Why the Recent Global Attention on Digital Transformation in (Legal) Metrology?

Byline: Katya Delak, Bob Hanisch, and Chuck Ehrlich

The last half-century has witnessed a sea change in how information technology affects our lives, largely enabled by the advent of increasingly cheap computing power and memory, along with interconnected networks. Computing technology has sought (and largely succeeded) to automate mundane tasks in that most people can share photographs or bank online without thinking about the underlying processes. Technology has matured enough that we are now poised for the emergence of driverless cars and sensor networks to enable smart homes and seamless manufacturing. We can all agree that much of our everyday activities have undergone and are continuing to undergo a digital transformation.

What then is digital transformation in legal metrology? Legal metrology relies on a set of tests, calibrations, and method assurances through a variety of established protocols. In some cases, calibrations are done by hand. Type evaluation occurs at a type evaluation authority, or in some cases by a manufacturer via in-house tests, that then provide a data set to a type approval authority for certification. Type evaluation certificates are then stored in digital form with the type evaluation authority and made publicly available through web access. In the case of modifications to a legal metrology instrument, type evaluation may also be updated. Field tests are carried out by state authorities or registered service organizations; the results of which are logged in ways that may vary from state to state. This might include paper documents, hard copy files, file scans, and nowadays digital files stored locally or remotely on a cloud-like system. In all, considerable variability exists in how data is collected, stored, maintained, and managed.

This process could certainly be streamlined, where many steps could be transformed to be carried out on digital systems. Similar enabling technologies that support constructs like smart factories could be used to enable a digitalization of the processes that support legal metrology, thus facilitating testing, calibration, certification, and reverification processes. Digital technologies could also help simplify the management of the supporting data and documentation, making it more accessible to users and more easily searchable and revisable when appropriate.

In this scenario, a person may still be required to review data associated with type testing or field testing reports and take appropriate action, but many steps in the system could be automated through the use of various digital technologies. In lieu of relying on field inspections, imagine a situation where a networked instrument would carry out an automated self-test to ensure it is still within calibration and tolerance specifications. The data would then be communicated to a state authority and automatically verified. In such a case, state authorities and business owners could also be notified of real-time instrument malfunctions, tampering, or out-of-specification conditions, and could intervene personally when necessary.

What is required for this transformation to happen in legal metrology? Like today's gadgetry, an underlying system would require that relevant parties can have access to system data. However, if the system is networked, or data is stored on a cloud, this will enable parties access to data without having to be on-site to examine a device. They could download stored calibration and type evaluation data, or even review audit trails. Greater flexibility becomes apparent if networked instruments can be updated remotely and re-verified virtually. However, this kind of system becomes complex quite quickly, and data privacy as well as security will require serious consideration. Still, certain concepts are being developed to help bring this scenario to reality.

The first of these concepts is a digital representation of a measuring instrument and could be as basic as instrument identifiers (model, serial number). Indeed, the **Research Data Alliance** has developed a recommendation for persistent identifiers (PIDs), a permanent reference to an instrument and its operational state at a given time, which could be used for such an application. The digital representation could also include a wealth of other information, such as the relevant legal information, including the type approval certificate; manufacturing information about the initial construction and testing; the instrument owner; field installation and verification information; and any repair, recalibration, and reverification information. Such a digital representation might also include reference to the legal metrology laws and regulations for the jurisdiction under which it operates.

In order for digital representations to be usable and for relevant data to be retrievable by users, the data has to be formatted to be searchable. Thus, it is imperative to have agreed-upon or standardized data formats that are harmonized globally. Standardized data formats would also apply to metadata, which is the data that identifies what data is about. As an example, scale manufacturers would need to use the same data formats for specific parameters, such as common descriptions of what is being measured, consistent units of measurement, as well as other metadata related to the digital representation as described above. To this end, the International Bureau of Weights and Measures (Bureau International des Poids et Mesures, BIPM) hosted a workshop this last spring on **The International System of Units (SI) in Findable, Accessible, Interoperable and Reusable (FAIR) Digital Data**. Joint efforts such as these provide information on what is happening internationally towards providing a harmonized approach to formatting and reporting measurement data.

The digitalization of legal metrology is already taking place in other countries, and the most recent issue (July 2021) of the **OIML Bulletin** provides a worthwhile summary of these activities. The National Metrology Institute of Germany (Physikalisch-Technische Bundesanstalt, PTB) and the National Physical Laboratory (NPL) in the UK have developed Digital Calibration Certificates (DCCs) to collect and organize standardized metadata and data concerning a calibration. PTB has developed a **"European Metrology Cloud"** and the Interamerican System of Metrology (SIM) has a set of task forces devoted to **"Metrology for Digital Transformation" (M4DT)** that are sharing information on automating laboratory processes, the use of cloud technologies for metrology, and DCCs. In fact, manufacturers that are engaged in European and/or Latin American markets may have already considered how to integrate with these digital systems.

In the U.S., NIST has begun an effort towards realizing the "Digital NIST" with an initial focus on DCCs and their potential customization for Standard Reference Material (SRM®) Certificates of Analysis and NIST calibration reports. Future efforts will include a major overhaul and modernization of data acquisition, extraction, representation, and management throughout the organization. Beyond this, NIST has an eye towards the development of the NIST Metrology Cloud, that would be used by industry, governments, academia, and regulators as a source of information and a guarantee of quality for legal metrology, international trade, data exchange, and calibration of instruments, among many other applications. The overarching goal of the cloud is to support the growth of U.S. companies in the global marketplace.

Digital transformation in U.S. legal metrology is imminent, and in some cases is already here. As we prepare for our future, the NIST Office of Weights and Measures is interested in learning about your current and anticipated needs for digital transformation in your organization as we work towards realizing the NIST Metrology Cloud. Please reach out to us (email: **owm@nist.gov**) with any insights, recommendations, or issues that would help inform our efforts and better serve you and the weights and measures community at large.