

# Lean Lab Guide



The Lean Lab Approach  
Nine Steps to Lean  
Self-Assessment  
Checklist

Easy Implementation  
of the Lean Lab  
Approach

## **Lean Lab Guide** Optimizing Workplaces and Workflows

**METTLER TOLEDO**

**Editorial**

Dear Reader,

Efficiency is increasingly important in the laboratory, as labs are obliged to generate results quickly, compliantly, and cost-effectively, often with limited resources.

Lean Management and Lean Lab imply optimized efficiency, concomitant with the minimization of any activities that do not add value: namely, of the 8 different types of waste that result in unplanned laboratory "DOWNTIME":

**D**efects

**O**verproduction

**W**aiting time

**N**on-engagement of all employees

**T**ransportation

**I**nventory

**M**otion / distances

**E**xtra processing

This guide describes each of the 8 wastes and its negative impact on a laboratory. Real examples of laboratory equipment such as balances, titrators, and pH meters provide you with concrete suggestions as to how to identify and eliminate typical inefficiencies, and make it easy to convert theory into practice. For each type of waste, the guide suggests the most suitable instruments, accessories, and services, highlighting how they can support you in increasing efficiency.

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## Lean Lab

The Lean approach is applicable in the laboratory as well as in manufacturing, and holds the potential to benefit both productivity and profitability.

### Potential benefits of the Lean Lab approach

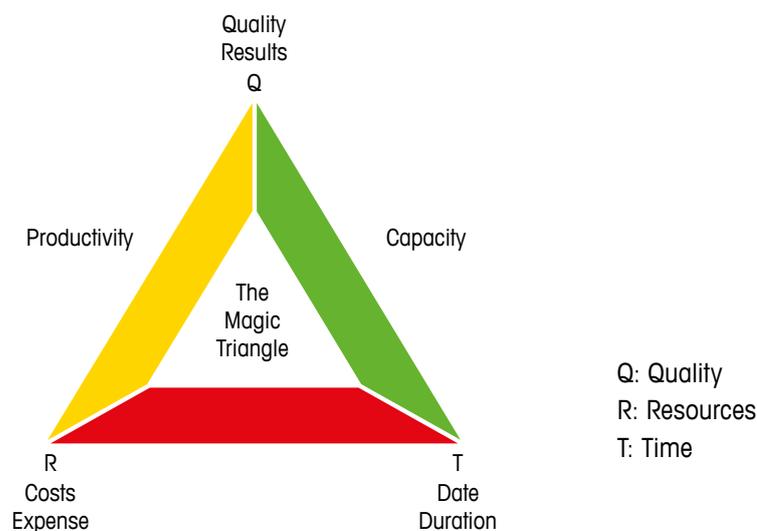
- More defined, structured, and controlled laboratory processes, delivering more consistent and predictable laboratory performance
- Significantly increased productivity
- Reduced lead-times
- Reduced costs
- Reduced levels of work in process (WIP)
- Improved right-first-time (RFT)
- A detailed understanding of lab capacity and resourcing requirements
- Greater empowerment of laboratory personnel
- A culture of proactive performance management and continuous improvement
- Improved quality of customer service

The Lean Lab assessment is primarily internal, involving process optimization that contributes to an organization's economic efficiency. Improvements to Lean operations can include device standardization, modularity, streamlining of workflows, optimization of workplaces, compatible software / networks, and competent services.

The goal is to speed up processes and build a culture of continuous improvement to sustain the business benefits derived from the principles of Lean Lab outlined above. This work impacts everyone from customers to analysts, and encourages lab personnel to draw on new and innovative ideas.

Transformations in mindset and behavior will sustain and augment the impact of Lean Lab. The good news is that Lean Lab principles can be implemented incrementally, module by module, at any time.

Success is measured by the Magic Triangle, the three corners of which must be balanced for the sustained implementation of Lean Lab.



# 1 The Lean Lab Approach

## 1.1 Lean Manufacturing as a model

The Lean Manufacturing approach aims to increase productivity and efficiency at manufacturing companies, as well as to focus on customer requirements and gain competitive edge through low costs and high quality. It takes into account the entire scope of a business, including management culture and employee satisfaction.

On one hand, Lean Manufacturing tries to optimize utilization of resources, while on the other it strives to avoid stretching resources too far (Japanese “Mura” and “Muri”). For this purpose, there are a number of distinctive standards and tools, such as the 5S movement, 7M and 3 Mu checklists, and the 7 (or more) types of waste, that are involved in analysis and the process of improvement. Ultimately, even just-in-time (JIT) production originated from Lean Manufacturing.

Measuring and monitoring the progress of actions that have been initiated through Lean Manufacturing processes is an important component of sustainable implementation and success. For participants, it can be motivating if their success can be tracked graphically in charts placed at conspicuous spots in production. Measurement criteria must be specified accordingly: for example, the number of claims, sales trends, development costs, absenteeism, accidents, etc.

Although it must be noted that there are major differences between the laboratory and production, it is still possible to adapt several aspects of the Lean approach to the laboratory. The aim is to optimize effectiveness and efficiency by minimizing all activities that do not add value. Throughput should be maximized and waste reduced. In other words, Lean attempts to do more with less and encourage cost reduction despite demands for improved quality or increasing throughput.

Lean objectives can only realistically be implemented by introducing rules through which processes are streamlined, simplified, standardized, and clearly presented.

## 1.2 Kaizen, or the path to Lean systems

The Lean approach does not require the implementation of all possible improvements or their corresponding metrics at once. It aims for continuous improvement using tools such as Kaizen<sup>[1][9]</sup>. The term Kaizen originates from Japanese and means betterment or amelioration. Kai means to be renewed, or change. Zen means good<sup>[13]</sup>.

With the help of small steps, implementation barriers remain surmountable.

This is important, because in most cases, there is no or little budget available for Kaizen. Kaizen is typically self-financed through savings derived from process improvements.

# 改善

Figure 1: The Kaizen characters.  
Kai stands for change, zen for good.

The Kaizen path runs through five steps that can be mapped as a circle, in the spirit of continuous improvement. The five steps are often abbreviated 5S. They are:

**Seiri (sort)** → Eliminate what is unnecessary from the work area.

This step is also referred as decluttering<sup>[10]</sup>.

**Seiton (set in order)** → Arrange the things that remain after Seiri. In other words, "A place for everything and everything in its place."<sup>[10]</sup>

**Seiso (shine)** → Maintain your workstation so it is clean and shining. Seiso makes equipment malfunctions immediately obvious.

**Seiketsu (standardize)** → Make cleanliness and order your personal concern. In a wider sense, this step is about setting standards and integrating Kaizen into daily duties<sup>[10]</sup>.

**Shitsuke (sustain)** → Make 5S a habit. The sustainability of the Kaizen process, a fundamental requirement of Kaizen, is addressed in the Shitsuke step.



Figure 2: The Kaizen circle.

## Seiri

Efficient systems are simple systems that permit one to find what is needed without effort. When unnecessary working materials are eliminated from the workstation, the materials remaining are understood to be more important, or even critical. The removal of unimportant or redundant items reduces space requirements. Distances become shorter, and cleaning becomes easier. Thus, the Kaizen process begins with the elimination of extra materials (devices, tools, utensils, chemicals, reagents...).

In many cases, employees may have become dependent on specific tools or other working materials even though they are actually unnecessary. These objects can be stored until it is clear that they are no longer needed. If required later, materials that have been disposed of can be retrieved or procured again.

Larger objects (furniture, devices, etc.) that have been recommended for disposal are provided with a special label so that all employees have an opportunity either to discuss their requirements or stop the disposal. This direct communication of needs can help create comfort with the Seiri process and is especially suitable for larger organizations.

## Seiton

With a reduced set of materials identified, the workstation is arranged so that every piece is easy to locate. Analytical instruments, beakers, gloves, pipettes, tubes, network cables, chemicals, deionized water, and more have their defined places. In principle, pieces are arranged in order of their use in the workflow, and should be replaced after use to maintain Kaizen (see also Seiso). Thus, the same workflow efficiency is consistently possible, and any missing items can be identified easily.

In production areas, the floor or workbench may be labeled to indicate a space reserved for a particular piece of equipment. Increasingly, this procedure is used in labs as well to indicate the correct position of pieces on the lab bench. Initially it might look funny or exaggerated. However, the resulting clear arrangement and order is immediately visible, and the increased efficiency is measurable.

METTLER TOLEDO supports Seiton tasks with compact and ergonomically designed lab instruments focused on workflow simplification. For example, with smart titrator design, everything required to carry out a titration is available in the immediate surroundings of the instrument, including the:

- Titration stand and stirrer
- Burettes
- Rinse unit (manual or automatic)
- Solvent manager (pump system for solvent and waste)

## Seiso

The order achieved by the previous steps “only” needs to be properly maintained. However, this requires that individuals adjust their habits to Kaizen rules. Without convinced, motivated, and appropriately trained employees, this cannot happen.

