"I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind . . ."

-- Lord Kelvin (1824 – 1907)

The Metrology of Antiquity

Chinese length standards based on the resonance tone of 'standard' bamboo whistles



Royal Egyptian cubit, based on the size of the Pharaoh's forearm and hand

Carob seeds, used to derive the carat

photo by gourmetsleuth.com

Courtesy of NIST

Fire Hoses Don’t Match Up

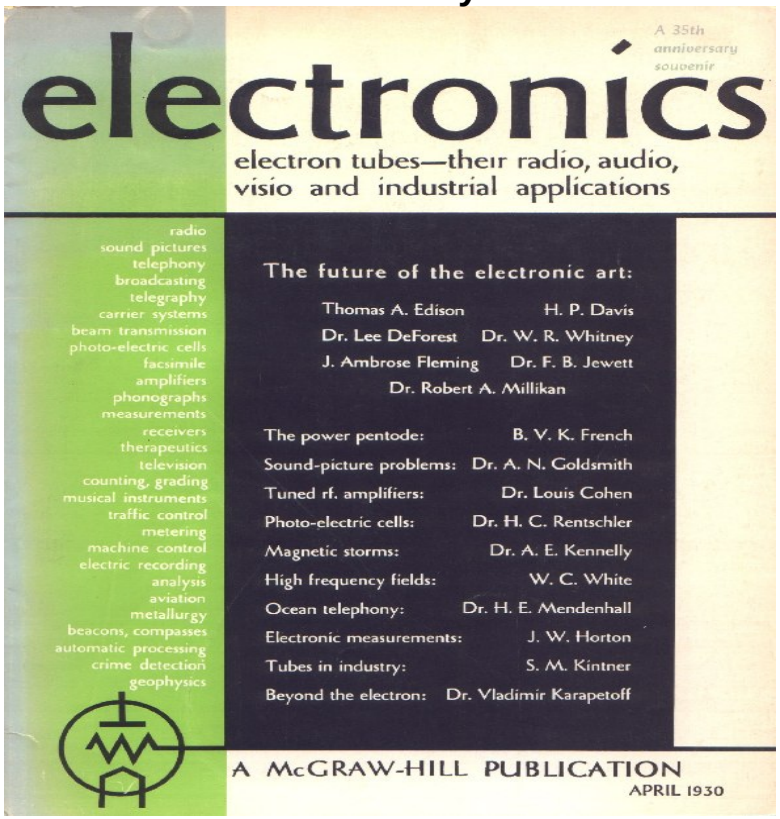
- Efforts in the 1830s to provide some national U.S. coordination of weights and measures.
- March 3, 1901: Congressional Charter for National Bureau of Standards.
- Baltimore Fire of 1904 demonstrated that fire hose standards were crucial.
  - “Great Baltimore Fire of 1904” -- 1500 buildings burned to the ground
  - Fire crews arrived from Washington, D.C., and New York City -- but their hoses would not fit Baltimore’s hydrants
  - More than 600 different fire hose sizes and hydrant connectors were in use

Fire Museum of Maryland

Enoch Pratt Free Libary

The Modern Age of Metrology

Metrology (System): the concept of a total measurement system, which provides a process for establishing an unbroken chain of measurement traceability back to a primary (national or global) standard, and includes the considerations of accuracy ratios and measurement uncertainty.



Electronics: A term coined for the title of a new trade magazine, Electronics, (McGraw-Hill Publishing Co) for the emerging radio and associated business and products (including measurements) using electronic (vacuum tube) technology. Circa, 1930.

