
# The Lean Laboratory
# Kaizen Institute Consulting Group

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**Master Dissertation Project**

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*"What we become depends on what we read after the professors are finished with us. The greatest university of all is the collection of books."*

*Tomas Carlyle* -

*"Inspiration does exist, but it must find you working"*

*Pablo Picasso* -

## ABSTRACT

Lean is a common term that roots back to the manufacturing environment of Toyota. However, during the last decade it has started to widen its meaning by attaining a sustained applicability in the service domain. Lean in laboratories is surely one of the most recent areas to undergo its transformational effects. The laboratory is an institution with its particular characteristics, once it has to be looked at from several perspectives: (1) Organizational, (2) Scientific and (3) Directive, turning it a defying challenge for any manager.

Unilabs Switzerland was facing serious problems and compromising their position in the healthcare sector when it was decided upon to embrace a Lean Project in collaboration with The Kaizen Institute. The challenge was to improve the service level by regaining the customer's confidence, reducing lead time, and eliminating complaints and errors. Most importantly, it was the need to react to the newly released legislation by the Swiss Government that decided to cut in approximately 20% the analytical test price index. Unilabs did in fact know where to go and had a clear idea about the results it should accomplish in the long-term, but it needed the expertise and knowledge that only a Lean expert could provide, in order to define clearly the path that would lead to success. The Kaizen Institute bases its practices on a solid ground and has achieved excellence in leading change through people involvement and training.

Through specific workshops and by involving everyone in the organization, Kaizen performed specific actions that aimed the transformation of people's paradigms and mindsets. Only if people are trained and empowered throughout the Lean journey can it result in a winning outcome. Based on the universal nature of the Lean Principles and the effectiveness of the Kaizen Systems, the work developed at Unilabs had a deep, positive impact and results are increasingly visible.

The tools underlying the improvements lead by the Kaizen Institute are based on an essential model: The Kaizen Management System (KMS). It contains structured problem-solving tools that enable the creation of basic stability in the working environment, but also, specialized instruments that facilitate the resolution of more complex problems. Above all, it includes the Total Change Management System, an essential cornerstone of the KMS to achieve success through Lean.

Ultimately, the Kaizen has not merely lead improvement initiatives, but granted the basic stability to create the necessary conditions for a sustainable future. This project has produced interesting results and proven well that the future of Unilabs invariably flows through the Kaizen practices, but other innovative initiatives have been followed: E-Lab and E-Prescription, concepts designed for the future, where laboratories operate ideally and waste free in a highly automated and computerized environment. This raises a very particular question that will also be addressed: are information and automation systems infallible means towards Lean?

This area undoubtedly hides a great potential, because healthcare necessarily concerns people's health, their fundamental right. It is imperative to grant efficient, waste-free and productive institutions, private or public, to guarantee adequate service levels. The future dictates a future that includes Lean as a fundamental part.

This project presents the specific reality surrounding laboratories, the Lean Principles and the Kaizen methodologies, and ultimately, proves its success by presenting tangible results achieved, through people, at the Unilabs laboratories.

## RESUMO

Lean é um termo que encontrou as suas raízes no sector da manufactura e está inevitavelmente ligado à Toyota. Ao longo das últimas décadas encontrou a sua aplicação no sector terciário e está em forte expansão. Lean no laboratório, é sem dúvida, um dos domínios mais recentes a sofrer os processos de transformação desta filosofia. Possuindo características verdadeiramente únicas e sendo o seu funcionamento determinado por três grandes vectores, (1) Organização, (2) Ciência, e (3) Direcção, o laboratório, constitui um desafio singular para a sua gestão.

Unilabs Switzerland enfrentava problemas sérios, capazes de comprometerem a sua actual posição de mercado, quando decidiu entrar numa parceria estratégica com o Kaizen Institute. O desafio consistia em aumentar o nível de serviço, passando pela recuperação da confiança dos clientes, a redução do *lead time* e eliminação de erros e falhas internas. No entanto, a verdadeira dificuldade dependia em reagir a uma lei, recentemente promulgada pelo Governo Suíço, que dita uma redução de aproximadamente 20% do nível geral dos preços das análises clínicas. A Unilabs sabia, de facto, quais os objectivos que pretendia alcançar no longo prazo, mas desconhecia algo que apenas um especialista no domínio Lean poderia providenciar, nomeadamente, o caminho que era necessário percorrer para alcançar o sucesso. O Kaizen Institute baseia as suas práticas em conhecimentos sólidos e atinge a excelência na gestão da mudança, através do envolvimento das pessoas e da formação.

Através de workshops e envolvendo todos os recursos humanos da organização, conseguiu-se agir sobre os paradigmas que afectavam a percepção das pessoas relativamente à sua situação real de trabalho. Apenas apostando em treino e responsabilizando as pessoas envolvidas, se podem alcançar desfechos positivos. Baseado nos princípios universais Lean e a eficácia dos sistemas de gestão Kaizen, iniciou-se um trabalho que começa já a produzir sinais visíveis de melhoria.

As ferramentas que sustentam qualquer iniciativa de melhora contínua, implementadas pelo Kaizen Institute, estão contidas no seu próprio modelo de gestão: Kaizen Management System (KMS). O KMS contém ferramentas estruturadas para a resolução de problemas simples, mas também, metodologias específicas para situações mais complexas. Acima de tudo, possui um sistema essencial à concretização de um projecto sustentável: o Total Change Management.

Foi fundamental para o Kaizen Institute de garantir não apenas melhorias imediatas, mas a realização de um projecto realmente sustentável no longo prazo. O projecto produziu resultados interessantes que invariavelmente ligam o sucesso da Unilabs às práticas aportadas pelo Kaizen, mas outros conceitos interessantes também foram analisados, como o E-Lab ou o E-Prescription. Ideias inovadoras e que determinam o laboratório do futuro, totalmente automatizado e desprovido de qualquer ineficiência. Coloca-se então a questão, e que também será abordada, se a automação e informatização constituem caminhos inevitáveis na procura do cenário Lean ideal.

A área em discussão esconde, sem dúvida, um grande potencial. O acesso a um serviço de saúde de qualidade constitui um direito fundamental do cidadão. É vital que se desenvolvam esforços no sentido de implementar a cultura Lean no sector da saúde, privado ou público.

Este projecto descreve a realidade específica que determina o funcionamento dos laboratórios, aborda os princípios Lean e as metodologias desenvolvidas pelo Kaizen Institute, e finalmente, prova o seu sucesso ao apresentar os resultados concretos atingidos, apenas conseguidos através do envolvimento das pessoas, nos laboratórios suíços da Unilabs.

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Constituting this work the brink of a long journey at the Faculty of Engineering, I would like to express my deepest appreciation to Professor Bernardo Almada Lobo who supported me in many critical moments of my academic development.

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# *Content*

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# CHAPTER 1

## 1. INTRODUCTION

This work results out of the collaboration between The Kaizen Institute Consulting Group and health care provider Unilabs. Unilabs currently owns over twenty laboratories in entire Switzerland after having completed a major acquisition operation. The market is highly competitive and newly released state legislation turns challenges for this company even harder. Top management, as well as operational employee levels, share the goal to improve business processes, increase productivity and ultimately become market leaders. During this journey, The Kaizen Institute will provide the necessary training and tools to achieve those goals. Through a series of diagnostic, educational, and practical workshops, as well as constant support and follow-ups, performed by The Kaizen Institute, Unilabs will manage to become a lean enterprise and spread the Kaizen culture among all their employees.

The goal of this project is to analyze the laboratories' current situation and spot improvement opportunities, as well as, start the implementation phase that aims for waste reduction and process optimization. The duration of this project was short compared to the long-term vision between The Kaizen Institute and Unilabs. The laboratories are still undergoing deep transformations and only specific initiatives have been totally concluded. This work will focus on those accomplishments and on the possible future state of the laboratories. Ultimately one will try to explore what a lean laboratory could look like and on what principles it is based upon.

From specific laboratory reviews that allowed one to understand the specificities of its environment, to information exploring the principles of lean and continuous improvement, one exploited a solid base of literature that served well the purpose of this project. It was important to understand the challenges of managing a laboratory before trying to frame them under a continuous improvement philosophy.

## 1.1. UNILABS SWITZERLAND PROJECT

Unilabs is currently a Pan-European healthcare provider owning diagnostic laboratories, specialized in several domains such as, Clinical Chemistry, Hematology, Immunology, Genetics, and Microbiology, in over ten countries. Its strong presence all over Europe is due to an aggressive expansion strategy lead by the Swedish health care group, formerly called Capio Diagnostics. This work will focus mainly on Switzerland, where Unilabs established its headquarters and got hold over the existing facilities. The main laboratories are located in Geneva, Lausanne and surrounding areas, Bern, Zurich, St. Gallen and Lugano. It is a network of separate but interacting units covering the entire country.

A major challenge this institution faces in Switzerland is a new legislation (*Labortarifsenkung*) [1] announced by the Swiss government early this year and that will be released July 1st 2009. The price index per type of analysis will be significantly lowered (approximately 20%) in order to balance public expenses and the affected laboratories, which strongly depend on public healthcare institutions, started already to prepare for this change. But there are other concerns for Unilabs as well: loss of market share, increasingly unsatisfied customers, low productivity levels, obsolete facilities and a high level of "avoidable" costs. The fast organic growth of the group caused some internal turbulence and heterogeneities. In every laboratory one witnesses different practices and methodologies, a diverse internal organization, or incompatible interacting mentalities among the numerous facilities. This means that Unilabs is not able yet to apprehend the level or quality of the rendered services, nor understand their processes to a deep extent. Ultimately, the fact that the "new" Unilabs started as an agglomerate of separate units, some with narrow and familiar business practices, turns this mission even harder. The entire group has necessarily to strive towards common goals and an aligned action.

[1] *The Swiss healthcare counselor Pascal Couchepin foresees, with the proposed policy, a yearly reduction of 200 million Swiss Francs (in a total of thousand million). This initiative resulted out of the revision of a price index created in 1990 that did not fit the current scenario. This policy is to be introduced from 1st of July 2009 and obliges anyone that performs clinical analysis (medical offices, hospitals and laboratories) to an average decrease of 21% for each type of analysis. This is also the cause behind the decentralization of analysis currently performed at doctors' offices to professional laboratories due to its low profitability when performed in low volumes.*

## 1.2. PROJECT GOALS

The first visits to the laboratory facilities revealed immediately several symptoms of unproductive behavior: (1) Material Waiting that contributes for increased turnaround times, (2) People Waiting not adding any value to the process, (3) People Moving loosing time and energy unproductively, and (4) Lack of 5S or Visual Management. The working environment displayed a relaxed attitude and neither active monitoring initiatives, through the use of indicators and charts, nor a continuous improvement culture, were existent.

The global project goals established can be summarized as follows: (1) Improve Productivity by 20% to reinforce competitiveness in foreseeable harsh market conditions, (2) Improve Quality of Service, (3) Improve other Cost Drivers, like Inventories and CAPEX[2] through better equipment utilization, and (4) Involvement and Development of People through Continuous Improvement Systems and Initiatives.

This project was divided in three phases. (1) Phase 0: Preparation and Alignment of Targets; (2) Phase 1: Foundation Seminar, Value Stream Design Workshop, Pilot Workshops; and (3) Phase 2: Deployment Workshops. Phase 0 has been concluded. Phase 1 activities are currently being performed at the group's various laboratory facilities. However, Pilot Kaizen Workshops are at a very initial phase. Due to the large dimension of this project and the wide geographical, cultural, as well as, managerial spectrum, all activities are moving forward at a relatively moderate pace.