The new, simplified system arrangement allows the quick and unambiguous identification of problems. Any issues that arise must be dealt with in due course in the spirit of continuous improvement (5S).

## Seiketsu

The Seiketsu step sets standards. In this step, the new system should become the personal concern of each of the employees involved so that improvements are sustainable.

Seiketsu aims at cleanliness or tidiness on both the environmental and the personal fronts, and empowers all involved to maintain performance benchmarks.

Seiketsu is also about prevention, in particular, of:

- Accumulation of unnecessary things
- Breakdown of procedures and processes
- Instruments getting “dirty”, failing calibrations, and becoming inoperable
- Deterioration of equipment

Standardized processes, applied across the company, enable employees to adapt quickly to any workstation, reducing training expenses significantly.

## Shitsuke

Changes and improvements should be sustainable. Employees must make it a habit to properly maintain correct procedures and to work according to the new status quo. This step is often difficult to achieve since it asks for behavioral change and ongoing motivation.

Signs, posters, and periodic performance reviews are some of the support tools that help to ingrain 5S into habits and culture.

## 1.3 Avoiding waste

The 5S methodology forms a unique circle to continuously improve processes round by round (see Figure 2). However, to bring the rather theoretical 5S methodology to life in practice, guidance for daily work has been developed, including the avoidance of waste.

Lean Manufacturing classifies 8 types of waste to be avoided, easily remembered as DOWNTIME. Ultimately, unplanned downtime is what must be avoided. (Planned downtime can be dealt with.)

DOWNTIME can be broken down as follows:

1. Defects: Defective products require corrective action or result in rejected output (process failure). Further, interrupted processes must be restarted (reactive processes).
2. Overproduction: Products and output not needed by customers. Overproduction consumes labor and financial resources, preventing the accomplishment of necessary work.
3. Waiting: Idle or unproductive processes, missing materials, defective or unsuitable equipment, etc., tie down resources, preventing their use to add value during waiting periods.
4. Not engaging all employees/untapped potential: Employees' institutional and process knowledge should be leveraged wherever possible to improve workflows.
5. Transport: Unnecessary transport of materials provides no direct benefit to consumers. However, it uses resources that might be employed elsewhere.
6. Inventory: Maintaining additional inventory may create a buffer for weak spots in production. Yet as with overproduction, excessive inventory ties down capital and space and generates unnecessary handling costs. However, inventory may be required to maintain readiness to deliver in short order.
7. Motion: People or equipment moving or walking more than is required for processing.
8. Extra processing: Inappropriate resources and unsuitable systems may result when production is not fully considered during process development, making processes difficult to monitor. This causes errors, reduces flexibility, and leads to process failures and unproductive waiting periods<sup>[1]</sup>.

D	Defects
O	Overproduction
W	Waiting
N	Not engaging all employees/untapped potential
T	Transportation
I	Inventory
M	Motion
E	Extra processing

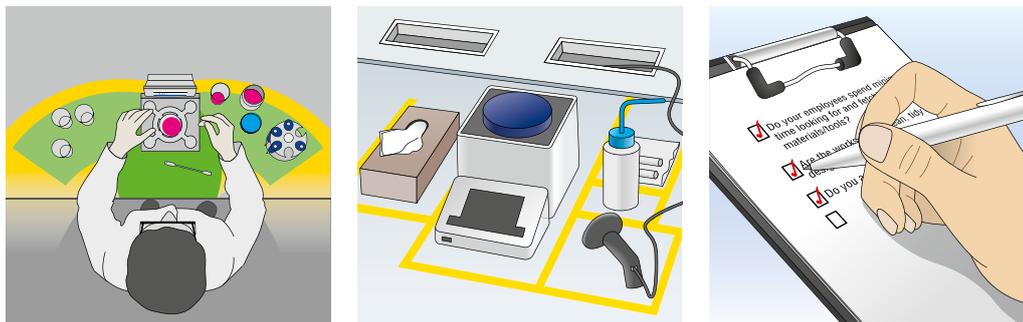
Table 1: Another presentation of the 8 Lean Wastes<sup>[1]</sup>.

### Self-assessment

Chapter 2 includes the nine steps supporting the realization of your Lean Lab. Each sub-chapter includes three to five questions to help you assess your current lab situation. In Chapter 2.1, you will find an evaluation and feedback on your answers.

## 2 The Nine Steps to Lean

### 2.1 Housekeeping – keep it simple



Can your employees find tools quickly and easily?

Yes  No

Are the workstations clean, tidy, and fit for purpose?

Yes  No

Are general laboratory tools stored in an orderly manner and are they easy to locate?

Yes  No

Do you audit these conditions regularly?

Yes  No

#### 2.1.1 Complex processes

Extra, or overly complex, processes indicate a lack of interaction between an organization's development and production departments. When implementing Lean principles, the development department must always make sure that the process is in line with available production options. Otherwise, conditions cannot support the process that has been developed.

Analogously, in the lab area, this typically implies that method developers should take into account the options, capabilities, and resources available at later analysis points. For example, for any methods performed near the production line, the education level and training of shift workers should be considered. This could include evaluating automation possibilities for analyses to limit operator intervention and produce higher security and reproducibility.

For the last few years, METTLER TOLEDO has been keenly involved in reducing operational complexity and has paid special attention to process simplification. Using a graphical user interface (GUI) with One Click™ allows an operator to start even complex processes with a single motion. Additionally, One Click has been implemented across many different instruments, maximizing user opportunities to leverage these shortcuts (see Figure 3).

Increasing standardization of interfaces, user management, data security, method setup, etc., simplifies the learning process and instrument operation for a variety of analytical techniques, as shown in Figure 3 below. These techniques are common in quality control labs around the world.

An additional level of process security and simplicity is added by METTLER TOLEDO LabX®. LabX is a unified software platform designed to manage all METTLER TOLEDO laboratory instruments and the data they produce. The software guides users through full standard operating procedures (SOPs), simplifying and securing processes. The centralized management of instruments, users, and data strongly supports Lean Lab by eliminating the need for PCs and paper records, reducing training efforts, and more.

