Industry 4.0 Reality Check
Weighing Works for Quality Control

A new Industry 4.0 demonstration machine shows individualized production with lot size 1, flexible manufacturing and future concepts for IT integration. High-resolution weigh modules proved to be the ideal solution for reliable, flexible and simple quality control of individualized products.

The SmartFactory\textsuperscript{KL\textregistered}, which is founded by the German Research Center for Artificial Intelligence (DFKI), developed a fully functional demonstration machine for discrete manufacturing as a showcase for Industry 4.0 (or The Internet of Things). The SmartFactory\textsuperscript{KL\textregistered} and the institute were supported by 50 leading automation and software companies.

**Individualized mass production is possible**
To demonstrate individualized production with lot size 1, SmartFactory\textsuperscript{KL\textregistered} produces personalized business-card cases in various colors. The case has “product memory” in the form of a radio frequency identification (RFID) tag. This RFID tag stores all the necessary information for manufacturing, such as parts list, production status, the name to be engraved and quality parameters. The data stored on the RFID tag allows the cases to actively manage their own production. That allows the individual case to be made without the need for extra production control, which is the prerequisite for flexible and individualized mass production with lot size 1.

**Flexible manufacturing facilitates fast changeover**
Future manufacturing concepts have to be flexible to efficiently adapt to new products and to be moved to new locations. To do that, SmartFactory\textsuperscript{KL\textregistered} comprises nine mobile modules. The modules are supplied with electricity and com-
pressed air and connection for data exchange via one loose cable. That allows the modules to be completely independent from one another and allows the production team to shift the modules in different orders as needed or to even take out modules if they are not needed. Their independence allows efficient commissioning and format changes for different products. The individual modules correspond to the Reference Architecture Model (RAMI 4.0), which describes Industry 4.0-compliant production equipment. They represent the element “Station” which include “Control Devices” and “Field Devices”.

### Reference Architecture Model

**RAMI 4.0**

The overview below shows SmartFactoryKl® application displayed using the RAMI 4.0 model of Industry 4.0 or Internet of Things.

### 1 Layers

1. **Business**: Giveaway for visitors at the trade show  
2. **Functional**: Holding Business cards with name of owner  
3. **Information**: All product data. Ensuring data integrity

### 2 Life Cycle & Value Stream

1. **Type**: Development and Maintenance of Product  
2. **Instance**: Individualization with color and name of holder

### 3 Hierarchy Levels

1. **Product**: Business Card Holders  
2. **Field Device**: Motors and conveyors  
3. **Control Device**: Scale for quality control  
4. **Station**: Module with PLC, motors, conveyors, scale and other sensors  
5. **Work Center**: Production Line  
6. **Enterprise**  
7. **Connected World

### Absence of manufacturing execution systems

SmartFactoryKl® doesn’t require a manufacturing execution system to steer the product through the production process. Data exchange via OPC UA between modules is limited to the mutual recognition for clarification as to whether the adjacent module fits with the next manufacturing step.
Weighing is the right choice

A manufacturing process consisting of automatic and manual modules does not automatically guarantee perfect quality. Therefore, the cases are weighed for quality control with a high-precision WMS weigh module. Their weight value is compared with the specific target weight that is stored in the RFID tag. Weight detection with a high-precision weigh module makes it possible to detect faulty, missing or excess components with great certainty, even if a part is not visible from the outside of the product.

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Business Card Holders

Individualized business card holders in different colors and with holder’s name engraved. Each card holder has an integrated RFID tag to memorize all product data.

WMS Weigh Module

High-precision weigh module for quality control detects deviations of one point in four millions with a capacity of 400 grams and repeatable readability of 0.1 milligram.

www.mt.com/WMS-oe

Weight-Based Quality Control

This white paper explains advantages and provides application hints for weight based quality control in automation.

www.mt.com/ind-wp-wbqc-oe

by courtesy of SmartFactoryKL®
Integrate Weighing into a PLC
In Less Than 5 Minutes

Fully engineered Device Description files for Siemens and Allan-Bradley PLC Systems allow you to simply integrate weighing devices via drag and drop in their well-known programming tools. After wiring is completed and all devices run, typically it takes less than five minutes to transfer weight values into the PLC input register.