TABLE 1- GLOBAL PROJECT OVERVIEW

| | | | | Phase I | | | | Phase II |
|---|---|---|---|---|---|---|---|---|
| Entreprises | Production | Logistics | Other | Kaizen Foundations Seminar | Value Stream Design Workshop | Pilot 1 Kaizen Workhop | Pilot 2 Kaizen Workhop | Deployment Workshops |
| COPPET | 97 | | 46 | 1 | 1 | 1 | 1 | 4 |
| MITTELLAND | 86 | 3 | 16 | 1 | 1 | 1 | 1 | 4 |
| ST Gall | 78 | | 49 | 1 | 1 | 1 | 1 | 4 |
| ZURICH | 47 | 3 | 9 | 1 | 1 | 1 | 1 | 3 |
| SECHERON | 36 | 27 | 5 | 1 | 1 | 1 | 1 | 3 |
| RIVIERA | 35 | 7 | 4 | | 1 | 1 | 1 | 3 |
| ZLZ | 33 | | 4 | 1 | 1 | 1 | 1 | 3 |
| LUGANO | 33 | 10 | 15 | | 1 | 1 | 1 | 3 |
| LAUSANNE-CYPA | 24 | | 5 | 1 | 1 | 1 | 1 | 2 |
| CAROUGE | 23 | | 6 | | 1 | 1 | 1 | 2 |
| LAUSANNE | 23 | 9 | 10 | | 1 | 1 | 1 | 2 |
| MEYRIN | 22 | | 2 | | 1 | 1 | 1 | 2 |
| CHAMPEL | 17 | | 4 | 1 | 1 | 1 | 1 | 1 |
| NEUCHATEL | 10 | 5 | 1 | | 1 | 1 | 1 | |
| VALAIS | 10 | 4 | 2 | | 1 | 1 | 1 | |
| CLT | 10 | 8 | 3 | | 1 | 1 | 1 | |
| IMAGERIE DU FLON | 9 | | 3 | | | 1 | | |
| NATILAB | 6 | | 0 | | | | | |
| FERTAS | 6 | | 1 | | | | | |
| ROLLE | 5 | | 0 | | | | | |
| DR ANDRES | 3 | 2 | 0 | | | | | |
| BIOMEX | 1 | | 0 | | | | | |
| GNT | | | 24 | 1 | 1 | 1 | 1 | |
| UMS | | | 52 | | 1 | 1 | 1 | |
| | | | Teams | Managers | Managers | Multiskills | Multiskills | Multiskills |
| | | | # Workshops | 9 | 18 | 19 | 18 | 36 |

[2]*Capital expenditures (CAPEX) are expenditures creating future benefits. Examples of CAPEX are: (1) Acquiring fixed assets, (2) Starting a new business, or (3) Legal costs of establishing or maintaining one's right of ownership in a piece of property (in Wikipedia).*

Table 1 includes all the laboratories currently owned by the group and its characteristics (Production, Logistics, and Other) and indicates the predicted activities to be performed until the end of the project.

It is important to underline that despite the existence of parallel global goals it is the project goals that will be fundamental for this work. Based on the project schedule, the global project goals, as well as, the conditions agreed upon by both, Unilabs and The Kaizen Institute, one can summarize the goals of the dissertation project into theoretical and practical goals.

The theoretical goals are:

(1) Deepen the understanding about Lean Thinking and the Kaizen Management System (KMS), including its tools and methodologies;
(2) Create a general picture about laboratories and understand its role and functioning;
(3) Create a link between the Lean/Kaizen philosophy and the current reality of laboratories and explore the concept of Lean Laboratory.

The practical goals are:

(4) Elaborate the laboratory's current state map;
(5) Spot improvement possibilities based on identified sources of waste, lack of flow, and unproductive behavior at the laboratory facilities;
(6) Initiate short-term initiatives and report the transformation/improvement process;
(7) Describe future transformation/improvement initiatives, as well as, present existing concepts about long-term improvement projects.

The ultimate goal is to achieve sufficient theoretical knowledge in order to address the current challenges faced at the laboratory facilities creating new approaches and sustainable solutions.

The Kaizen Institute will base its activities on the Kaizen Management System and implementation will occur through Gemba Kaizen Workshops. It is important to note that due to lack of time and the extended duration of the project most of the improvement initiatives will be conceptual rather than factual.

## 1.3. SYNOPSIS

This work is structured in three main parts: (1) Literary Review, (2) Implementation, and (3) Conclusions.

In chapter 2, the theoretical foundations for the entire work are presented. The Lean Principles and the Kaizen Management System are explained in detail, as well as their complementary functions. Although the Kaizen Management System implicitly contains the Lean Principles it was important to present both, compare them, establish the connection between them, and elucidate about their differences. Despite entitling most of the improvement initiatives as Lean, success is only granted when one considers the key aspects hidden in the Kaizen methodologies. Furthermore, one will look closely at the laboratory as an institution and reveal what external and internal factors challenge

and limit its management. Then, with a clear picture of what a laboratory is, it will be reflected upon the nature of a Lean Laboratory.

The third chapter is divided in three specific sections. Their content was developed within the following three topics: (1) Improvement Concept, (2) Improvement Implementation, and (3) E-Lab. First three examples describe how the different laboratories were approached during this project and, depending on their initial state, what future state concept was elaborated, as well as the predicted activities to be performed. Secondly, concrete and real improvement initiatives are described. The principles, methodologies and tools presented in the theoretical chapter will effectively be applied during these improvement activities. At last, the concept of Lean is brought a little further, and due to the very particular characteristics of the Swiss Health Care System, the concept of E-Lab is introduced.

The last chapter will resume the previous content offering a subjective and personal view about it. Reflections about the potentials behind the techniques applied to improve the laboratories, their eventual disadvantages and, in the author's opinion, their core and fundamental aspects, are shared. Finally, to conclude, one will take a look at the future. Lean principles are being applied widely, in laboratories, hospitals and other service providers, and currently, the world is facing serious challenges in Health Care. Could Lean and its principles, and the Kaizen methodologies be a solution to the current practices and offer a viable alternative?

# CHAPTER 2

## 2. LITERARY REVIEW

Continuous Improvement (CI), a generic term that encompasses any effort, methodology, or philosophy that aims for the constant and cyclical improvement of business habits, practices or processes, has its roots in de mid 20th century, catalyzed by both the American and Japanese industry. Although it was the Japanese to make this philosophy flourish, it was the Americans that served as their catalyzing force: Henry Ford who was the first to introduce mass production, Deming who was a renowned statistician, consultant and lecturer, who made lasting contributions to the studies of quality, and Juran, who looked at the vital importance of the human aspects behind continuous improvement. These individuals had influence in the Japanese industrial environment and inevitably spurred their fast development. At present times it continues to inspire people and businesses, crossing economic sectors and spreading relentlessly. Its application has started to become increasingly important also in the service sector: *lean* in banks, insurance companies [Imai, 1997] or health care providers, is growing rapidly, and despite being in an early expansion phase with growing acceptance visible improvements have already been produced. Lean laboratories are among those newcomers, achieving "the better" through Continuous Improvement, and constituting an important stage before the usual automation process is chosen. It is important to remember that, continuous improvement is not a simple application of a wide set of rules, it is a culture that is lead, performed and achieved through people.

Throughout the next sections of this chapter one will explore specific topics. In the first part, the concept of Lean and its meaning will be explored. Lean can be summarized in five principles that have a tremendous importance. However, one will rapidly understand that it lacks in sustainability. The Kaizen Management System will investigate this topic in the second part. The final section will come closer to the reality of laboratories by first, explaining the functioning and the challenges of an ordinary

laboratory of clinical chemistry, and secondly, attempting to approach the concept of Lean Lab by integrating all the previously presented information.

## 2.1. LEAN THINKING

Soon after the destructive and recessive effects of the 2nd World War, the Japanese were eager to transform themselves into an economic power; that might be at the heart of their very success. Japanese auto-manufacturer Toyota was the first notable concurrent to appear. It strived to create new working methodologies, opposed to the American mass production, batch and queue methodology. As one can witness, it granted its long-term competitive success until today.

Henry Ford (and later, Sloan) addressed the challenges posed by craft production and revolutionized it in the early 20th century by introducing mass production to the manufacturing world [Urbance]. Ford's vision increased productivity levels dramatically but left some matters unsolved that neither his successors could tackle. Mass production had its shortcomings, such as, little or no communication between divisions, lack of coordination, large buffer inventories, quality problems, product design decisions that were unaware of manufacturing limitations. After all, at that time, it was the standard way of working and no one was willing to change. Japanese manufacturers from Toyota, aware of all those limitations, spotted a clear opportunity of improvement and created an alternative ideology called the Toyota Production System (TPS) [Imai, 1997], the predecessor of Lean Production. The main goal was to achieve a total systems view focusing on processes rather than hierarchical structures or rigid departments. Toyota focused on strengthening relations with customers and suppliers being therefore able to synchronize the entire supply chain. Ultimately, through people empowerment, waste elimination and focused problem solving, they achieved high motivation levels, a smooth production flow and quality products. All conditions were set for them to grant continuous improvement and increasing success.

The Japanese production system rapidly gained importance and followers all over the world. It was authors like James P. Womack and Daniel T. Jones [Womack, 2003], or Masaki Imai [Imai, 1997], which contributed largely to the dissemination of this philosophy. What used to be privileged information can nowadays be accessed unlimitedly through a vast collection of books, publications or the internet. Success through lean, however, is not a reality for most companies. But, before asking ourselves, what still is the missing link for global companies to successfully apply these techniques, we have to clarify the principles behind Lean.

Lean Thinking is about attacking *muda* (a Japanese word for waste or any activity that does not add any value) because waste can be found to a large extent in any organization. The difficulty, however, is to be able to identify waste. It exists in various forms but neither of them is desirable: (1) Defects, (2) People waiting, (3) People moving, (4) Too much processing, (5) Material waiting, (6) Material moving, and (7) Too much production. When presenting *muda* one should also mention *mura* and *muri*, two other types of undesirable phenomena. The table below presents a brief summary of this concept based on [Coimbra, 2009].

TABLE 2 – TYPES OF WASTE

| | | |
|---|---|---|
| **Muda** | *Waste* | |
| ***Defects*** | | Defects or scrap represent waste and internal, as well as, external failures of quality have to be considered. |
| ***People waiting*** | | People waiting are not adding any value. |
| ***People moving*** | | While excessively moving people are not adding any value. This is often due to deficits in layout and workstation organization. |
| ***Too much processing*** | | Redundant or repeated activities are often missed. Operations can be simplified and/or integrated reducing the amount of necessary steps for its completion. |
| ***Material waiting*** | | Commonly known as stock or inventory. While material is waiting no value is being added and the invested capital is standing still. |
| ***Material moving*** | | While material is being moved no value is being added and no transformation is happening. |
| ***Too much production*** | | This refers to excessive inventory and the same reasons as before for material waiting apply. It normally happens due to errors in forecasting demands and production or an unbalanced production. |
| **Mura** | *Variability* | Represents lack of stability and reliability. |
| **Muri** | *Difficulty* | Stands for the concept of time and energy loss. Examples are bad ergonomic positions, waste of energy, and a risk of injury. |

It is frequent to witness organizations where people working on the shop floor loose time performing unnecessary activities, excessive inventory exists, or final products have to be re-worked or thrown away. Muda symbolizes money thrown straight into the waste basket and has to be eliminated persistently. Lean is about cutting on waste and focusing on value. As stated in "Lean Solutions", by James P. Womack and Daniel T. Jones [Womack, 2005], it is the result of a series of actions conducted properly in the correct sequence at the right time to create value for customers. In short, lean thinking is *lean* because it provides a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers with exactly what they want [Womack, 2003].