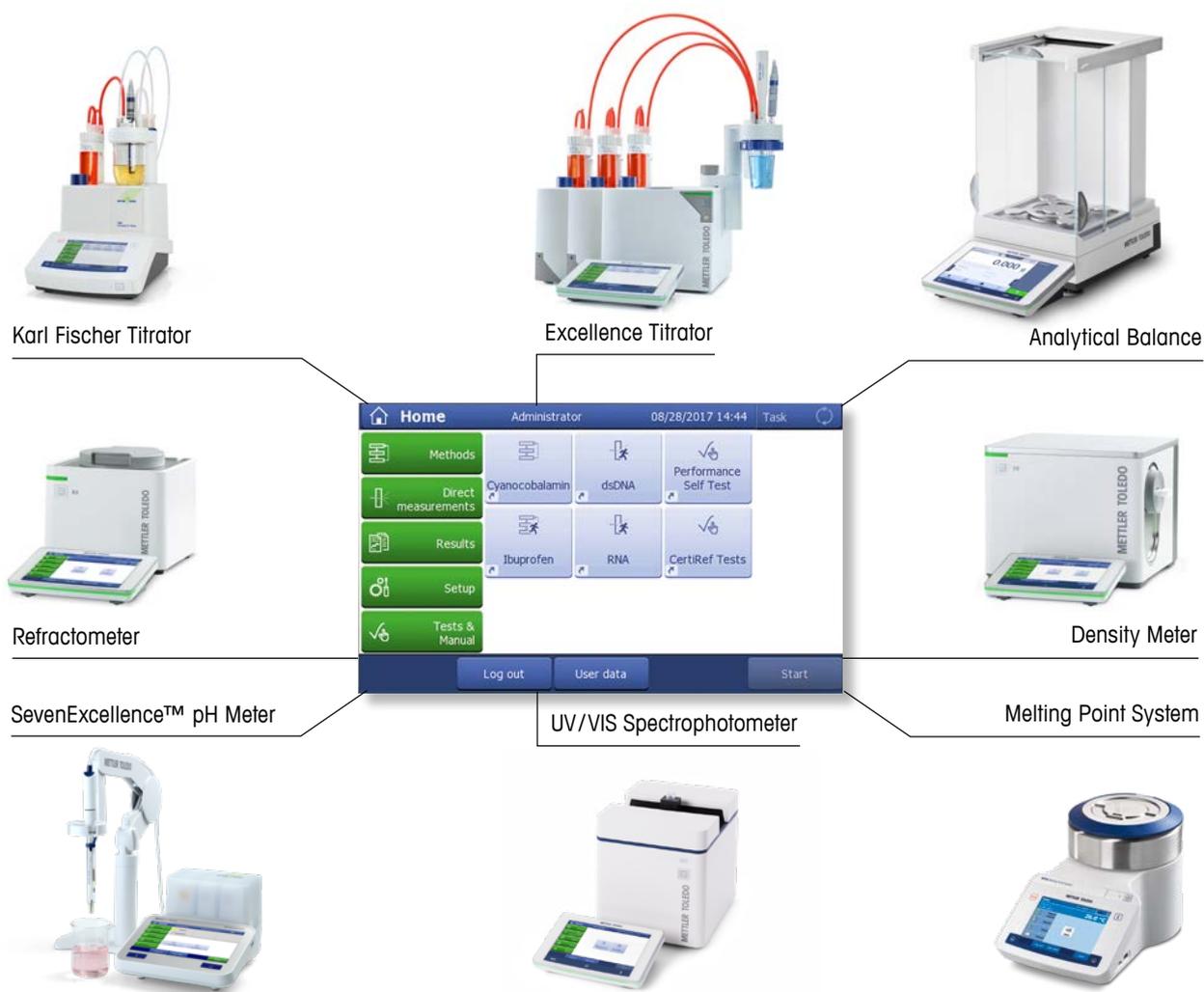


Figure 3: A common interface across all key lab instruments assists the implementation of Lean processes: METTLER TOLEDO standard and Karl Fischer titrators, density meters, refractometers, melting and dropping point instruments, pH meters, balances, and UV/VIS spectrophotometers are conceptualized for similar operation.

Even small-scale solutions can yield important process benefits. These may include:

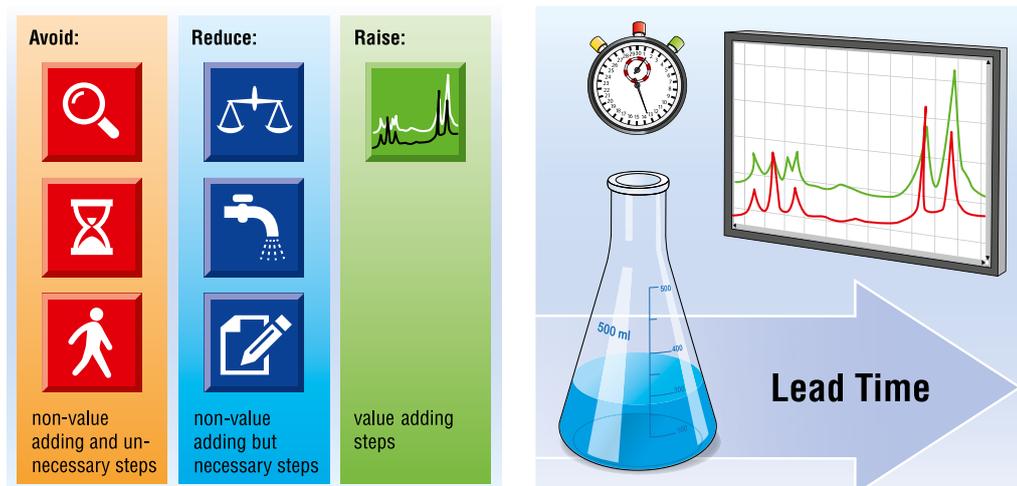
- A barcode reader to log sample IDs and automatically assign methods of analysis
- A fingerprint scanner such as the METTLER TOLEDO LogStraight™, which enhances security and eliminates the need to save or enter passwords
- A sensor to automatically open balance draft-shield doors or to start measurements without the need to touch the device (METTLER TOLEDO ErgoSens)
- Use of an active directory enabling single sign-on, etc.

With the integration of LabX software into a superordinate system (e.g. a LIMS or ERP), the transfer of methods and data is automated and kept safe from transmission errors. Using a common software platform to integrate several lab instruments into the ERP or LIMS reduces complexity considerably. It also reduces costs for validation, maintenance (e.g. during upgrades of the operating system), and first-time implementation.

#### Tips for optimization

- Untidiness is not permissible.
- Look on every shelf and in every drawer for unnecessary materials.
- Start a 5S program. Everything in its place!
- 5S also works on hard drives (IT).
- Is everything in good order? Nothing tidies itself, regular auditing is a must!
- Assign a supervisor for each area.

## 2.2 Value-stream mapping – minimize overproduction



Is everyone in the lab aware of individual work steps?

Yes  No

Are there target times for standard analyses?

Yes  No

Are lead times measured?

Yes  No

Do you know the proportion of non-value-adding but necessary steps in your workflow?

Yes  No

Do you know the proportion of non-value-adding and unnecessary steps in your workflow?

Yes  No

Do you know the proportion of value-adding steps in your workflow?

Yes  No

### 2.2.1 Refuse

Refuse is a form of overproduction waste inherent to laboratories. Chemicals such as reagents, solvents, buffers, etc., are expensive to procure and dispose of. Their waste must be minimized to reduce expenditure and create added value in terms of operator and environmental safety as well as energy savings.

Using a titration method as an example:

The consumption of chemicals (titrant, reagents, solvents) can be manipulated through sample size. Sample weight, titrant usage, and repeatability (precision) are closely linked. Through exact dosage and evaluation options, the weight, and thereby chemical usage, can be minimized while still generating the necessary precision. In addition, smaller sample sizes help to optimize measuring time and increase efficiency.

Taking sample size as an example, the optimal burette dosing range of 30% to 90% of the nominal volume enhances precision while conserving materials. Even small amounts saved can accumulate into a huge volume over time. Standardized automatic cleaning, level indicators on supply containers, and advanced error / malfunction notification during sample series can also help minimize solvent waste.



Figure 4: LabX Mail: Results or warning messages can be sent from the LabX software to your smartphone via e-mail or SMS.

To obtain these savings, METTLER TOLEDO provides effective tools such as:

- Pulsed cleaning functions of automatic sample changers (PowerShower™)
- Fill level sensors (LevelSens™)
- Electronic smartphone notifications

### 2.2.2 Over-testing

Measuring too many parameters, testing too many samples or retesting a sample too many times are aspects of over-testing. Such “excessive checks” are considered waste and can be caused by:

- Laboratory supervisors being misled about technical capabilities and implementing routines that in general are not necessary
- Operator mistrust of results, leading to repetition of tests
- Customer requests for excessive testing to be sure of the quality of delivered goods

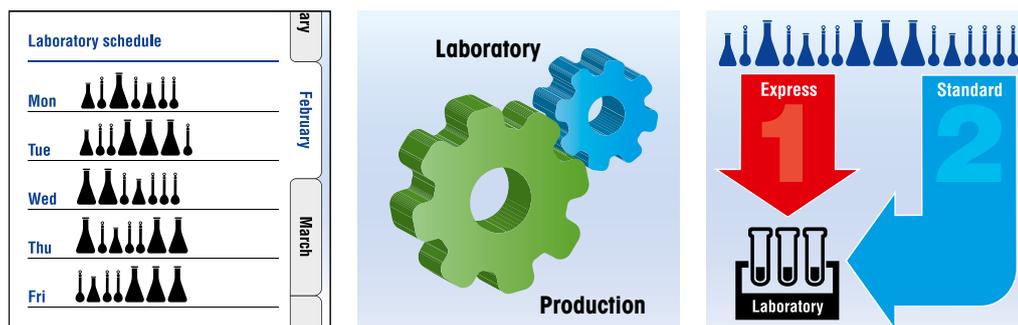
Well-established SOPs, well-trained operators, and mutually agreed-upon test-scope sheets support a leaner lab and prevent over-testing.

If over-testing becomes the norm, organizational and economic problems may arise. This drives up the cost of goods and reduces efficiency.

#### Tips for optimization

- Calculate standard times for analyses.
- Measure lead time.
- Determine what the value-adding steps are in terms of whether an external customer would pay for these steps in the workflow.
- Employ assistants or external companies for auxiliary activities (such as dishwashing, producing rinse solutions, etc.).

## 2.3 Workload – reduce waiting time



Is the workload distributed evenly over the days/week?

Yes  No

Is there a separate procedure for urgent jobs?

Yes  No

Is your workload synchronized with the previous phase (production)? Do timelines coincide?

Yes  No

Are agreed-upon deadlines being met?

Yes  No

### 2.3.1 Monitor processes

Procurement of chemicals, instruments, and equipment, and eliminating waiting time for such materials, is an optimization task for the purchasing department. However, the lab must order supplies in a timely manner and stock critical chemicals, reagents, and solvents.

Untoward incidents can be systematically avoided, such as with continuous monitoring of reagent consumption. Levels of titrant, solvent, waste, etc., can be automatically checked using level indicators (e.g. LevelSens). Such indicators can generate an appropriate warning message and trigger a timely refill, change, or procurement. In addition, Titration Excellence methods contain meters that indicate the consumption of specified chemicals through the accumulated dosed volume. If a certain amount of consumption is exceeded, a warning message is triggered.