State-of-the-art connectivity
METTLER TOLEDO offers a comprehensive range of transmitters, weigh modules, scales and weighing platforms, which are made for easy integration into machines and instruments. The product range covers capacities from 100 grams up to hundreds of tons with the smallest readability of 0.1 milligram. All models can be connected to PROFINET IO RT and EtherNet/IP directly or via an optional easy-to-install gateway.
Standardized PLC-I/O image offers flexibility
All METTLER TOLEDO weighing devices with incorporated connectivity to PROFINET IO RT and EtherNet/IP have the same data at their input/output image inside the PLC. This simplifies weighing equipment standardization for the machine manufacturer because different weighing devices may be exchanged without changing the PLC programming. That provides unlimited freedom for the machine manufacturers to always select the right weighing devices.

www.mt.com/ind-connect-PLC-oe

Engineering Note: Connectivity to PLC
This engineering note explains and shows how easy it is to connect a comprehensive range of METTLER TOLEDO weighing devices to the most common PLC Systems.

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ISO 9001 Regulation Revision due 2018
New Business Opportunity for Machine Builders

Compliance with the ISO 9001:2015 revision requires a risk-based approach. To comply with the revised standard, your customers must evaluate weighing equipment installed in machines that you have supplied. We support machine manufacturers in consulting their customers and we also perform the necessary on-site calibrations.

Many of your customers are likely ISO 9001 certified. Due to the recent revision of the standard, they will have to evaluate their performance verification processes for their measuring equipment by 2018. That evaluation is required for weighing equipment incorporated into machines and instruments.

Turn new requirements into business
As a result, customers might contact you to evaluate the calibration of the weighing equipment you installed a while ago. Such consulting can trigger new service business for you, as recalibration services are an enhancement to your existing preventative maintenance services.

Partnering to create a win-win situation
Our experts use Good Weighing Practice™ (GWP™) methodology to evaluate and recommend calibration processes based on a risk-based thinking approach. With GWP®, you receive a document with all the necessary information, including results of our risk assessment and the rec-

Experts to Consult Machine Manufacturers and Customers
Experts from METTLER TOLEDO can consult machine manufacturer and customer in performing a risk analysis, determining the right test weights and calibration intervals including documentation.

Availability of Certified Test Weights in the Right Class
All METTLER TOLEDO Service Organizations are in possession of certified test weights in the accuracy class that suits to the process tolerances of your customer’s application.

Good Weighing Practice™ Includes Risk Analysis
Good Weighing Practice™ is applicable to new and existing equipment from any manufacturer for selection, calibration and operation of weighing equipment including risk based thinking.
ommended intervals for recalibration for compliance with the new requirements.

We can provide weighing-equipment verification with a GWP Verification at your customers’ sites. In addition, we are able to perform the calibration on your behalf. This partnership offers you incremental business when your own service technicians and the necessary test weights are not available.

www.mt.com/OEM-Service-oe

The 2015 revision of ISO9001 has brought some major changes. The combination of the process approach with risk-based thinking, and employing the “Plan-Do-Check-Act Cycle” at all levels in the organization is relevant for weighing applications with relevance for product quality. Companies have to update their processes until September 2018.

METTLER TOLEDO serves global customers with one of the largest sales and service networks in our industry – over 5,000 sales and service specialists strong. Machine manufacturers can benefit from this organization by cooperating with our experts and service technicians for better serving their own customers.
A Leap in Process Efficiency
Expert Advice: Continuous Solids Dosing

Continuous manufacturing of oral solid dosage (OSD) forms provides significant efficiency and quality benefits – but it can also pose substantial process-development challenges. Dr. Ralf Weinekötter, an expert on continuous dosing and mixing, provides insights on the capabilities and limitations of such systems.

How does a tablet manufacturer benefit from a continuous approach?
A tablet press can be considered a continuous system already. However, the tablet mixture has historically been prepared in a batch mode. Making the entire process continuous provides significant efficiency gains and contributes to better product quality.

What is the role of dosing and mixing in this process?
The continuous dosing-mixing module is an essential element of continuous OSD production. It typically consists of gravimetric feeders for APIs and excipients, as well as a mixing module that feeds directly into the tablet press, granulator or extruder. Such a system requires much less floor space and substantially reduces development and validation time because scale-up is no longer needed. Current systems can process between 50 grams and 250 kilograms per hour.

What needs to be considered when switching to a continuous process?
Product quality is substantially determined by the accuracy and consistency of upstream gravimetric dosing processes. Any error will result in a deviation from target quality. Additionally, mix homogeneity is influenced by mixing chamber and paddle design, rotational frequency.