There are five principles that sustain the lean perspective: (1) Specify Value, (2) Identify the Value Stream, (3) Flow, (4) Pull, and (5) Perfection [Womack, 2003].

When it comes to defining value we have to be able to look through the customer's eyes and express it as the exact product or service that he wants. Knowing what the customer wants means also delivering what he is ready to pay for. Therefore, it is fundamental to complete this step successfully, because even if we delivery the product or service right way it will not necessarily guarantee the customer's satisfaction, and is to be considered *muda*.

Focusing on the value stream is the next step. Usually one depicts every single stage of the value stream, using a technique called the "Value Stream Mapping", and identifies parts that can be eliminated, integrated or modified. It is an important exercise that forces one to think about the current processes and ways of simplifying them. If possible, one should not limit this analysis to the firm's borders and could also include suppliers and customers.

Once we have isolated and reorganized the value creating steps it is important to create flow. This means breaking old habits and paradigms such as producing in batches, thinking purely in efficiency or maintaining separate departments. Creating flow in the entire supply chain allows to produce several product families, in small lots and volumes and to be flexible upon a constantly varying demand, and ultimately, to accomplish the next principle. After having implemented the first three steps successfully lead time will fall and allow faster deliveries. Consequently, rather than pushing towards the customer, they will pull the product or service themselves and still get it delivered on time.

By now the company's value stream is lean and flexible and there is only one link missing for this system to be sustainable: perfection. The lean principles constitute a never ending cycle of continuous improvement, and as important as the first four steps, are the enduring habits of continuously improving our current state.

Over the last fifty years, Toyota still masters its continuous improvement philosophy and ranks among the top enterprises in the world. There are examples of companies that have managed to implement similar methodologies, others have achieved only short-term success, and failure was many times the case. "How do we do it?" is often the question because businesses do not know what to do beyond the mentioned principles or a bunch of other tools, such as 5S, Kobetsu Kaizen, or SMED, and fail to understand that attention has to be paid to the human details of the transformation. In other words, behind a lean company there is an active management process that grants continuous improvement and long-term self-sustainability. The answer is found within Management Systems. Toyota, Bosch or Daimler Chrysler represent just a few examples of companies that built their own models. These models of improvement integrate operational, as well as strategic goals, and define how the company manages change. The Kaizen Management System (Figure 1), created by the Kaizen Institute Consulting Group, is also a Management System and shows other aspects, relevant for companies to become successful in their journey towards lean.

## 2.2. THE KAIZEN MANAGEMENT SYSTEM

The Kaizen Management System (KMS) is a model applicable and adaptable to any organization. Four major layers constitute the KMS: (1) Purpose and Targets, (2) System and Tools, (3) Change Management, and (4) Foundation Principles and Tools.

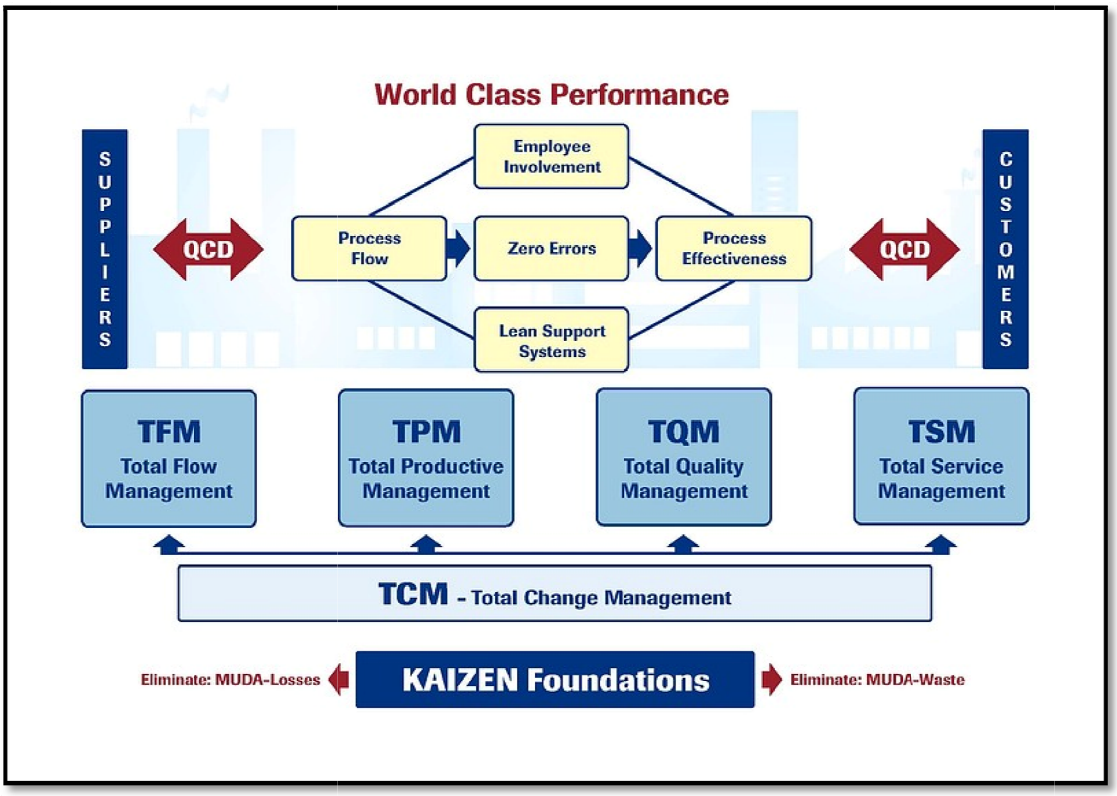


FIGURE 1- THE KAIZEN MANAGEMENT SYSTEM [COIMBRA, 2009]

### 2.2.1. PURPOSE AND TARGETS

The top layer sets the strategy and necessary targets to achieve sustainable growth and competitive advantage. Targets have to be clearly defined using a Quality, Cost, Delivery, and Motivation (QCDM) approach and setting appropriate Key Performance Indicators (KPI). This means that one has to consider Quality, Cost, Delivery (or Service) and Motivation as the fundamental keystones to strive towards World Class Performance (WCP) and implement an effective monitoring systems to track the company's development. Top management plays a fundamental role, because it is their task to grant that their mission statement and their vision are accomplished through clear operational improvements.

### 2.2.2. SYSTEM AND TOOLS

The second layer answers the question: "What has to be done in order to achieve the targets?" The Kaizen Management System includes four distinct systems that try to respond to that need: (1) Total Flow Management, (2) Total Productive Maintenance, (3) Total Quality Management, and (4) Total Service Management. Every system

possesses important tools that can be applied effectively to specific problems and environments.

The system that suits the scope of this work is the Total Flow Management System. This does not exclude the applicability of any of the other systems in the aim of Lean Laboratories. However, due to the nature of the work performed at the laboratories it is more appropriate to explore this system and its tools to a greater detail.

## Total Flow Management

The TFM Model is built of (1) Basic Stability, three major pillars, (2) Production Flow, (3) Internal Logistics Flow, and (4) External Logistics Flow, and (5) Value Stream Design. Below, a description of the first layer, the most relevant tools in the aim of this project, removed from the three pillars, and in the end, the last layer, will be presented.

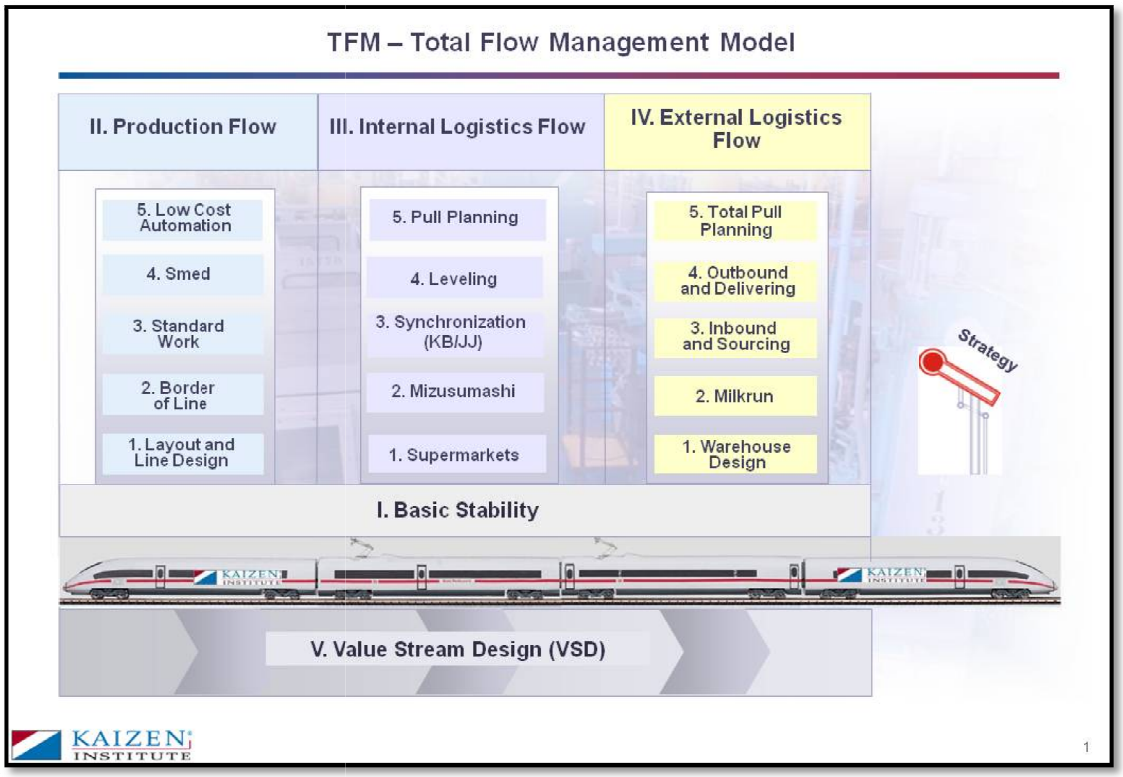


FIGURE 2 – THE TOTAL FLOW MANAGEMENT MODEL [COIMBRA, 2009]

### *Basic Stability*

This layer is crucial for the effectiveness of the entire system. It addresses problems in terms of Quality, Cost, Delivery and Motivation, in a total of four dimensions: Manpower, Machine, Material and Method, also called the 4M. In order to apprehend the status of these four dimensions it is vital to go to the *gemba (gemba* means in Japanese the place where the core processes happen) and check for any major issue. Table 3 below intends to show possible symptoms for the lack of stability in any of the 4M's and possible solutions to address the problem [Coimbra, 2009].

TABLE 4 - THE 4M'S AND INSTABILITY SYMPTOMS

| *Dimension* | *Symptoms* | *Solutions* |
|---|---|---|
| ***Manpower*** | Punctuality, absenteeism or lack of discipline at the workplace. | Create target groups to address the problems involving supervisors and operators, clarifying the reasons and root causes behind the undesired behaviors. |
| ***Machine*** | Availability losses, performance losses, quality losses. | Create focus groups that investigate the root or the most frequent causes to find solutions. The calculation of the Overall Equipment Efficiency (OEE) can also be a path for improvements. Most importantly is that the focus group should include representatives from the affected departments, especially, maintenance and production. |
| ***Materials*** | Lack of materials, delays in the supply. | A focus group should try to understand the top ten problems that occur, narrow them down to find the root causes and then, apply specific tools, if applicable, from the KMS. |
| ***Methods*** | Flow problems when removing safety inventories, high variability in time and quality. | Hold Gemba Kaizen Workshops with a focus group and concentrate of granting reliability and stability. |

The most relevant is Manpower. People have a fundamental role in the well-being of a business. Ultimately it is them to operate Machines, Material and to execute the

TABLE 3 - THE SDCA CYCLE

| | |
|---|---|
| ***Standardize*** | Standards are created together with the employees. |
| ***Do*** | Carrying out the standard (training, practice, experience). |
| ***Check*** | Check standard with current situation to ensure effectiveness. |
| ***Action*** | Improve the standard as required. |

Methods. Granting this important dimension will be a necessary prerequisite for basic stability. As presented in the table above, symptoms of lack of stability in manpower could be absenteeism or unpunctuality, or the wrong and unproductive behavior at the working place. These factors influence strongly the creation of flow. They continuously introduce stoppages that affect the entire supply chain and inhibit any improvement attempt. The recommended approach suggests a Standardize, Do, Check and Act (SDCA) action [Coimbra, 2009].