The late 1950s: A National Measurement System in Trouble

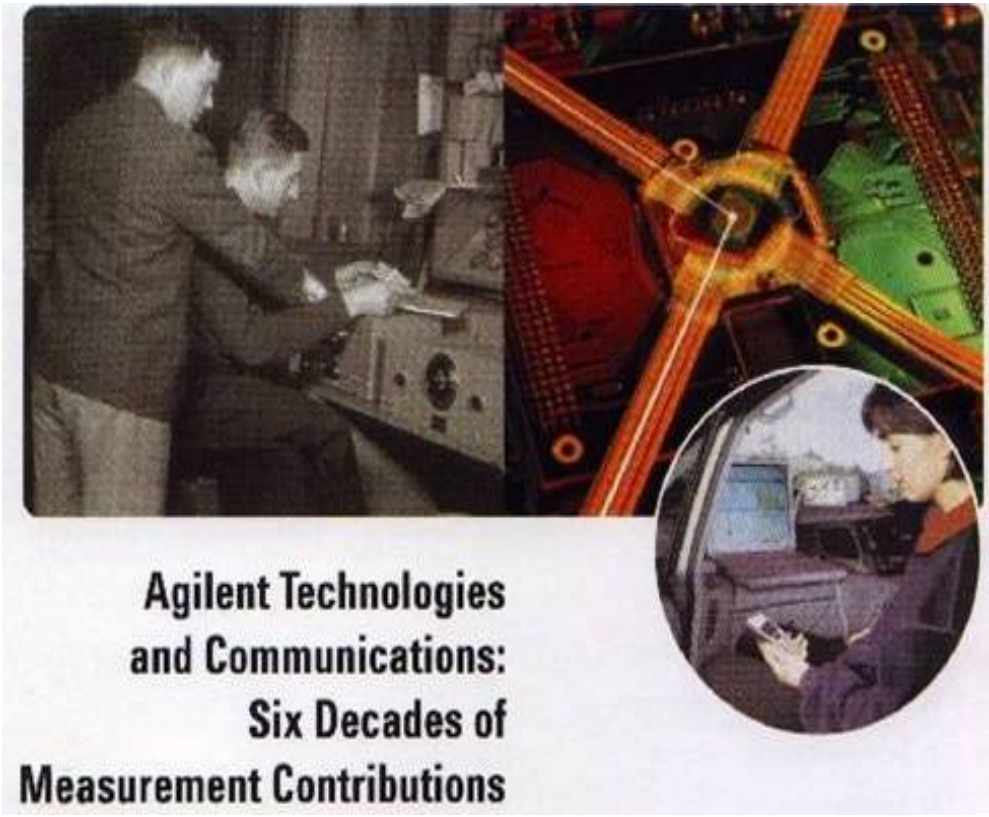
NCSL Founding Committee

- **Measurement assurance was spotting or non-existent**
- **NMIs were just beginning to recognize lack of traceability**
- **The establishment of MIL-C-45662 and other military quality specifications for calibration processes**
- **NIM was established in 1955**
- **The birth of the National Conference of Standards Labs (NCSL), 1961**

NIST move to Gaithersburg

HP/Agilent Contributions to Metrology Technology

1. HP 100A Frequency Standard, circa 1941
   * Quartz crystal frequency standard
2. HP 430A-478A Microwave Power Meter, circa 1950
   * DC to microwave substitution
3. HP 410B AC-DC voltmeter, circa 1950
   * Novel thermionic diode for detection to 700 MHz
4. HP 524A Frequency Counter, circa 1952
   * 10 MHz direct reading
5. HP 5060A Cesium Atomic Frequency Standard, circa 1964
   * First commercial atomic standard
   * Supported global “Flying Clock” NMI time synchronization project
6. HP 8551A Microwave Spectrum Analyzer, circa 1964
   * 2 GHz sweep, 60 dB dynamic range
7. HP 5100A Frequency Synthesizer, circa 1964
   * 0 – 50 MHz, direct synthesis, programmable
8. HP 8410A MW Network Analyzer, circa 1967
   * Scattering parameter characterization
9. HP 5526A Laser Measurement System, circa 1970
   * Dual frequency, sub-microinch
10. HP 8540A Automatic Network Analyzer, circa 1968
    * Computer corrected data, scattering parameters,
11. HP 3458A Digital Voltmeter, circa 1975
    * 1 uvolt, 8 ½ digits
12. HP 8902A Measuring Receiver, circa 1984
    * Precision measurements of RF/MW signal levels



The Future of Metrology

1. Market driven forces that disrupt
2. Geographic diversification of R&D and Manufacturing
3. The digitization of everything
4. Move to software-intensive architecture
5. Increased performance of today's instruments
6. Surge towards Web-based business

The New Frontiers of Metrology

1. Measurement technology
    * Commercial instrument manufacturers
    * NMI research in many nations
2. International Cooperation on basic standards
    * For example; the BIPM electronic kilogram
    * Regional associations of NMIs like EURAMET, SIM, SADMET, COOMET, MENAMET,
      Asia-Pacific Metrology Program

3. International Cooperation on measurement assurance processes
    * For example, ISO 17025
    * ANSI/NCSL 540Z-series of standards
4. International Cooperation on laboratory accreditation
    * For example, ILAC, EUROLAB, NACLA, A2LA, APLAC, NARA, and many others
5. International Cooperation on Legal Metrology
    * For example, OIML
6. International Cooperation on all of the above
    * The NCSLI organization of organizations with interest in global metrology

World Standards Day

From the pages of *Open Systems Today* –

October 13, 1994:

"The International Standards Organization (ISO) and the International Electrotechnical Commission (IEC) designated October 14 as World Standards Day to recognize those volunteers who have worked hard to define international standards.... The United States celebrated World Standards Day on October 11; Finland celebrated on October 13; and Italy celebrated on October 18."

No further comment about the global state of "standardization" is necessary !

Thank you …

to you the world leaders in creating critical measurement solutions and promoting equitable standards.

Enjoy the symposium

Acknowledgement

I would like to acknowledge John Minck, HP/Agilent retired, and long-time Editor of the NCSLI Newsletter, who assisted in preparing some of this material. He also granted permission to reproduce in part the narrative history of NCSLI, from their 40th Anniversary Edition, which is provided here as a handout.