Equipment wait time can be reduced through automation. Automatic sample changers, combined parameter measurements, and automatic data/result transfer can spare the lab technician from waiting in front of the device until a result appears. See Chapters 2.4 and 3.1 for more information regarding automation in the lab.

Nevertheless, how does the lab technician know a batch is ready? How does he or she know when there is a problem with a measurement series and intervention is required?

This problem can be solved with the help of appropriate software. Network-compatible LabX software allows the tracking of measurements even from remote office workstations. With the help of a notification function, LabX can send results or a warning message via e-mail or SMS. With proper installation, measurements can even be tracked on your smartphone.

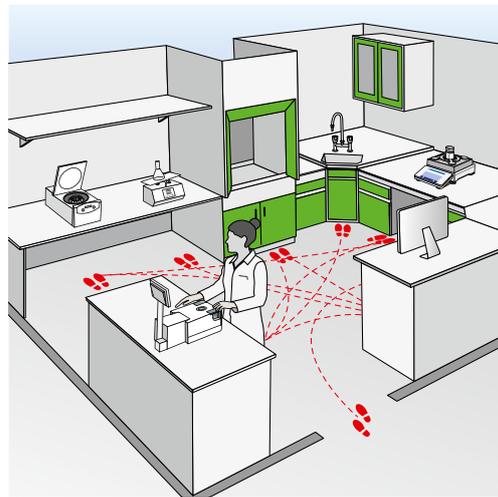
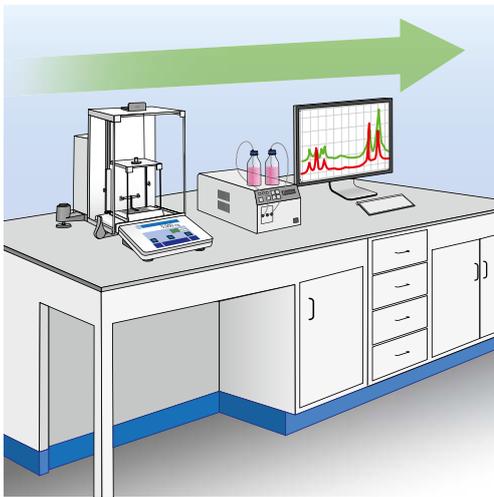
Software can also assist with the planning of analyses, more specifically through relevant task-scheduling tools (task management). This implies that individual samples are distributed to and placed at the proper instruments (titrator, density meter, refractometer, etc.) as per priorities and instrument availability.

Once scheduling has occurred, assigned lab technicians carry out the analyses. Task scheduling, as determined by requirements, can substantially increase efficiency by grouping several analyses of a sample or substance.

**Tips for optimization**

- Set helpful laboratory service hours, for example at least 6 am to 6 pm.
- Synchronize your workload with the previous phase.
- Set up an option for urgent analysis.
- Assign someone to distribute samples according to current capacity and urgency.
- Keep a workflow plan (e.g. for the HPLC or GC).
- Optimize set-up times (e.g. for HPLC or GC).

2.4 Laboratory workflow – shorten distances



Is the analytical equipment arranged in a logical sequence?

Yes  No

Is the analytical equipment consistently arranged according to technology?

Yes  No

Are the distances between individual steps in the workflow short and sensible?

Yes  No

Do the samples flow through the laboratory?

Yes  No

## 2.4.1 Movement

Wasted “motion” implies the movements of individuals, by contrast with transportation waste, which focuses on the movement of materials (see Chapter 2.4.2). Looking for data, information, or tools, or moving among equipment such as laboratory instruments, printers, or copiers, are typical cases. These movements add no value. Thus, they are waste<sup>[14]</sup>.

Strategically considering office and lab layout helps to minimize wasted movements. However, the implementation of such measures is often difficult in practice due to limited lab space, building construction restrictions, installation requirements, and the like (see figure in Chapter 2.4).

Another approach to the topic is to look for the reasons behind the movements. As an example, striving for a paperless lab eliminates the need to move to printers and file cabinets. Collecting all measurement data and results from analytical instruments with LabX software and storing them centrally on a server allows immediate access to them via any PC on the network. This approach not only saves paper and movements but simplifies the archiving process, and perhaps reduces other wastes.

## 2.4.2 Transport and long distances

This type of waste, when considered in the laboratory environment, implies unnecessary routes to pick up samples and tools or collect materials. Tools, glassware, analytical instruments, accessories, SOPs, and chemicals can be arranged in an appropriate lab location so that lab technicians and operators can avoid long transportation distances. (Personnel motion is considered a separate form of waste under Chapter 2.4.1.)

Setting up appropriate workstations in suitable and dedicated laboratory locations is another solution. Only instruments, tools, and materials required for tasks at a particular workstation should be accommodated in the immediate surroundings. This restriction helps operators to find necessary materials quickly and helps to maintain a simple and clear workstation arrangement. No searching, no distances, no distractions.

Optimization of sample flow can also contribute to reducing transport. For example, if samples are to be subjected to a series of analyses, these may be undertaken in adjacent workstations. Increasingly, analytical procedures are grouped together and combined so that in a single processing step, several parameters can be determined in parallel or in sequence. Examples of such multi-parameter systems from METTLER TOLEDO and their advantages are described in detail in further papers<sup>[2][21][4]</sup>.

An example is application of an automatic sample changer in order to determine multiple parameters of multiple samples in succession<sup>[3][4]</sup>. Automatic transmission of results also cuts down on distances<sup>[5][6]</sup>. In addition, a general trend of “near-line” stations has arisen. Analyses are carried out close to the process – where the sample is generated – and results are sent electronically to the next processing unit.

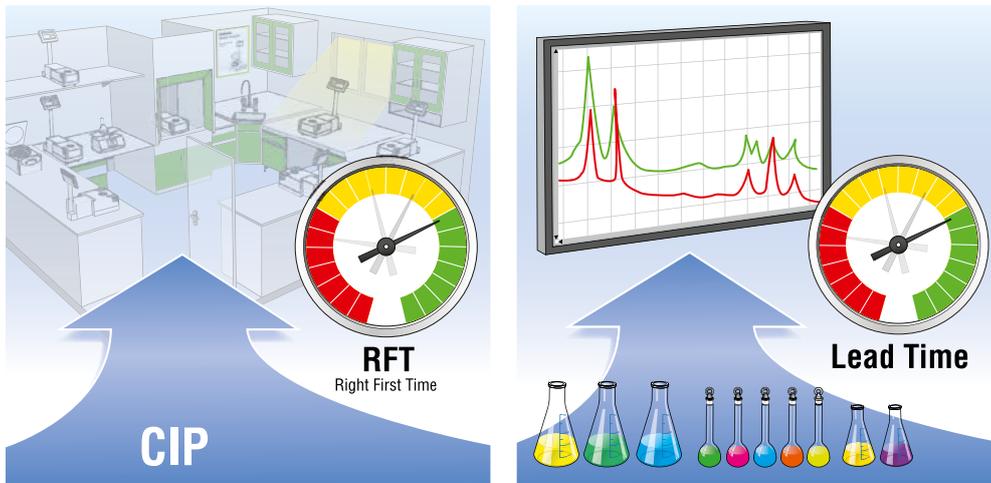
### Tips for optimization

- Optimize the travel distance.
- Arrange your analytical equipment according to technology or in work cells; it may be necessary to change the layout of the laboratory.
- When you build a new laboratory, take the unique opportunity to apply Lean principles.
- Make sure that samples flow through the laboratory.



Figure 5: A typical workstation in a Lean lab of a major customer. The yellow markings on the lab bench show the exact location of each item and the location in which it can be found. Thanks to such arrangements and standardization, even employees from other areas can quickly find their way.

## 2.5 Performance management – eliminate errors



Are the most important indicators, such as out of specification or right-first-time (OOS; RFT) results, regularly determined and used to optimize processes?

Yes  No

Are the indicators analyzed, visualized, and included in reports available to employees?

Yes  No

Can you report on productivity without investing additional time and effort?

Yes  No

Is the available laboratory capacity being managed effectively?

Yes  No

Errors in production lead to unusable goods. However, errors in the lab can lead to incorrect decisions on the production floor, causing financial impact due to claims of compensation for shortages of goods and consequent losses, customer complaints that necessitate product replacement or exchange, loss of reputation, and further damage.

Incorrect quantitative results can lead to the over-dosing of valuable substances, with negative repercussions for production costs. Insufficient dosing can result in ineffective formulation, possibly leading to recalls. Therefore, it must be ensured that lab measurements are accurate, correct, and properly documented. If analytical results are determined to be OOS, immediate follow-up investigations must be carried out, particularly in the pharmaceutical industry. In order to monitor processes and detect any inconsistencies as quickly as possible, it is important to define suitable key performance indicators (KPIs) and to review them daily. Typical KPIs are lead time and first pass rate, as they provide immediate evidence as to process errors.