Often there is no standard at all. Supervisors admit to have explained rules and tasks to their employees; employees, on the other hand, consider to be performing their job in the correct fashion. This unquestionably introduces variability and flow turns into something unachievable. Standards have necessarily to be constantly revised, effectively trained, documented in an easy and visible manner, or created from scratch. Standards represent the most efficient and safest way of performing a task, but its validity is temporary. That is why, the SDCA cycle grants a continuous improvement of the standards and an increasingly stabilized working environment. This builds the solid ground for productive habits, continuous improvements and the persecution of the lean principles.

There is a powerful law underlying every simple standardization process. The purpose of any standardization initiative is to avoid variability and the effects it can have. Heinrich's Law proves that small accidents or mistakes have a defined correlation with catastrophic incidents. It states that for every 300 near-misses (almost accident), as little errors or insignificant yet undesired occurrences, statistical conditions are created for 30 minor accidents, with significant yet harmless effects, to happen. That on the other hand creates the sufficient conditions for one harmful accident to happen, with effects that can weigh up to 30% of a budget or even cause serious injury [von Eiff, 2001]. It is therefore necessary to work on the supporting layer of this pyramid, on the little happenings. Standardization reduces those minor accidents to small proportions and so that further ones can be avoided. Furthermore, it is statistically proven that standards contribute to the elimination of up to 80% of variability. The remaining 20% have necessarily to be addressed with specific improvement tools.

Finally, it is the people's minds that represent the ultimate barrier for the success of any improvement initiative. Therefore, it is required to have patience and keep in mind that rapid and sudden changes can be destructive and diminish the effectiveness of any future attempt.

Simple 5S actions (sort out, straighten, scrub, standardize and sustain) are a great starting point. As will be explained in one of the next sections, it is an effective way of creating impact and transforming the working environment. People understand rapidly the benefits of a Continuous Improvement philosophy and demonstrate growing acceptance.

### *The three pillars*

The most important tools to be explained are Standard Work, belonging to the first pillar, and Mizusumashi, a tool from pillar two. These will be introduced once they were important during the project and effectively implemented. All the others go beyond the scope of this work and shall not be presented [Coimbra, 2009].

#### Standard Work

The fundamental goal when implementing Standard Work is to limit the workers' movements to the strictly value adding movements and still grant quality. Working methodologies often hide an excess of activities performed by the workers that do not add any value and that might even contribute to higher fatigue or non-ergonomic postures. The path for better habits to predominate lies within a thorough observation of

the work. Only then, one is able to understand and motivate new and improved working habits. Creating standard work means achieving a state of fluidity in the worker's movements so that the job will be done in the least amount of time and with perfect quality [Coimbra, 2009].

In [Coimbra, 2009] one can find an explanation of Standard Work as being composed by four key elements: (1) Standard: The best, safest, easiest and most effective way of performing a certain task, achieving the best link between human and machine work; (2) Work Cycle: The sequence of movements done by each operator is a work cycle; (3) Cycle Time: Time needed for the operator to complete one work cycle (including all movements of one part, from start to stop); and (4) Work-In-Process (WIP): Minimum number of units of work (between operations) needed by the operator to complete the work cycle without interruptions. It is with these fundaments in mind that one can effectively work towards better working solutions.

The process towards improved working standards follows five core stages: (1) Define the target for improvement, (2) Observe the work, (3) Improve the work, (4) Standardize the work, and (5) Consolidate the work [Coimbra, 2009].

The first step is fundamental in any improvement initiative. Only with clear goals in mind can one achieve an improved state. The second stage is important for one to understand the current working methodology and identify waste. The time needed, as well as the amount of material waiting and used to complete a work cycle, and the nature of the movements themselves should be followed closely. *Muda*, such as excessive waiting time, movement or transportation should also be noted. Ultimately it is key to analyze and separate value-adding parts of the work from unnecessary, unproductive, and simply unnatural movements.

Next, the goal is to improve the work. One has collected data, has a better understanding of the current state, and is ready to redesign the working standard. This is a process that depends on the work itself, the environment, the tools and materials used, and the product. It is important to find paths that eliminate all waste and improve the analyzed working routine. Only then, one is ready for the next step, the work standardization, where one clearly defines how the work shall be performed in terms of operator movements, cycle time, and WIP, and finally, presents the standard to the operators in an easy and visual form.

Operators should be insistently formed by their supervisors in their new working standards. To support that process of consolidation one recurs to visual help that should always be near the working station, and training. Habits take a long time to be replaced by new ones and in order to achieve a successful implementation of working standards this constitutes an indispensible step.

The new standard should always constitute an improvement when compared to the habits that were performed before. However, this should not represent the final stop. Regularly, supervisors should analyze the working routines at each working post and strive to come up with new, improved and more productive solutions.

### Mizusumashi

The term *mizusumashi* is Japanese and is often called “transporter”, “train”, or “metro”, by the people unfamiliar with this tool. In fact, it is a system that follows predetermined routes, in predetermined schedules, as the above items do. The *mizusumashi* is one of the most important means of creating flow in internal logistics [Coimbra, 2009]. Its utilization was a countermeasure to the wide application of forklifts, especially in industrial environments, once they operate based on the current necessity, imply high costs, risk of accidents, and do not grant an immediate, flexible and quick response. The *mizusumashi*, on the other hand, has fixed routes, determined stops, and performs the same activities based on a standard working cycle. Additionally, it lowers the levels of WIP, once it is performing the same route on a regular basis and the risk of running out of material is eliminated. At each stop, materials, products or information are supplied or transported regularly to the next stage, and therefore creating flow in the supply chain.

This tool aggregates all wasteful activities previously performed by the operators, such as transportation and movement, allowing them to concentrate exclusively on their activity. If before operators had to supply themselves with different sub-assemblies in order to perform their work, or look for materials or tools, now, it is the “metro” that will supply at the right time, the right quantity, and the needed materials. One could also say that it is the metro that sets the pace for the entire supply chain, because its routes are calculated based on the global production rate aimed for.

Once again it is important to define standards with visible and clear information about cycle times, stopping points and materials to collect and deliver, and supervise the performance of the *mizusumashi* after implementation. Once it is such an important tool to create flow it is crucial that all procedures are respected.

### *Supply Chain Design*

Supply Chain Design (SCD) requires one to have understood the previous principles: basic reliability and the existing set of tools. When applying this tool it is fundamental to have a prepared mindset once it creates the needed awareness for flow improvements [Coimbra, 2009].

James Womack and Dan Jones had a profound influence on the development and popularization of it. There are three stages that define the SCD process: (1) Value Stream Mapping – analysis of the current state, (2) Value Stream Design – creating a vision or map of the future state, and (3) an action plan – taking action to change the supply chain. All three stages are performed by a multidisciplinary team where people of different departments are involved and contribute with their vision for the improvements of the supply chain. Leadership involvement is a key factor. When aiming for a transformation, process management staff has to be involved and monitor the improvements achieved by the team.

In order to start, normally a product family is chosen, but the team can also try to focus on the main process of their company and even have the liberty to decide to include customers or suppliers. Product families are chosen according to the degree of shared

processes among the different product references. This allows the grouping of product references and to design the supply chain according to that.

The material flow is the first to be mapped. It is initiated by performing a *gemba* walk. Team members go to the shop floor and collect data. In every step of the process data, such as (1) time, (2) quantity, (3) distance, and (4) area, is collected in terms of (1) value adding operations, (2) material waiting, (3) quality control or any type of checking, and (4) transport or movement, as the table below demonstrates, [Coimbra, 2009].

TABLE 5 - THE VALUE STREAM MAPPING SYMBOLS

| *Symbol* | *Meaning* |
|---|---|
|  | A value-adding operation. |
|  | Material waiting. |
|  | Quality control or any type of checking. |
|  | Transport or movement (including logistic operations). |

The next step is called the Value Stream Mapping. The team has now a deeper understanding of the supply chain and is ready to map it on a blank sheet using the presented symbols. The collected data has also to be included. It is important to understand the ratio between the total lead time and the total value added time. When data is introduced one also identifies bottleneck operations, excessive operation times, work in process or stock, or distances travelled by the people. Ultimately, when also analyzing the layout one realizes that it is not organized in the best possible manner.

Information flow should also be mapped on the same blank sheet, following the material flow. It shows who or which department performs which processes and, once again, how it looks it terms of data, such as turnaround time, processing time, and process costs. There are significant improvements that can be achieved on an informational level as well.

After completion of the entire map, one instantly identifies sources of waste, redundant processes, or general improvement possibilities. Therefore, the next step is the Value Stream Design where the improved version of the supply chain is mapped. This new version will be exempted of waste. Additionally, operations will be aligned in a more efficient and thoughtful fashion, and the introduction of data, will turn the quantification of the pretended improvements possible.

According to the problems identified in the supply chain one will recur to the extensive collection of tools existent in the Total Flow Management System and apply them with direction and purpose. Smaller improvements can immediately be implemented. However, when it comes to the extensive redesign of the supply chain, one might recur to simulation or the utilization of mock-ups, for testing and fine-tuning.

The Kaizen Institute summarizes the above explained content with a very simple figure that is displayed below. From the understanding of the current state one creates a possible future state, a so called, future vision, or Kaizen Vision. On the road to that goal, one will apply the principles underlying this system, create basic reliability, and use the given tools to achieve the desired improvements.

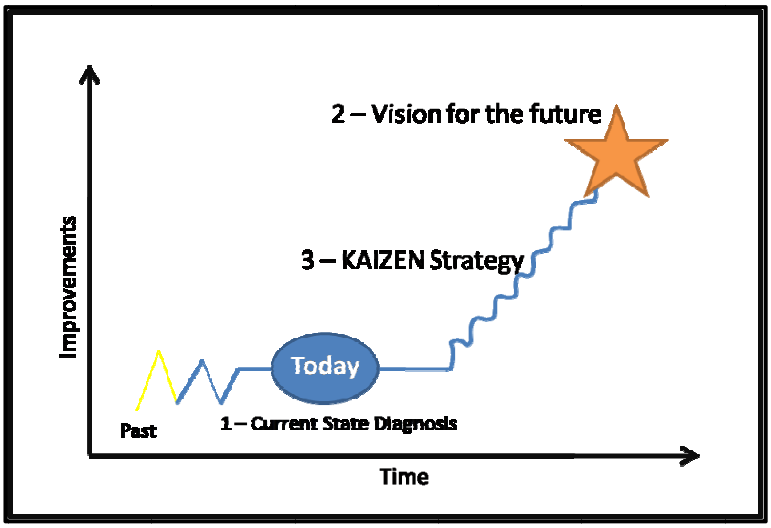


FIGURE 3 - KAIZEN JOURNEY [COIMBRA, 2009]

### 2.2.3. TOTAL CHANGE MANAGEMENT

The third layer (Figure 1) is about "How" to perform a Kaizen (or Continuous Improvement) strategy. It is organized in three pillars: (1) Effective Teamwork, (2) Direction and Control, and (3) Kaizen Leadership [Coimbra, 2009].