Dr. Ralf Weinekötter
General Manager, Gericke AG, Switzerland

Dr. Weinekötter studied Chemical Engineering at University Karlsruhe, Germany and ENSIC Nancy, France. He was awarded his Ph.D. at the ETH-Zürich, Switzerland on the topic of “Continuous mixing of fine solids.” Weinekötter is a respected author of articles, papers and books, including Mixing of Solids, published by Springer Verlag, Germany.
Key Benefits:
Continuous Solids Processing

- **Better quality**: Easy integration with downstream processes, such as tablet compression, reduces segregation risk.
- **Improved efficiency**: Continuous manufacturing is an automated process with integrated sophisticated online measuring devices and control technologies to ensure accurate formulations.
- **Faster time to market**: Scale-up from lab to pilot to production is no longer necessary. Extending the operating time of the pilot module to reach normal production output is sufficient.
- **Less space**: A continuous dosing-mixing-module’s footprint is just 2 x 2 x 2 meters.

Why is weighing technology a critical part of continuous dosing systems?
Dosing of micro-components, such as APIs, requires a level of accuracy that only can be achieved with gravimetric dosing feeders. Other technologies for powder dosing, such as flow meters, are significantly less accurate.

What are important specifications for weighing sensors in these systems?
Precise feeding requires advanced weighing, optimal design of the screw feeder and a sophisticated controller that analyzes weighing-sensor data and selects the optimal settings to ensure a constant feed rate.

The weighing sensor must combine high accuracy with a large capacity. The capacity is essential because the sensor has to carry the screw feeder with the feed hopper, which contains the dosing material. Not many weighing technology companies, apart from METTLER TOLEDO, can provide sensors that master this challenge of high capacity with pristine accuracy. In addition, the weighing sensor must provide a high measurement update rate and fast transmission of weighing data to the controller. This is necessary to accurately control the screw feeder and ensure constant material throughput.

Are continuous processes the future of pharma preparation?
Continuous processes provide significant benefits in terms of efficiency, quality and process safety. We have reached a point where suitable systems are available to help companies transition to the continuous method, and we believe the coming years will generate many more exciting developments.
Trust Your Old Weighing Equipment?
You Could Have False Sense of Security

Process tolerances in your manufacturing process could have changed a while ago. Old measuring equipment which, despite frequent recalibration, might not comply with today’s accuracy requirements. We can get you compliant with a professional verification.

Most machine manufacturers use weighing in their own production for logistics, formulation or quality control. Their scales were often procured long ago and they are no longer accurate enough because process tolerances have changed. That can happen even when scales are regularly verified with test weights as part of the quality-control process.

**New regulations might require action**
The new ISO9001:2015 revision requires a risk-based evaluation of measuring equipment. It could also require a reevaluation of existing equipment.

**Auditing an installed base**
Our service technicians can help you comply with the ISO revision using our Good Weighing Practice™ (GWP®) method. It includes risk evaluation and provides a statement regarding whether the scale is suitable for the particular application for which it is used.

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**Efficient Weighing and Piece Counting**
Compact bench scales for simple weighing or piece counting with printer and scanner provide features for efficient printing of customized labels. Connectivity to ERP System support state of the art data management.

**Portable Scales Provide Flexibility**
Factory layouts change often to make manufacturing processes more efficient or adapt quickly to new products. Portable scales or mobile pallet truck scales provide flexibility to adapt fast and easy to new situations in the future.

**Floor Scales for Simple Weighing in Production and Logistics**
Different platforms sizes including ramps and pit frames made of painted carbon steel up to 316 stainless steel with IP69k protection offer the right solution for any environment and application.
Weighing Terminals for a Multitude of Applications

Windows-based weighing terminals combine PC based standard applications or customer-specific software with weighing. Their IP69k protection, including rugged cable connectors allow use in harsh environment.

Additionally, the user receives a recommendation for calibration intervals and suitable test weights for calibration.

**Scientific selection method**

GWP is applicable to new and existing equipment from any manufacturer. It supports you with a standardized scientific methodology for secure selection, calibration and operation of weighing equipment. It also provides documented evidence for reproducible weighing results in harmony with all current quality standards in laboratory and manufacturing, including a risk evaluation.

[www.mt.com/GWP-oe](http://www.mt.com/GWP-oe)

**Good Weighing Practice™ Certificate**

Documenting proper evaluation of existing and new equipment. A certificate documents the performance of each balance versus process requirements based on a calibration. The safe weighing range displayed in the certificate visualizes the specific weighing security and risk of each scale.

InTouch™ Remote Services is a cloud-based, off-the-shelf solution that is making maintenance easy and downtime a thing of the past for businesses large and small. Machine manufacturers can pass on the benefits of InTouch predictive maintenance and monitoring to their customers.

Besides gaining a competitive advantage with InTouch, you can receive valuable information about the performance of your equipment during warranty and later as paid service.

For more information about Remote Performance Monitoring visit:  
www.mt.com/ind-intouch-remote-oe