Errors may arise during the transmission of measured values, rather than due to poor measurements. Errors during transcription of sample names or numbers must be systematically ruled out as well.

Transcription errors can be avoided by coupling devices together, such as connecting a balance to a titrator or using SmartSample™ RFID tags on titration beakers to electronically transmit sample weight and ID. LabX SmartCodes™ automatically assign the correct method to a particular sample, preventing errors and worry.

For secure documentation of measuring results, all devices can also be connected to a printer. Alternatively, data can be collected electronically with the help of LabX laboratory software. LabX connects to LIMS or ERP systems via a network. Results can be electronically archived without “wasted distances” and lost time and can be forwarded, for example, for production approval.

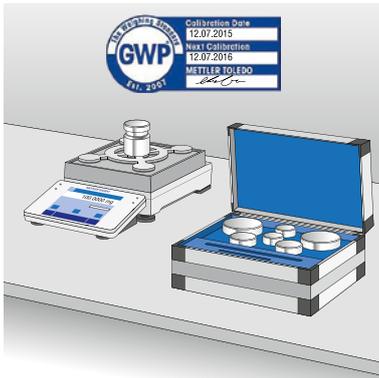
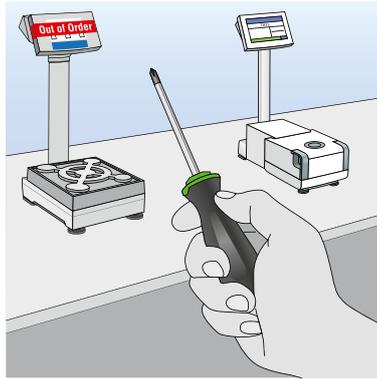
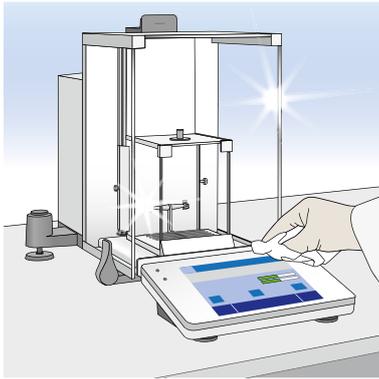
#### **Tips for optimization**

- Measure your key performance indicators (KPIs), which may include lead time and first pass rate.
- Visualize the KPIs.
- Discuss KPIs regularly with your staff.
- Ask your management for a Gemba Walk.

#### **What is a Gemba Walk?**

A Gemba Walk is the action of going to see the actual process, understand the work, ask questions, and learn, and is a fundamental part of Lean management. The Gemba Walk is designed to allow leaders to identify existing safety hazards, observe machinery and equipment conditions, ask about the standards in practice, gain knowledge about the status of work, and build relationships with employees. The objective of the Gemba Walk is to understand the value stream and its problems rather than to review results or make superficial comments. The Gemba Walk is an activity that takes management to the front lines to look for waste and find opportunities to improve the overall performance of the company.

## 2.6 Equipment – avoid defects



Is your most important equipment in top condition?

Yes  No

Are equipment capabilities and technologies adequate and regularly assessed?

Yes  No

Can calibration/qualification of the most important equipment be carried out efficiently?

Yes  No

Are replacement parts or important components managed properly?

Yes  No

Does equipment ease of operation match the level of competency and knowledge of the staff?

Yes  No



## 2.6.1 Measurement uncertainty

For proper optimization, it must be ensured that the precision of measurement results lies in the specified range. One option is to calculate measurement uncertainty theoretically, and then determine it empirically (via experimentation).

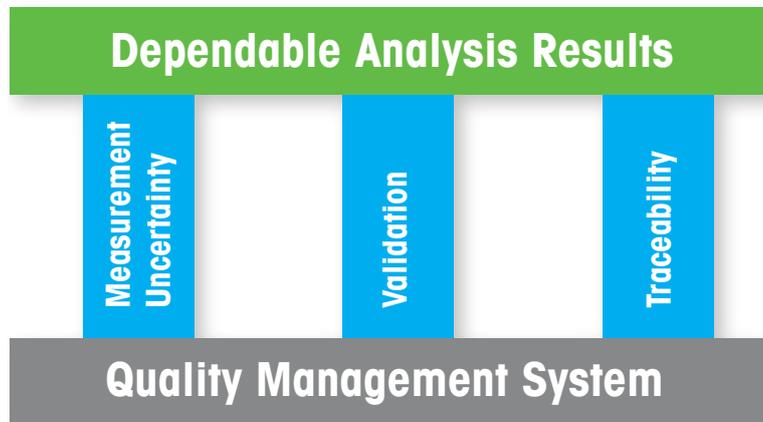


Figure 6: Measurement uncertainty is one of the three pillars for dependable measuring results in a quality management system.

Measurement uncertainty provides a confidence range for measuring results. In regulated environments, the ability to calculate measurement uncertainty must be proven and documented (ISO 17025).

Prerequisites to achieving dependable measurement results – or, in other words, a particular uncertainty – are:

- Well maintained instruments and validated methods
- Instruments certified with traceable reference materials
- Employees with adequate preparation and training

The evaluation of the confidence range allows retroactive conclusions about the lab's quality management system.

To support users, METTLER TOLEDO offers services for the calculation of measurement uncertainty.

Other examples that are outside the scope of this discussion include:

- Automatic result validation through feasibility checks or tolerance levels
- Statistical quality control (SQC) for long-term monitoring of results, early detection of trends
- Security while carrying out an analysis: self-controlling automated systems or performance checks of measuring devices, automatic calibration, and error notification

## 2.6.2 Device errors and test-equipment monitoring

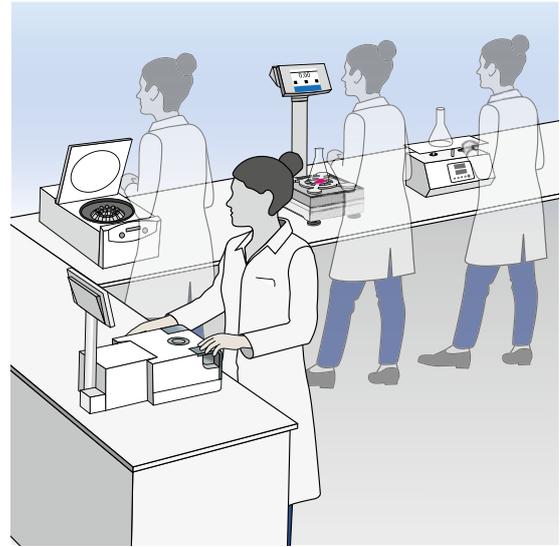
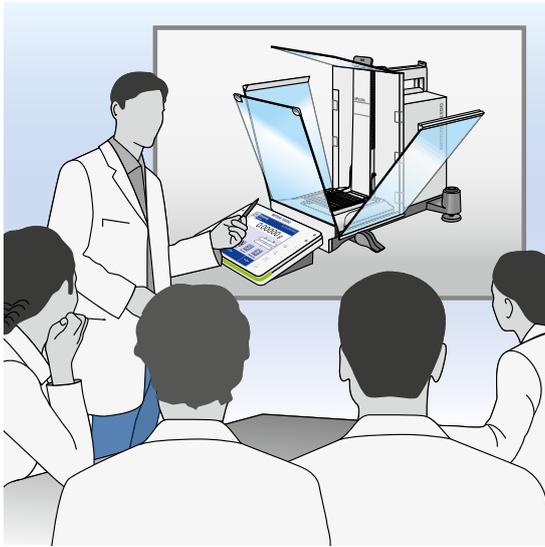
METTLER TOLEDO offers EQPacs for equipment qualification. EQPac documents comprise all necessary forms and tools for a proper device qualification (IQ/OQ) that is carried out by certified technicians. METTLER TOLEDO trains and qualifies all its service technicians accordingly.

Each certified lab has test equipment monitoring in place which also includes the regular maintenance of lab instruments. METTLER TOLEDO supports customers with service solutions that include calibration, preventive maintenance, and repair. This support is also in line with Good Measuring Practices, a program that includes a variety of measurement techniques, such as weighing, titration, and thermal analysis (see also Chapter 3.3).

### **Tips for optimization**

- Perform regular maintenance on your equipment, to ensure no, or fewer, unplanned breakdowns.
- Make sure any necessary consumables and spare parts are stored onsite.
- Automate existing systems whenever possible (such as with an autosampler or quicker data transfer).
- Practice active obsolescence management.
- Reduce sources of contamination (such as water baths).

## 2.7 Laboratory personnel skills – release untapped potential



Is there an overview stating which employees can perform which activities at what level (skill matrix)?

Yes  No

Is staff employment flexible enough?

Yes  No

Is enough time and money being spent on staff training?