#### Effective Teamwork

Effective Teamwork is about performing improvements in teams across the entire company on four distinct levels: (1) Kaizen Strategy Workshops for management levels, (2) "Value Stream" projects for multidisciplinary teams of high level supervisors, (3) "Gemba Kaizen" Workshops for mixed intermediary teams, and (4) Daily Kaizen Activities for teams constituted by supervisors and employees. Only if these four levels of teams perform Kaizen activities on a regular basis can improvements be achieved.

#### Direction and Control

Direction and Control aims to establish the goals to be achieved by the several Kaizen Teams and most importantly, to control their accomplishments. Normally this task is performed by a nominated Kaizen responsible who supports, follows and supervises all improvement activities.

An example of a controlling tool is the Kaizen Audit. When planning a simple 5S action one should perform a Kaizen Audit before and after the improvement activity. This enables one to check the attained progress and improve direction, if necessary.

### Kaizen Leadership

Kaizen Leadership sets the condition for a business to become a self-learning and self-developing entity. It sets the ground for a continuously increasing awareness of the Kaizen principles and the possible improvement areas. Kaizen Coaches that are designated by the company and supervisors have the responsibility to instruct their employees and teams, respectively, on a continuous basis. It is fundamental to create new habits, an open-minded culture, and acceptance towards the Kaizen philosophy.

These three elements will grant the success of a Kaizen Strategy because it is all about performing Continuous Improvement everywhere, on a daily basis and involving everyone. Total Change Management (TCM) educates a firm to constantly revise their current state, assess improvement possibilities, establish a vision (future state), plan their journey choosing what tools and methodologies to use, and monitor their improvements. TCM also gives companies the chance to develop their own models, following the structure of the KMS, but including only the necessary and needed tools. Most importantly, TCM gives businesses the chance to align their strategic goals with the correct operational goals. Following the three pillars of TCM one achieves coherence, long-term sustainability and Excellency.

### 2.2.4. FOUNDATION PRINCIPLES AND TOOLS

TABLE 6 - THE FOUNDATION PRINCIPLES

| Principles | |
|---|---|
| ***Quality first*** | Quality is a fundamental keystone of continuous improvement. The three principles that support quality are: (1) Market In: it is important to anticipate and understand unstated customer wants and needs and create an ultimate customer experience; (2) The next operation is the customer: this principle transforms the company into a supply chain of suppliers and customers with each supplier aiming for zero defects and perfect quality for their customer (next stage in the supply chain); an (3) Upstream Improvement: this means that the cause of a problem is normally found at a deeper or earlier phase of the process. |
| ***Gemba orientation*** | Following a *gemba* oriented attitude means: (1) Go to the *gemba* and observe the actual reality; (2) Checking the *gembutsu* (the elements of that reality such as tools, materials and information); and (3) Speak with data, what implies a thorough collection of valid and solid data. When improvement opportunities appear one should act immediately, on the *gemba*, and together with the people that work there, in order to change their habits for the better and implement improved working methodologies. |
| ***Waste elimination*** | In a previous chapter one has looked at the seven types of waste that one can find on the *gemba*: (1) Defects, (2) People Waiting, (3) People Moving, (4) Too much processing, (5) Material Waiting, (6) Material Moving, and (7) Too much production. It is important to try to constantly eliminate these types of waste. |
| ***People development*** | The involvement of people is crucial once there are the means towards any improved state. Through strong leadership commitment and participation, people should be involved in regular activities, their opinions and experiences should be heard and teamwork motivated, when striving towards the continuous improvement of methodologies and habits. |
| ***Visual standards*** | Information that is apprehended through visual means is normally the most effective. Therefore, it is important to implement standards using visual aids. This way, one grants that the standards is easily understood and respected, avoiding unwanted variability at the working place. |
| ***Process and results*** | Aiming for results without being concerned with the path that leads to it can result in failure. Therefore it is important to focus on the process and its improvement. |
| ***Pull Flow thinking*** | This principle integrates two of the principles of lean thinking discussed in chapter 2 and has the same meaning. It is important to create flow in terms of material and information in the entire supply chain by eliminating waste and, in necessary, redesigning parts of the supply chain, and let the customer pull the pretended consumption. |

TABLE 7 - BASIC TOOLS

| Tools | |
|---|---|
| ***5S*** | (1) Seiri (Sort), (2) Seiton (Straighten), (3) Seiso (Scrub), (4) Seiketsu (Standardize), and (5) Shitsuke (Sustain). These are the five Japanese words that stand for (1) Sort out and discard what is not needed, (2) Put what is needed in order, so that it is ready for use when needed, (3) Clean workplace, equipment and prevent defects, (4) Standardize, make sorting, straightening and scrubbing routine, and (5) Self-discipline and training, respectively. Using this methodology one can eliminate waste and create a healthy and sustainable culture of continuous improvement at the workplace. |
| ***Standard Work Tool*** | This tools is divided in five steps: (1) Define Improvement Targets in terms of Quantity, Cycle Time or Efficiency, (2) Observe the Work, (3) Improve the work by eliminating *muda* and establishing an action plan, (4) Standardize the Work, and (5) Consolidate to Work by training the operators. This tool creates the conditions to establish solid working methodologies and reduce daily variability. |
| ***N5W Tool*** | When facing a problem one has simply to answer the question "Why?" five times. In fact, this exercise should be performed on the *gemba* in order to validate it immediately. This repetitive cycle self-questioning allows one to ultimately arrive at the root cause and take immediate action, eliminating permanently the problem source. |
| ***5W1H Tools*** | What? When? Where? Who? Which? And How? Six questions to help one look at the problem from different perspectives. The additional benefit is that is isolates the problem in terms of a location, responsible and time and ultimately eliminates the root cause. |
| ***Basic Problem Solving 3C Tool*** | It is a global tool that integrates other tools, such as the two previously described. Additionally it uses the Fishbone Diagram in order to attain for the root cause of the problem. 3C stands for (1) Concerns, (2) Causes (Root-Causes), and (3) Countermeasures. Ultimately one should perform a (4) Check on the found solutions. The first "C" is a simple description of the problem. The second aims to find the root cause by applying specific tools such as the fishbone diagram or the N5W tool. The third step is to elaborate countermeasures that are often the simple standards or SDCA actions. |
| ***7 QC Tool*** | A set of seven quality tools aims to solve problems. It allows one to look quantitatively at problems and study possible solutions. The seven tools are: (1) Pareto Diagram: the 80/20 rule, (2) Scatter Diagram: plots two variables in a chart to check correlation between both, (3) Cause and Effect Diagram: all possible causes are drawn into consideration and judged (asking 5 whys) with regard to their effect on the problem, (4) Histogram: check average and dispersion using a bar chart, (5) Process Diagram: makes a diagram with the process steps or operations, (6) Check Sheets: check data according to several segments or breakdown categories, and (7) Control Charts: check results over time using basis statistics. |

Within the last layer we find the fundamental principles and basic tools (Figure 1) that support the Mission (Purpose) and the Targets [Coimbra, 2009].

These principles have to be understood and accepted by everyone in the organization and should be reflected by their mindset. It is important to have this "way of thinking" always present once they are a fundamental part of any Continuous Improvement initiative, and also embedded in the tools. These tools are the most basic and fundamental ones, however, they produce visible and immediate results. Table 7 summarizes the most relevant tools [The Kaizen Institute, 2009].

The mentioned principles found a wide and visible application in the industrial sector. The weight of this sector in the economy has suffered a natural and decreasing trend, while the tertiary sector has risen to an increasingly dominant position. Due to this natural phenomenon of today's working society it is important to expand the usage of lean principles to other domains such as service providers. Lean Healthcare or Lean Laboratories are terms that are gaining popularity and have produced a limited but reasonable amount of literature. Lean or Kaizen principles are universal and applicable to any business. Let us focus on its relevance in the laboratory environment and try to answer what truly constitutes a Lean Lab.

## 2.3. THE LABORATORY

Laboratories play an important role in a patient´s health and/or medical treatment when facing illness. Even though they act invisibly to most of us, they certainly are fundamental to our society. By rendering services to both public and private parties, they primarily aim to provide relevant information in order to support their daily decision-making process. Laboratories operate in a very specific type of environment that contributes with limiting factors of (1) scientific, (2) organizational and (3) directive nature. Altogether, they pose a real challenge for management. Let us see how each one of the mentioned pillars influences laboratories and let conditions be constantly varying and sometimes disadvantageous.

The activity performed at a laboratory is strongly linked to solid technical skills and a deep scientific understanding. Analysis and evaluations are most commonly performed or supervised by academicians and due to the changing and evolving nature of science this sets the competency level high. Specifically in Clinical Chemistry the domains that converge to this science are immense: (1) Medicine, (2) Chemistry, (3) Pathology and (4) Pharmacology include most of the sub-domains. Within those, however, we can find other more popular domains such as (5) Microbiology, (6) Hematology, (7) Immunology or (8) Biochemistry. So laboratories have to know on what specialties to focus, what kind of research and development to encourage and what skills to aim for, including them in their strategic goals.

Secondly, under an organizational point of view, there are other strong factors that influence laboratories at several levels, such as, (1) Availability of Human Resources and Skill, (2) State Legislation, (3) Educational System of the Country, (4) Buildings and Infrastructure, (5) College of Chiefs of Clinics, (6) Hospital Administration, (7) Material Resources and (8) Public Health System [Vonderschmitt, 1991]. A laboratory's directorship may have to adapt to the prevailing Health Care System, to the infrastructures available in a hospital laboratory and to the cost policies of its administrations, to the materials and equipments offered in the market, to the influence

the educational system may have on the diversity of tests offered, and ultimately to the economic development of the region. Within these limiting constraints laboratories have to be able to adapt creatively and implement sustainable strategies.

Finally, we can point out basic principles that support the conduct of any laboratory in its pursuit to provide a valuable service: (1) Reliability, (2) Speed and (3) Economy [Vonderschmitt, 1991]. People's health or lives are dependent on a reliable source of information. Laboratories have to grant precise, accurate and specific information and avoid errors, such as, mixing samples, contamination or miss-evaluation. A laboratory's credibility could be at stake so a trustworthy and reliable conduct has to be a permanent goal. Speed is also essential because doctors, hospitals and ultimately patients label clinical information to be urgent and vital. Laboratories should, though, be concerned with implementing adequate mechanisms to respond efficiently to customer's requests and cases of emergency. Another important dimension to be considered is economy. Management, regardless of the purpose of its business, has to be concerned with costs and process optimization. Due to a high variability of tests and procedures, as well as, available equipment and materials in the market, it is a challenging task to achieve optimality in this field.

Both, private and hospital laboratories face complicated challenges. The domain is complex, the external factors pressing and the responsibility high. At this point the question arises: "What could be the main goals of a laboratory manager?" Certainly, to grant high levels of service, lean and optimized workflows and to create long-term relations with their customers, solely based on the quality of their work.

## 2.4. THE LEAN LABORATORY

Until this chapter a considerable amount of information was presented. First, the question "What is Lean?" was answered by presenting its aim (to eliminate *muda*) and its core principles (Specify Value, Identify the Value Stream, Flow, Pull, and Perfection).

Secondly, a system that implicitly contains all the previously mentioned Lean Principles was presented. The main difference is that it not only spurs Lean practices, but most importantly, grants sustainability. It turns the importance of management commitment and the need for a global Continuous Improvement culture evident. Furthermore, it presents a set of tools and methodologies that answers the questions about "What?" and "How?" Kaizen or Lean can be implemented in an organization.

Finally, one has looked at the key aspects that determine the functioning of a laboratory (scientific, organizational, and directive aspects). They encompass the main challenges that a laboratory faces and that have to be overcome.

Invariably, and in short, a Lean Laboratory is an organization where the inevitable challenges that it faces, are addressed keeping in mind the five core principles of Lean: (1) Value, (2) Value Stream, (3) Flow, (4) Pull, and (5) Perfection. And, thinking of long-term success means applying an adequate improvement system, possibly the Kaizen Management System, which grants sustainability and continuity.

When imagining a lean laboratory it is inevitable to think about automation, mechanization and information systems. A sophisticated, well-functioning laboratory necessarily needs automated processes and to be connected to the exterior through efficient online platforms and a supporting information system. In fact, the will to automate a laboratory and to opt for expensive and heavy information systems is often an instinctive reaction. This happens in the laboratorial environment, but in any other business area as well. Is it the wrong approach? First, let us try to understand the definition of automation, as well as its advantages and disadvantages.

Mechanization means support or substitution of human force and movement by mechanical equipment. Mechanization implies a standardization of movements and there is no feedback mechanism. Automation differs from mechanization in that certain feedback mechanism [Vonderschmitt, 1991]. The main motives for a laboratory to automate lie within the need to avoid continuously repeated human action and avoid human error. Advantages are such as: (1) High reliability, (2) Speed and economy, (3) No fatigue, (4) No gross errors, (5) Short analysis time, or (6) Large volume. In a Pre-Analytics department, for example, where the specimens are received, mechanization could support (1) specimen collection, (2) specimen transport, (3) identification of specimens and samples, (4) separation of serum or plasma, and (5) sample distribution. The advantages are clear and there is no doubt that intensive human capital could never substitute the efficacy and simplicity of automation. But there are also some disadvantages one should be aware of: (1) Technical aspects, such as difficult software for laboratory assistants to understand, high dependency on the after-sale service, heavy machine failure and complicated repairs and high maintenance costs; (2) Educational aspects, because only motivated and alert laboratory assistants should work with modern analyzers; (3) Motivation of personnel, once automation will ultimately eliminate the need for skilled personnel and reduce the diversification of the technicians responsibilities; (4) Analytical aspects, due to cross-contamination risks or the limitations of the equipment opposed to a required flexibility and variety of tests; and finally (5) Organizational aspects, because a strong back-up structure must exist in case of failure, as well as other motives that were referred before, such as motivation, instruction, maintenance and personnel administration, all problems of organizational nature [Vonderschmitt, 1991].

There is no reason to avoid choosing automation or information systems and the uncountable advantages they offer. They simplify processes and turn them more reliable, reduce human intervention and allow a large volume increase. Information systems connect the business to their entire customer base and facilitate an internal connection among all equipments and applications. However, there is a vital aspect that cannot be forgotten and that is hidden behind a simple sentence: "(…) in the private home or in the laboratory, man first seeks to simplify, to reorganize, to mechanize and ultimately to automate the work." [Vonderschmitt, 1991] Let us pay special attention to all steps, and their order, towards automation. This undoubtedly indicates us the importance of understanding the business processes before engaging in a costly automation (or computerization) initiative. Does other laboratory literature suggest the same approach? The following three references try to answer that question. They are presented separately once they differ in scope and domain.

The first paper, [Ash, 1996], it is stated that the primary force driving healthcare reform is cost reduction, being the trend having the greatest impact, the reduced revenue per test. Increased efficiencies can results through increased automation and process improvement, and, the true value of laboratory services in healthcare will be appreciated only when waste is eliminated and utilization is properly controlled [Ash, 1996]. The paper clearly encourages new business practices that constitute an alternative to the traditional approach that would grant service at any cost. Furthermore, it states that continuous improvement is not really a new strategy, but needs to be encouraged in all laboratories, for there is much progress to be made. In addition it says that strategies should include the streamlining of the organization, automation, and process improvement, and strongly encourages, employee empowerment, because, as employees take ownership of their jobs, they will come forward with suggestions that will improve productivity throughout the organization. Ultimately it recommends laboratories to cross borders and engage in improvement teams that include their customers, such as hospitals. A needed collaboration that should aim for overall cost reduction of the entire value stream and stimulate the creation of joint solutions.

Our second reference [Melanson, 2007] brings the subject of automation closer. The benefits of automation are well documented and derive from the replacement of manual, potentially dangerous, error-prone steps with automated processes requiring minimal operator intervention [Melanson, 2007]. It also underlines the special importance of a thorough workflow analysis that demonstrates the weaknesses and strengths of the existing processes. Furthermore, it suggests the creation of multidisciplinary teams of different managerial levels to start such a project, and finally, that laboratory automation may allow for the proliferation of best laboratory practices and create more standardization between laboratories.

Finally, the third reference, [Broad, 1997], concerns the implementation of a Laboratory Information Management System (LIMS). It refers three main lines of action for the company to implement a LIMS: (1) becoming very customer focused; (2) designing responsive processes that are value orientated and not bureaucratic; and (3) focus on efficiency throughout the supply chain as opposed to a single department. Furthermore it underlines the special importance of change management for the successful implementation of a LIMS and that includes (1) establishing clear objective, (2) strong leadership, and (3) effective people management. Ultimately it states: “(…) identifying and realizing these opportunities is a challenging, people oriented process” [Broad, 1997]

Most of the principles these references contain, connect to the previously introduced KMS or even, the Lean Principles. They share the importance of understanding well the laboratories’ processes, by involving all departments, suppliers and customers. The need for standardization and the creation of best practices and the relevance of a continuous improvement and waste elimination culture are spurred. Most importantly, their contents bind us to the importance of change management, the very essence of the TCM model. It is vital to involve employees in the improvement activities and support them through strong and committed leadership.

This last section does not intend to refute the value of automation and information technologies. It aims to reinforce the importance of first stabilizing a business, by starting to understand and improve their processes, reduce waste, encourage standardization, and lead through effective people management. Only by granting these fundaments can any attempt of implementing sophisticated equipments and complex information systems be a success. Management should be sensitive or familiar to the Lean Principles and the Kaizen philosophy.

It is within this frame of thinking that the laboratories of Unilabs were addressed. The next section will introduce the occurrences of practical nature of this project.

# CHAPTER 3

## 3. KAIZEN AT THE LAB

The collaboration between The Kaizen Institute and Unilabs Switzerland aims to improve productivity levels across the several laboratory facilities in Switzerland. During this project several of the locations have been visited and followed. In the next chapter the activities and improvements realized at the visited facilities will be introduced, based on the already presented theoretical foundations.

In the first part one will look at some diagnostic activities performed by the Kaizen Institute. This means that each example will be structured in: (1) Initial State, (2) Improvement Possibilities and Predicted Activities, and (3) Possible Future State.

The second part will present two practical examples that have already occurred at the laboratories and show evident improvements. They are structured as follows: (1) Initial State, (2) Improvement Possibilities, (3) Performed Activities, and (4) Improvements and Future Perspectives.

Finally, one will take the concept of Lean Labs a little further and introduce some of the latest efforts that Unilabs has been developing, such as the innovative *E-Labs, E-Prescription, Gyn-Online* or the POC systems.

Before entering the first part it is important to remember the approach that was followed by The Kaizen Institute. It is obviously based on the already presented KMS. However, what truly guided the performed activities at the laboratories was the TCM system. The explanation about this system can be looked up in chapter 2; however, it is important to remember the main lines of action (2.2.3.).

The TCM system is divided in three main parts: (1) Effective Teamwork, (2) Direction and Control, and (3) Kaizen Leadership. The most important to be recalled is Effective Teamwork because it decides what really happens on the *gemba* and how the work is performed. Therefore, one should keep in mind all four types of activities included in

the Effective Teamwork domain, especially the last three: (1) Value Stream Projects for multidisciplinary teams of high level supervisors, (2) Gemba Kaizen Workshops for mixed intermediary teams, and (3) Daily Kaizen Activities for teams constituted by supervisors and employees.

## 3.1. PART 1

### *3.1.1. EXAMPLE 1: UNILABS DR. WEBER (ST. GALLEN)*

This laboratory is organized into various departments: (1) Pre-Analytics, (2) Clinical Chemistry, (3) Cytopathology, (4) Hematopathology, (5) Hematology, (6) Special Chemistry, (7) Cythogenetics, (8) Microbiology, and the support departments, (9) Reception, (10) Housekeeping, (11) Shipping/Logistics, (12) Offices, and (13) IT. The main customers and suppliers are hospitals and medical offices.

#### Initial State

The initial state reflected a very rigid and departmentalized structure. After a visit to the entire laboratory, every department was mapped and waste was identified. These are the general sources of waste that were identified:

TABLE 8 - LIST OF IDENTIFIED MUDA AT UNILABS ST.GALLEN

| | ***muda*** | |
|---|---|---|
| | Time loss in sample search | Communication is not optimal |
| | Long ways | Visual Management is not optimal |
| | Incomplete info on forms | No Synchronization |
| | Excess of material in the lab | Non efficient IT system |
| | Standards generally not in place | Suggestion system not optimal |
| | Time loss in information search | Information delays |
| | Space utilization is not optimal | Overprocessing |
| | Ergonomics is not optimal | |

This laboratory is the second largest in entire Switzerland and receives up to 1600 files every day. The Pre-Analytics department performs its work on an early morning shift from 4:30am until 10:00am. During this time it dispatches the Microbiology files to its department and prepares all the remaining samples for all the other departments, by introducing the data into the system, preparing the aliquot tubes, labeling the tubes, centrifuging them and performing the decantation. From 10:00am the several departments can start their routine analysis work.

The infrastructures are also a great barrier for the creation of flow. The laboratory is divided in four floors connected through confusing and energy consuming stairs. Because there are no standards in place, laboratory technicians loose time and energy in

searching samples, information, or people. The laboratory owns inefficient IT systems and the access to statistical data is limited.

The next figures (Figure 4 and Figure 5) are examples of departments that were mapped. Once the approach of the Kaizen Institute intended to gather the major sources of waste, and not to study the detailed processes, the usual symbols for the Value

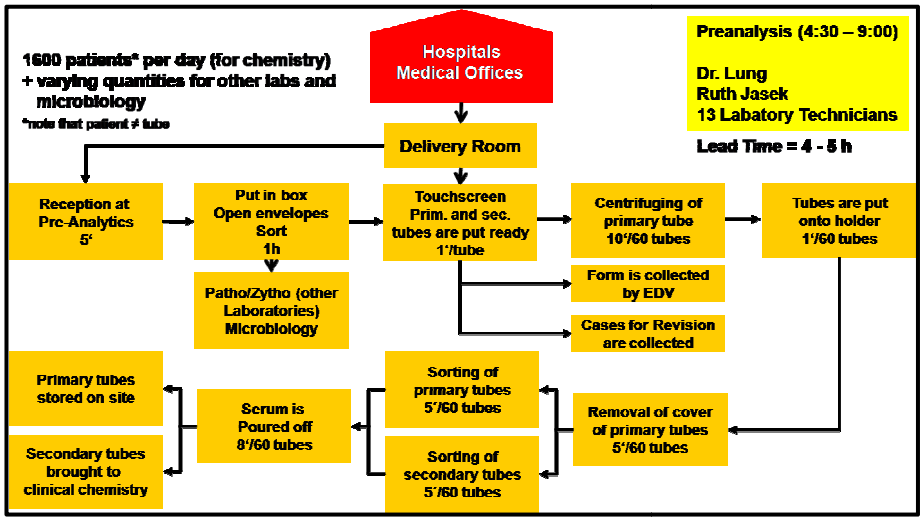


FIGURE 4 - INITIAL STATE PRE-ANALYTICS ST.GALLEN

Stream Mapping were not used.