Yes  No

### Untapped potential

Calling on untapped employee potential is a complex social, economic, and human topic and cannot be solved solely with technical solutions. Because of this, the topic of untapped employee potential will not be dealt with in greater depth in this guide, despite its importance. However, METTLER TOLEDO offers a variety of resources, including customer seminars and webinars, framed around this subject. For further information or to contact your closest METTLER TOLEDO representative, visit ► [www.mt.com](http://www.mt.com).

#### Tips for optimization

- Keep skill matrices, not only stating yes/no, but including details on skill levels of each employee.
- Determine how many employees can substitute for each other.
- Make enough time and money available for staff training.
- Perform regular laboratory staff fitness checks, for example, for techniques such as HPLC.
- Monitor unplanned absenteeism.

## 2.8 Chemicals and auxiliary material – manage your inventory



Are laboratory chemicals and other materials re-ordered systematically, immediately and without great expense?

 Yes  No

Are expiry dates of laboratory chemicals and reagents systematically checked?

 Yes  No

Are the inventories of reagents and consumables managed effectively?

 Yes  No

### Inventory

Inventory waste in a laboratory typically refers to:

- Overstocking of chemicals
- Stocking expired chemicals
- Keeping obsolete equipment

However, inventory waste is also influenced by equipment purchases. Unsuitable, poorly performing equipment may not meet requirements, but still requires the investment of the initial purchase. An example: To meet the user's weighing uncertainty requirements a balance of higher performance (i.e. with respect to repeatability and minimum weight) may be purchased. Or a less efficient measurement technique may be used in place of one that would generate savings, such as using a drying oven for moisture-content determination when a fast, accurate halogen moisture analyzer would perform the same measurement in minutes instead of hours.

Inventory waste also includes documents, files, data sheets, results, and reports which pile up easily in the lab (see Chapter 3.2, Data integrity). Care must be taken to clean out and discard this waste. Once these storage items are removed and data capture becomes automated/electronic, results- and information-capture becomes faster and more streamlined, as does data retrieval.



Figure 7: Overstocking of reagents as inventory waste.

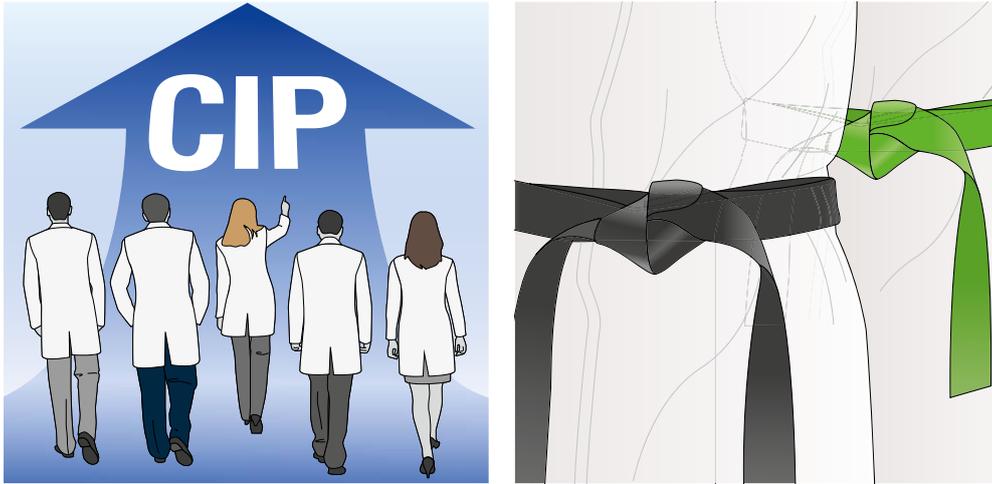
In North America, an electroplating company acquired an ion chromatograph (IC) to determine the nickel content of electrolytic baths. Such baths have a very high concentration of nickel and a highly saline sample matrix. A complex procedure is required to prepare bath samples for ion chromatography which, together with the comparatively long sample measurement, made the company's entire ion chromatography process long and complicated. In other words, the method was more susceptible to faults, and hence required more intensive maintenance.

As an alternative, complexometric titration, a robust and approved method that is very simple to automate, was recommended. In the end, the company was able to reduce quality-control efforts by at least a factor of two, which made both lab operators and company management happy and highly satisfied.

#### **Tips for optimization**

- Use an appropriate laboratory labeling system.
- Manage materials using the Kanban method (see page 35).
- Avoid excessive inventories.
- Reduce the number of chemicals and auxiliary materials used.

## 2.9 Continuous Improvement Process (CIP) activities – trust your staff



Are systematic methods such as value-flow analyses used for process improvement?

Yes  No

Are staff sufficiently involved in these processes?

Yes  No

Are there dedicated staff who have been trained in systematic process optimization?

Yes  No

### Tips for optimization

- Train staff in root cause investigation methods.
- Motivate your employees to become involved with CIP/Kaizen activities.
- Measure the progress.
- Discuss the progress and how to make further improvements.

## 2.10 Checklist analysis and feedback

Count the number of questions you answered “Yes” to, and add them up.

1–15  Yes  X

Start a Lean project in your laboratory. Start with small steps, e.g. following the 5S model. Assign a project leader who can dedicate approximately 20–50 percent of their time to this project. Analyses are also good to see where the greatest deficits lie.

16–28  Yes  X

You are on the right track, but there is still room for improvement. You may want to reclarify the question of resources or assign priorities differently.

29–36  Yes  X

Congratulations! Your lab is lean. Keep it up! Continuous improvement and follow-up are crucial. Share your knowledge with your colleagues. Your efforts should be visible in terms of costs, quality, and lead times.

## 3 METTLER TOLEDO Solutions

### 3.1 Automation

#### 3.1.1 Simplification and standardization

In this section, we deal with standardized solutions in the lab made possible by METTLER TOLEDO products. Instruments that are used for routine analysis in R&D, quality control, and production labs may include balances; titrators (including Karl Fischer), density meters and refractometers for liquids; spectrophotometers; measuring devices for melting, dropping, and softening point; and meters to measure pH, conductivity, dissolved oxygen, and ion concentration.

METTLER TOLEDO instruments have been designed for easy operation using the One Click function. They can also be controlled via LabX.

#### 3.1.2 Lab automation: Do not over-automate

The desire for laboratory automation can be overdrawn with exaggerated and expensive measures. In the 1990s, as the topic of laboratory automation temporarily enjoyed a boom, a German pharmaceutical company decided to install a laboratory robot for parallel determination of all quality parameters of a “large” product.

After a long establishment phase and the first five years of its routine application, the economic results were astonishingly sobering: The quality of the results was indeed higher than before, fewer retests were necessary, and the results were available more quickly. However, the expected, dramatic, reduction in costs had not been achieved. Expenses had actually risen.



Figure 8: Custom-built laboratory automation achieved economic efficiency only with difficulty. Savings were spent on additional expenses<sup>[7]</sup>.

Although the number of laboratory technicians involved was reduced, the complex system required new, specialized employees to ensure essential system accessibility. High investment costs required an even larger number of batches to be processed to realize savings.

The investment paid off only after a decade, and was considered largely written off<sup>[8]</sup>.

When compared to this type of customized automation, sample changers and modular analysis instruments are inexpensive. They can be implemented with low investment risk, are optimized for simple dedicated operations, and can be paid off very quickly.

### 3.1.3 Integrated “monobloc” vs. modular automation

A “monobloc” is a static predefined combination of multiple steps of analysis into one automated system. As described above, such systems are complex to maintain and troubleshoot. A failure paralyzes the whole system.

An effective alternative is single workstation automation via independent, compact instruments that are uniformly operated. Such a system becomes advantageous with respect to susceptibility to failure and downtime. It can be integrated into a flexible network and controlled/managed via intelligent laboratory software, e.g. LabX.

The individual automated instrument plus management software combination is in large part a cost-effective alternative for purchase, maintenance, and qualification. The probability that all network instruments fail simultaneously is remote compared to an integrated system in which hardware pieces are highly dependent on each other. With individual devices, bottlenecks in sample throughput, which can hinder approvals, can be avoided.

### 3.1.4 Cost of automation

The period after which an investment is actually paid off (return on investment; ROI) can easily be estimated. The so-called “payback period” is the time period required to compensate the system purchase costs with the savings achieved (e.g. economical use of chemicals, waste disposal, etc). Periodic savings are converted into annual savings. Then, procurement costs are divided via the annual savings to calculate the payback period.

Depending on sample throughput, degree of automation and labor cost savings, the ROI of equipment such as a titration system can occur typically in a few months.

#### **Calculation example: Determination of water hardness**

Work steps: Preparation of a 50 mL sample, addition of indicator and buffer, entry of sample ID, titration, sensor cleaning (here: the mirror of the Phototrode™), rinsing, and sample change.

Required labor time: For manual execution, estimated to be 39 minutes for 10 samples. Time savings thanks to automation: 34 working minutes for 10 samples. Thus, for 40 samples/day at 200 working days per year, about 450 working hours can be saved annually. At average labor costs of USD 45/hour, annual savings of USD 20,250 are achieved. Procurement costs: Between USD 20,000 and 40,000. Hence, the automated solution is compensated in less than 2 years only through reduction of labor costs, not counting improvements in the quality of results and reduced use of chemicals and production of waste.

Although this calculation holds a few uncertainties, it is accurate enough to justify the investment.

## 3.2 Data integrity

### 3.2.1 Data transcription

In the lab world, “data integrity” means that:

- Analytical results are recorded properly and are complete
- Reports are correctly transferred to the next (higher) documentation level
- Results and reports are securely and sustainably archived

Results and data may be used at a later time for various purposes, e.g. for audits or as evidence in case of an incident.

In the pharmaceutical industry, data integrity can be achieved only with high effort. Sample measurements must be done properly. Automated lab instrumentation generates reproducible results and print records that prove data integrity and validity. However, the transcription of these results in many labs is still performed manually. This takes a lot of time and is acutely error-prone.

The list of stories about transcription errors is long. Often heard comments are “In our lab we need 10 minutes to record a pH value and 60 minutes to transcribe the result to LIMS or ERP software.” Or, “Manual data transcription takes 40 percent of the lab technician’s time.” There are also high costs related to unusable batches, recall actions, and employees who have been dismissed because of improper error-handling.

Manual transcription is expensive and no longer state-of-the-art because there are more efficient solutions available. The connection of analytical instruments and meters to LIMS or ERP systems avoids transcription errors and reduces the transcription workload possibly much more than any other Lean measure in this guide.

A typical data flow in many labs before optimization may look like this: An analytical instrument generates results. Data is printed on paper records. These records are used to transcribe the numbers into reports. Reports are double-checked for errors and perhaps recalculated for plausibility. Some records require a second person to check again (the four eyes principle). Reports may also be transcribed into the LIMS or ERP system. The paper records are stored and then are scanned and stored on a server for up to 50 years.

Modern data flow solutions, on the other hand, provide automated, safe, and fast data transfer. Thus, they can contribute substantially to the leanness of your lab.

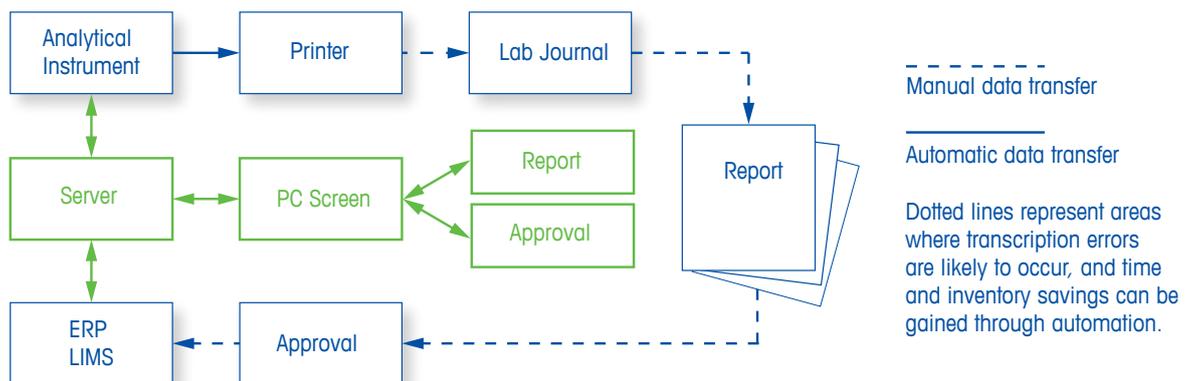


Figure 9: Data workflow in a lab. Green: Modern solution. Blue: Conventional solution.

### 3.2.2 Automated data transfer

Automatic data transfer offers significant benefits; however, its setup must be done very carefully and requires resources. Before data can be transferred automatically from an instrument to a LIMS or ERP, suitable software must be installed. Automated data transfer must be set up in a way that avoids errors and can be validated. When designing and implementing custom software, this is a significant effort that requires IT department resources and intensive testing. Hence, the process is rather expensive. However, it is also highly necessary in order to create a secure and efficient data transfer process and to avoid the risk of database corrosion.

The instruments found in a lab are very diverse and sometimes do not even have dedicated software. Nevertheless, they all create valuable data and should ideally be connected to a computer or ERP for easier control and data capture. It's important to consider the workload for initial installation and validation as well as later updates when setting up the lab.

### 3.2.3 Simplified setup

As an alternative, third-party software offers data integration possibilities. The software collects data from all instruments and transcribes it automatically to the LIMS or ERP. This is tailored software developed and built in special customer projects. The customer has only a single software package to maintain, which sounds like a simple solution.

In reality, such projects need high effort: The customer must evaluate requirements carefully and the software company must implement them. Programmers must become experts in all analytical techniques and re-engineer the algorithms. Programmers must also have good contact with all instrument suppliers to get data protocols. And this not only for the first version: Any changes must be reflected in new protocols and tested for validity. The scope of the work justifies (almost) any price.

Alternatively, there are "off-the-shelf" solutions available. Usually they are better tested and cheaper, and carry lower risk. For the world of chromatography there are a number of software solutions that integrate most chromatographs on the market and are written by chromatography experts. It makes a lot of sense to standardize all chromatography applications to one of these packages. This also reduces installation and testing efforts considerably. Typically one-third of the instruments in a modern laboratory are for chromatography.

Most labs also use balances, titrators, and pH/conductivity meters, as well as instruments for density, refractometry, and melting point. This instrument family makes up another third of a lab's equipment. Spectroscopy is also frequently applied.

METTLER TOLEDO's LabX software has the capability to connect all of these instruments to the LIMS or ERP system. However, LabX does not support other suppliers' instruments.

Data is transferred via .API, .CSV or .XML format\*. Many IT experts will not allow communication via API. However, ERP software often has XML transfer interfaces, which makes data transfer easy to program.

(\*) API = application programming interface  
CSV = comma separated value  
XML = eXtensible markup language

Hence, data transfer from LabX via .XML to the LIMS or ERP for all supported instruments is our recommendation for Lean data integration in order to:

- Save lab technicians' time
- Increase data quality (eliminate transcription errors)
- Create a system that is easy for the IT department to maintain

### 3.2.4 LabX network

With networked LabX software, setup can be further simplified. With such an arrangement, a lab needs only one PC for up to 10 instruments. The connection can be set up in such a way that up to 30 instruments can be connected to the same business server.

There is only one connection to LIMS or ERP to maintain for many instruments. Thus, the IT process is made Lean as well.

## 3.3 Good Measuring Practices

METTLER TOLEDO's risk-based guidelines for weighing, titration, and all other analytical techniques empower you to make the right decisions when and where they really matter. The five steps of Good Measuring Practices cover the entire lifecycle of your instruments and provide you with practical guidance to implement a sound quality management system.



### 1. Evaluation

Analyze your process flow and its associated criteria to consistently ensure the highest quality of your applications and data.

### 2. Selection

Choose the combination of instrument and measuring technology that best matches your process needs.

### 3. Installation & Training

Enjoy every confidence in your new device and master it with full professional skills right from day one.

### 4. Calibration & Qualification

Trust the manufacturer-trained METTLER TOLEDO Service Team when it comes to calibrating and qualifying your instruments.

### 5. Routine Operation

Benefit from tangible recommendations for optimal performance verification, calibration, and maintenance.

METTLER TOLEDO's Good Measuring Practices are available for weighing, titration, pipetting, electrochemistry (pH, conductivity, redox potential, dissolved oxygen, and ion concentration), density, refractometry, thermal analysis, melting point, dropping point, and UV/VIS spectroscopy.

► [www.mt.com/gp](http://www.mt.com/gp)

## 4 Conclusions

### 4.1 Lean: A matter of budget?

Lean Lab improvements go beyond an iterative procedure. Processes are improved in feasible steps. This is, therefore, typically a low- or no-budget process that is self-financed thanks to increased efficiency.

In pharmaceutical laboratories, which work under GLP and GMP rules, such changes are not always easy. If the process is validated, and the equipment qualified and described in the approval documentation and SOPs, changes can induce high costs and extra work which cannot be recouped in due time. In such cases one can only hope that enough scope for process customizations and improvements was given. As an example, for a specific device (analytical instrument, balance, etc.), the supplement "or equivalent" should not be omitted in order to allow for later replacement with improved devices or other enhancements.

When in-house knowledge about Lean Lab is lacking, one can try to acquire expertise via consultants. However, external advisors and consultants may not possess detailed knowledge of lab workflows, internal requirements, and company regulations<sup>[8]</sup>. Careful selection of consultants and strict cost control are musts in order to stay with the Lean idea and keep budgets low.

### 4.2 Lean Lab in small steps

The Lean Lab approach primarily involves task process optimization with the objective of improving the economic efficiency of an organization (lab, factory, company, etc.). This is mainly an internal exercise.