The above figure represents the Pre-Analytics department. As was explained before, all the samples that arrive at the laboratory have to be processed by this department. The figure explains in detail all the steps from reception until dispatch into the remaining laboratory areas.

The second figure represents the laboratory department where 80% of all analytical

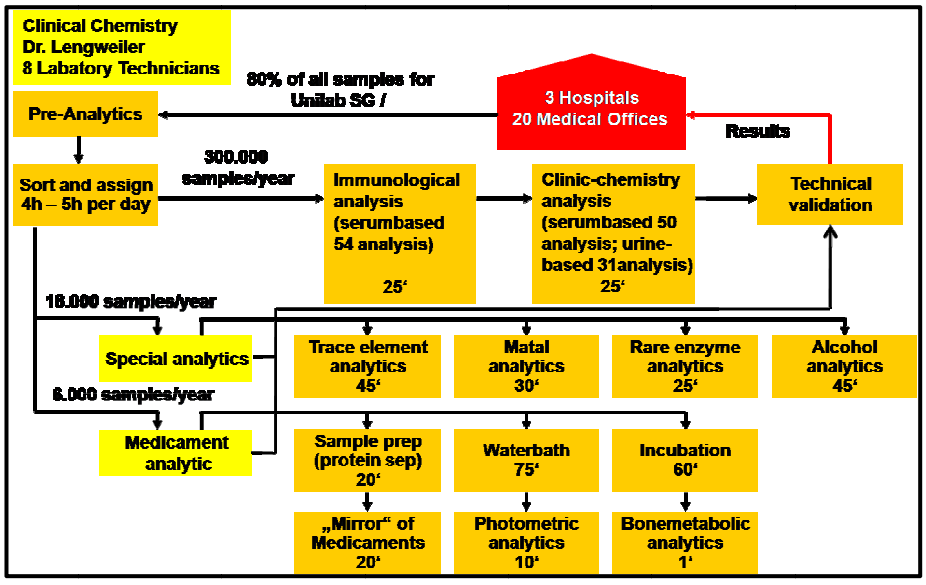


FIGURE 5 – INITIAL STATE CLINICAL CHEMISTRY ST.GALLEN

activity happens. Clinical Chemistry is the largest domain and it includes the most frequent type of analysis. The above map shows the stages that a sample could undergo.

These maps are useful and represent an important initial step towards the planning and implementation of improvements. They allow one to understand the entire process: the sequence of activities, priorities among them, and additionally, their duration, the amount of work-in-process they produce, the human resources involved, and the production volume.

## Improvement Possibilities and Predicted Activities

The main goal is to eliminate *muda* and to create an efficient workflow. Currently, the laboratory lacks reliable data. In order to aim for the creation of flow it is important to analyze the various processes and register process times. Furthermore, the Kaizen Institute will perform several Gemba Kaizen Workshops in order to create a 5S culture among the entire laboratory and provide useful problem-solving tools for specific problems. Once the laboratory suffices in quality data and shows evidence of improvements in standards, 5S and basic problem-solving capacities, the conditions are set to work towards the Future State Map.

Concerning the presented figures, exemplifying the Pre-Analytics and Clinical Chemistry departments, some potential improvements were identified. Pre-Analytics: (1) Implement standards for customers to correctly fill out the delivered forms and contribute to the reduction of non-conformities upon their reception; (2) Introduce a scanning device that facilitates the reading and introduction of data into the information system; (3) Improve the layout of the department which is still divided into several rooms; (4) Work on the integration of tasks in order to create a better flow. Clinical Chemistry: (1) The available space for the entire department is excessive and implies long walking distances and loss of time in transportation and avoidable movements; (2) No clear visualization of standards; (3) The existing structure is not optimal at the moment and could be improved through the re-organization of equipment and layout improvements; (4) Broken communication standards at the interface to the remaining departments; (5) 25% of the labor time is lost in walking and searching.

## Possible Future State

The possible future state is shown by figure 7. It clearly points towards a leaner organization. Information flows are optimized among the different departments and a customer interface exists, eliminating the currently used paper forms which induce significant and time-consuming errors.

A leveling system balances the entire workflow and facilitates the distribution of samples among the interacting departments. That would also mean that the Pre-Analytics department would be the decisive part of the chain by introducing a smooth production flow into the system. Technicians would not be looking desperately for samples and information anymore because the entire laboratory would be steered by a central and visible leveling unit. Workload at each workstation would also be controlled by a local leveling system. A leveling system would contribute significantly towards an improved state. Its activity could be steered through an information system and the main

goal would be to create a clear priority level and sequential order, for the samples entering the laboratory. This would allow the creation of flow throughout the entire supply chain, the immediate tracking of samples, and shorter lead times.

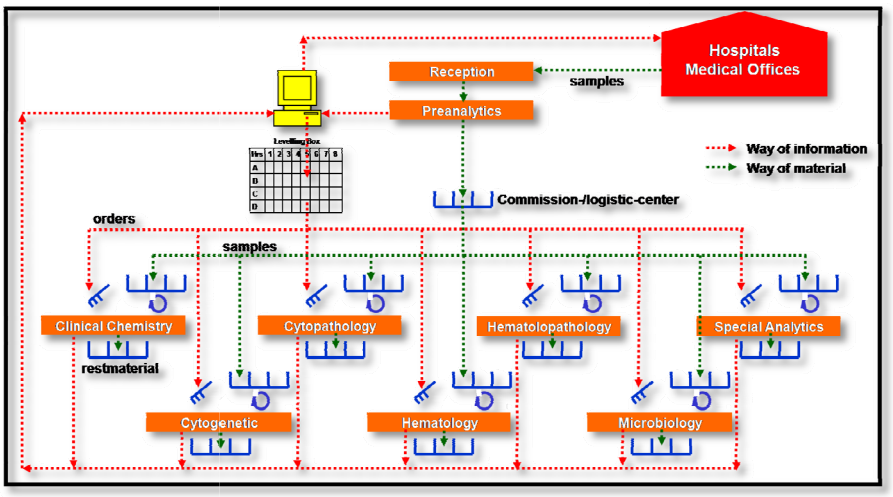


FIGURE 6 – FUTURE STATE OF THE UNILABS LABORATORY ST.GALLEN

The entire laboratory layout would be optimized. Departments would start to interact through the implementation of a *mizusumashi* concentrating all *muda* activities into one single activity. This transporter would also have logistical responsibilities and distribute all consumer goods, improving stock management.

In the end, the laboratory would be able to dedicate more time to their true core activities and spend less energy, time, and resources, into sample tracking, transportation of material, and excessive movement of people. Obviously, the path towards the proposed future state would first imply the pursuit of 5S actions, visual management, standards, and a continuous improvement culture, supported and lead by the management teams. Only after the stabilization of the core processes would it be reasonable to start with more specific tools from the KMS, and slowly, the laboratory would come closer to optimality, the proposed future state.

### 3.1.2. EXAMPLE 2: UNILABS MEYRIN

The laboratory of Meyrin is a very small but particular laboratory once it is located next to a public hospital. The incoming samples are in their majority from the public hospital; however, the laboratory also manages to serve local medical offices. The core structure of the laboratory and the main analytical domains (Hematology, Immuno-Hematology, and Clinical Chemistry) are similar to the previous example. However, the fact that it operates next to a hospital highlights especially the sense of urgency of providing fast response.

#### Initial State

As was explained in the theoretical part, at first, a visit to the *gemba* was performed. A team of supervisors and laboratory technicians were present and the goal was to go

through every existing stage of the value chain. For the external visitors from the Kaizen Institute this rendered waste sources clear and set the conditions to apprehend better the particular characteristics of the processes on site. After that initial phase, the team gathered and the core processes were mapped. Recurring to a product family matrix the core processes could be easily identified. That matrix was created by listing all the existing types of analysis available, versus all the existing processes (operational stages).

On Figure 7 one can identify a vast list of analysis on the vertical axis and a list of the existing processes (operations) on the horizontal axis.

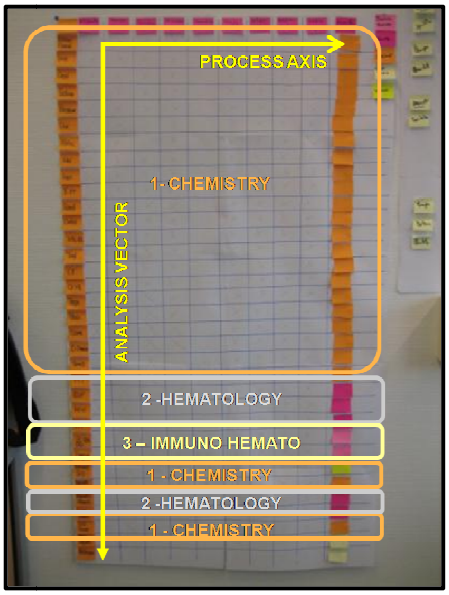


FIGURE 7 - PRODUCT FAMILY MEYRIN

In the resulting matrix a cross was marked in case there was an intersection between operation and analysis. In the end, by looking at the entire matrix, it was easy to aggregate common patterns and decide which core processes to map. The resulting product families were: Clinical Chemistry, Hematology, and Immuno-Hematology, and each domain had their specific operations associated.

By now, everyone had a deep understanding of the core processes and was ready to map them. As an example in figure 9, the process map of the Hematology department is shown.

The map (Figure 8) represents a Values Stream Design. It aims to represent the entire value stream of a specific process and in this case, displays two types of flow: above, the information flow, below the material flow. The symbols represent value-adding

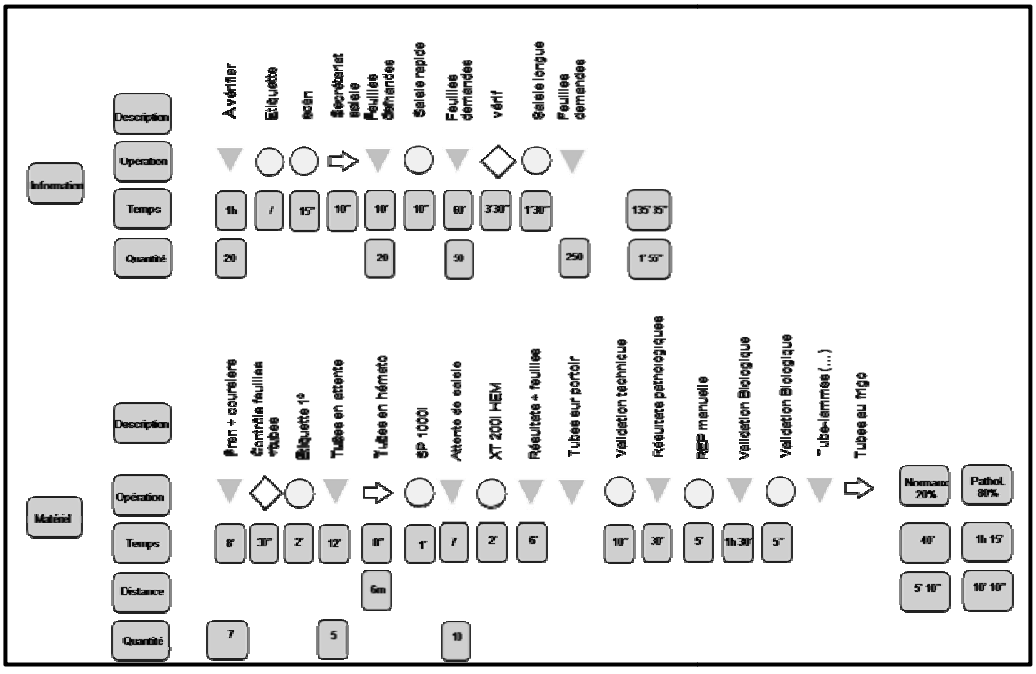


FIGURE 8 – INITIAL STATE MAP HEMATOLOGY MEYRIN

operations (represented by circles), stock (represented by inverted triangles), transportation (represented by arrows) and checking procedures (represented by diamonds). In addition, it contains important data, such as time, walking distances, and quantity.