Lean Lab can be initiated even in small steps. Contributions must be made module by module and can be extended anytime. The main focus of METTLER TOLEDO solutions is on technical aspects such as:

- Standardized operation of different devices
- Modular device combinations
- Standardized network-compatible software
- Competent services

These include products and solutions such as automated analytical instruments, LabX software, universal One Click operation, and many features of modern balances and analytical instruments that contribute considerably to leanness and help to implement it sustainably.

<b>Eliminate Waste</b>	<b>Selected METTLER TOLEDO Contributions</b>
Invest in the right instruments and equipment	<ul style="list-style-type: none"> <li>• Consultancy for design qualification (DQ) or user requirement specification (URS)</li> <li>• Good Measuring Practices: Five steps to improved measuring results.</li> </ul> Go to: ► <a href="http://www.mt.com/gp">www.mt.com/gp</a>
Shorten transport and distances	<ul style="list-style-type: none"> <li>• LabX for data transmission</li> <li>• SmartSample: Consolidate sample weight and ID on RFID (radio frequency identification) tag at balance</li> <li>• Multiparameter solutions</li> <li>• Dedicated workstation solutions</li> <li>• Automatic sample changers</li> </ul>
Eliminate waiting time	<ul style="list-style-type: none"> <li>• Workflow automation</li> <li>• Notification (LabX Mail)</li> <li>• LevelSens (level indicator for solvent utilization)</li> </ul>
Simplify complex processes	<ul style="list-style-type: none"> <li>• Simple methods</li> <li>• Easy operation (One Click)</li> <li>• Standardized operation (common interface)</li> <li>• Standardized software (LabX)</li> <li>• Modular systems with standard automation solutions</li> <li>• User guidance</li> </ul>
Reduce operator movement	<ul style="list-style-type: none"> <li>• LabX: Test data stored on server instantly available</li> <li>• Multiparameter solutions</li> </ul>
Eliminate errors	<ul style="list-style-type: none"> <li>• Electronic data transmission (printer or LabX)</li> <li>• Feasibility checks (e.g. bubble check via sample oscillation as well as video view for density meters, automatic multiple measurement with maximum allowed standard deviation)</li> <li>• Secure sample-data flow with SmartSample</li> <li>• Safe, automatic method selection with SmartCodes</li> <li>• Instrument check (monitoring test equipment, EQPac)</li> <li>• Calculation of measurement uncertainty (MUPac)</li> <li>• Plug-and-play accessories and Intelligent Sensor Management (ISM®) sensors</li> </ul>
Reduce waste/disposal costs	<ul style="list-style-type: none"> <li>• Warning messages to smartphone (LabX Mail), allowing early intervention in case of errors</li> <li>• Level indicators for solvent utilization (LevelSens)</li> <li>• Optimization of titrant use</li> <li>• Fine dosing through precise burette unit</li> <li>• Automatic cleaning (pulsed, 1 or 2 solvents)</li> <li>• StatusLight™ (indicates if instrument is ready/ok or needs corrective action)</li> </ul>

Table 2: METTLER TOLEDO solutions for the elimination of waste.

## 5 Lean Lab Product Examples

### Titration Lean Lab setup – example 1

Titration Excellence • T5 Excellence titrator, including burettes and burette drives

InMotion™ autosampler Complete setup including:

- Electrode
- Propeller stirrer
- Rinsing pumps
- Rinsing bottle
- Waste bottle
- Titrator connection cable

Titration beakers  
(e.g. 100 mL polypropylene beakers)

Safety gloves (1 box)

Soft tissues (1 box)



### Titration Lean Lab setup – example 2

Titrator EasyPlus™ pH Complete setup including:

- Burette
- Reagent bottle
- Electrode
- Titration stand/magnetic stirrer

Titration beakers  
(e.g. 100 mL polypropylene beakers)

Rinsing bottle (deionized water)

Safety gloves (1 box)

Soft tissues (1 box)



### Density Lean Lab setup

Density meter • D4, D5, or D6 depending on required resolution and measuring range

Barcode reader

Waste syringe and waste bottle

1 or 2 rinsing bottles depending  
on required rinsing solvents  
(e.g. deionized water, ethanol)

Safety gloves (1 box)

Soft tissues (1 box)

Waste box



### Refractive Index Lean Lab setup

Refractometer	• R4 or R5 depending on required resolution and measuring range
Barcode reader	
1 or 2 rinsing bottles depending on required rinsing solvents (e.g. deionized water, ethanol)	
Safety gloves (1 box)	
Soft tissues (1 box)	
Waste box	



### Weighing Lean Lab setup

Analytical balance	• MS204TS
Additional draft shield: Swap draft shields for quick cleaning. Always have a clean draft shield ready.	
Barcode reader	
Printer	
Spatula	
Safety gloves (1 box)	
Soft tissues (1 box)	



### pH Meter Lean Lab setup

pH meter	• SevenCompact™ S220 pH meter including sensor stand and ISM sensor
Calibration buffer bottles (depending on requirements, 2–5) and beakers	
Rinsing bottle (deionized water)	
Barcode reader	
Printer	
Safety gloves (1 box)	
Soft tissues (1 box)	



## 6 Recommended Literature

Lean Lab Checklist, white paper, METTLER TOLEDO, 30249603B, ©01/2018

Titration Automation Guide, METTLER TOLEDO, 30452157, ©11/2017

Data Integrity Guide: Secure your measuring processes with LabX software, METTLER TOLEDO, LAB00434B, ©07/2019

Safer Food Production – Lean Manufacturing and Due Diligence, white paper, METTLER TOLEDO Safeline, SLMD-UK-WP-EN, ©08/2013

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## 8 Abbreviations

5S/5A	Workplace organization method, Japanese: Seiri (sort), seiton (set in order), seiso (shine), seiketsu (standardize), and shitsuke (sustain)
CAPEX	CAPital EXpenditure
CIP	Continuous Improvement Process
Cpk	The process capability indices Cp and CpK are parameters used in statistical evaluation of a process in production technology
DLZ	Lead time, German: Durchlaufzeit
ERP	Enterprise Resource Planning, eg. SAP
Gemba	Japanese term meaning “the actual place” or “the real place”: the place where manufacturing takes place or a service is provided
Kanban	Scheduling system for lean and just-in-time (JIT) production
LIMS	Laboratory Information and Management System
MES	Manufacturing Execution System
Muda	Japanese word for a pointless activity = waste
Obsolescence Management	Ensures that discontinued components of products are replaced promptly with suitable alternatives, or otherwise are specifically stockpiled
OEE	Overall Equipment Effectiveness
OLE	Overall Laboratory Effectiveness
OOS	Out of Specification
OPEX	Operational Excellence (a term of Lean Laboratory and production), Operational EXpenditure (a term of business economics)
POBOS	Pharma Operations Benchmarking (McKinsey & Company)
Poka Yoke	Prevention of unfortunate errors
RCI	Root Cause Investigation or Analysis
RFT	Right First Time
Six Sigma	A set of techniques and tools for process improvement
SMED	Single Minute Exchange of Die = set-up time optimization
TPM	Total Productive Maintenance
TPS	Toyota Production System
WIP	Work in Process

## 9 Acknowledgments

Our thanks go to all the internal and external Lean Lab experts who contributed to the creation of this comprehensive and helpful guide. In particular, we would like to thank Christoph Jansen of METTLER TOLEDO, and Erwin Studer, consultant and partner at PROFACT AG, each of whom has provided invaluable content and real life Lean Lab examples.

# Make Your Laboratory Lean

## For Efficient and Simplified Processes

**Make Lean a part of your company culture with METTLER TOLEDO's resource collection. With checklists, webinars, guides, and more, we help you to streamline and refine your workflows. Learn how an iterative approach can reduce the eight wastes and boost productivity – so that effort invested continues to pay off over time.**

The Lean approach provides a framework for how to organize physical spaces, digitalize records, coordinate interlinking process steps, and leverage employees' skills and knowledge. Calling for thorough understanding of operations and a critical, continuous assessment of inefficiencies, it helps you to navigate the pathway to improvement. METTLER TOLEDO's resources can support all stages of the Lean journey, benefiting beginners and those well along the way alike.

- Ease in gently with webinars: learn the principles of Lean and how METTLER TOLEDO applies them to its own production. Then discover how to undertake value stream mapping, with practical examples to achieving efficiencies.
- Conduct a guided assessment with our checklists. Perform a self-audit: consider how the eight wastes might be affecting your processes; identify how to implement 5S in your lab – and how to keep it going.
- Consolidate and reflect on your knowledge: explore our guides for further details of the Lean approach, and METTLER TOLEDO's solutions to reduce bottlenecks.



Browse the knowledge resources:

► [www.mt.com/Lean-Lab](http://www.mt.com/Lean-Lab)

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For more information

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