The conclusion of such a step is already very important. It means that the entire team has managed to understand every detail of their processes and can immediately start to think about improvements; visual information is a valuable help to spot potential improvement areas. Before trying to map the possible future state map the team was submitted to training. They were introduced to the Kaizen philosophy and the fundamental principles they should keep in mind when attacking the current state's limitations.

## Improvement Possibilities and Predicted Activities

It is important to establish a clear difference between the previous example and Meyrin. While the laboratory of St. Gallen was visited with the purpose of planning future activities, it was not possible to realize a work as deep and specific as in Meyrin. An additional factor is that in Meyrin it was the team that performed most of the activities; The Kaizen Institute acted as a mere supervisor. This brings us to an almost paradoxical truth: for the CI agent, the consultant of The Kaizen Institute, it is not important to understand to a deep extent the processes that are being transformed. It is rather the underlying principles dictating their functioning that are of greater importance. The list of improvement that is presented next was entirely suggested by the team at the laboratory and attacks the key areas that can be improved.

TABLE 9 - SUGGESTED IMPROVEMENTS AT UNILABS MEYRIN

| | ***Suggested Improvements*** |
|---|---|
| ***1.*** | Reorganize the opening procedure of the laboratory. |
| ***2.*** | Samples are transported directly to the Hematology department instead of being stocked at an intermediary location. |
| ***3.*** | Reorganize the sorting post: ineffective working methodology. |
| ***4.*** | Create a U-Cell with two primary labeling posts and one secondary labeling post. The goal of this improvement is to facilitate the creation of flow. |
| ***5.*** | Create a transportation rule for the samples by establishing a maximum of five tubes per rack. |
| ***6.*** | Eliminate stock at the data collection post. |
| ***7.*** | Eliminate the confirmation form and substitute it by an online mechanism. |
| ***8.*** | New working schedules. |
| ***9.*** | Automatic results validation. |
| ***10.*** | Employ a second intern. |
| ***11.*** | Implement an online validation system. |

## Possible Future State

The future state (Figure 9) evidently attained several simplifications based on the suggested improvements. It contains less intermediate stock, some operations were integrated, and excessive bureaucratic procedures substituted by online systems. In the end, the team managed to create a leaner and more reduced supply chain, by suppressing non-value adding activities and maintaining value-adding activities.

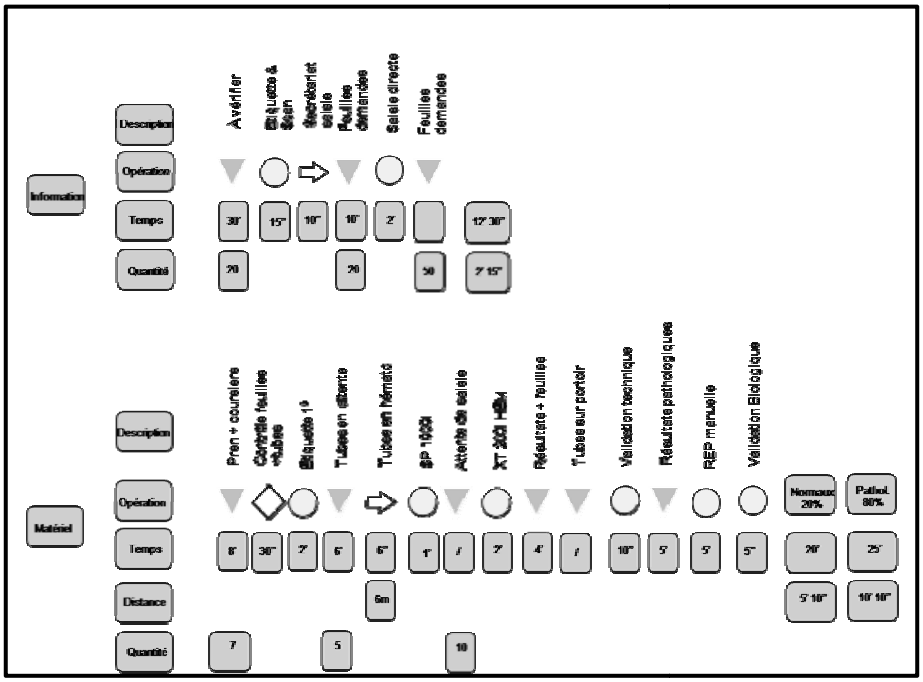


FIGURE 9 – FUTURE STATE MAP HEMATOLOGY MEYRING

Quantitatively, the following improvement can be summarized in Table 10. The value chain is divided in material and information flow, as referred before. The material flow suffers a second division once not all the operations are necessary in every case. If the samples are of pathological nature, more operations have to be included. The results that are presented in Table 10 are merely projected values. They result out of the deeper understanding of the current state of the value stream and the consequent design of a possible future state value stream. The elaboration of the future value stream is conducted by performing all the possible improvements, creating a leaner and waste-free situation.

TABLE 10 - ATTAINED IMPROVEMENTS AT UNILABS MEYRIN

| *Attained Improvements [minutes]* | *Initial State* | *Final State* | *Improvement (%)* |
|---|---|---|---|
| ***Information Flow*** | | | |
| ***Total*** | 135' 35'' | 12' 30'' | **-90%** |
| ***Value-Adding*** | 2' 15'' | 1' 55'' | - |
| ***Material Flow (Normal)*** | | | |
| ***Total*** | 40' | 20' | **-50%** |
| ***Value-Adding*** | 5' 10'' | 5' 10'' | - |
| ***Material Flow (Pathological)*** | | | |
| ***Total*** | 75' | 25' | **-66%** |
| ***Value-Adding*** | 10' 10'' | 10' 10'' | - |

The improvements are clear (Table 10). A simple process mapping and a look with the correct mindset were able to transform a process that was identical for the last years. The proposed improvements will be implemented at a slow pace and in parallel with other priority activities. It is important to further develop the people's habits and their mindset. The Kaizen Institute planned therefore, specific workshops about 5S, Standard Work and the deepening of the Kaizen Principles, in order to attain better results when aiming for the creation of flow. These planned sessions will help stabilize the working environment by simply teaching people how to implement standards and visual aids and to adopt a SDCA attitude, to continuously improve their current state. The proposed future state situation can be rapidly achieved if a committed and strong leadership is granted that enables people to keep motivated and transformations on the *gemba* happening.

To complement all improvement efforts the team will implement simple indicators. They are divided into four dimensions: (1) Quality, (2) Cost, (3) Delivery, (4) and Motivation. The indicators to be collected once the improvement actions started are: (1) Customer complaints and (2) Internal Errors (Quality); (3) Productivity and (4) Supplementary working hours (Cost); (5) Turn-Around-Time (TAT) for each process (Delivery); (6) Working accidents and (7) Suggestions given by co-workers (Motivation). These indicators will allow leadership to monitor the improvements taking place and co-workers to follow them day-by-day.

## 3.2. PART 2

### *3.2.1. EXAMPLE 1: UNILABS CYPA LAUSANNE*

This laboratory is rather small and there are plans from the Unilabs board to dislocate the entire facility to another location or even integrate it into an existing unit. This plan was considered, because the Cypa laboratory is not well located in geographical terms and does not produce enough volume. Before its acquisition it functioned based on a

rather familiar business model and working habits did not match the ambitions of the current Unilabs organization. Therefore, before any replacement operation starts it is vital to train people, confront them with new working paradigms and ultimately change their mindset. The apprehended knowledge base will grant the success when setting up the new facilities.

This implementation example pretends to show how effective a simple 5S action and a Standard Work action can be, and how they can transform the working environment. This means that the initial training workshops and the value stream mapping stage will not be included. The Example of Meyrin proves well the benefits that can be achieved through a process mapping. This example, on the other hand, intends to demonstrate the mentioned methodologies can have on the *gemba*.

### 5S: Initial State

The first part intends to show the general facet of the laboratory by displaying some pictures taken during the first visit to the laboratory.

FIGURE 10 – UNILABS CYPA LABORAOTRY BEFORE 5S

The working environment is clearly disorganized and does not facilitate relaxed and effective working routines. Material does not have a specified place or clear identification tags to facilitate their utilization. People clearly waste time in searching or sorting materials when using them. Stock levels are impossible to control. Ergonomics is affected by all the chaos at the working posts.

### 5S: Improvement Possibilities

The possible improvements are clearly related to a better organization of the working environment, adequate labeling and visual management.

## 5S: Performed Activities

The laboratory team was gathered and introduced to the main guide lines of the 5S action. All five steps of the 5S action were followed. Materials were sorted and the unnecessary eliminated. The useful materials were adequately put into place. Finally, the entire working environment was cleaned.

FIGURE 11 - UNILABS CYPA LABORATORY AFTER 5S

Specific mechanisms are now unmistakably identified, materials were sorted and stored in labeled boxes, stock levels were stored with colored tags, material was removed from locations they did not belong to, and tools were arranged on easily accessible surfaces. In the end, the working environment looked clean and organized and working routines were significantly improved.

Indicators, such as the Turn-Around-Time (TAT) per process or the number of customer complaints were implemented as well. After a couple of weeks only, the trend started immediately to be visible and slight improvements were already attained. In the following weeks, the laboratory staff will have the chance to audit their new working environment and check on the total scale the level of their internal 5S quality. Inevitably, working procedures will be easier and less confusing, the core processes will start to stabilize, variability will decrease and errors diminish.

## Standard Work: Initial State

The area of the laboratory that was subjected to the Standard Work Workshop was the Coloration Room. There, a considerable amount of manual work happens on a daily basis. Several materials, tools and reagents are used for that purpose. Once again, the team was gathered and the work was observed. Their task resided fundamentally to track the movements of the operating technician by sketching a spaghetti diagram. Basically, a spaghetti diagram consists of drawing on the laboratory layout every single movement the technician performs. This enables people to visualize excessive

movements, conflicting routes between operators, excessive distances walked, or inadequate layouts. Secondly, the team had to collect the time the technician spent on every process. Finally, the team had to list the materials and tools necessary for each operation.

FIGURE 12 - INITIAL STATE COLORATION ROOM CYPA

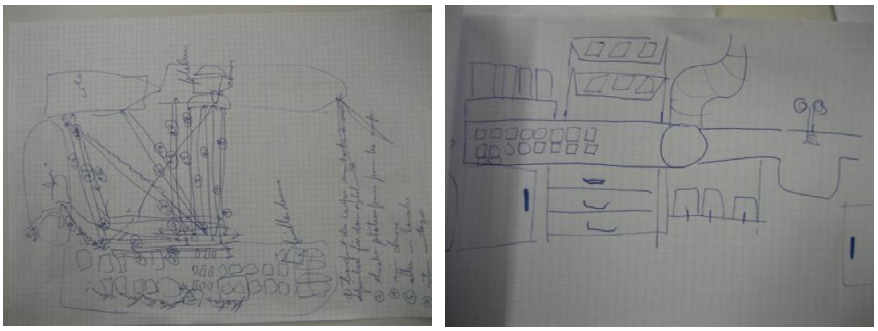

FIGURE 13 - SPAGHETTI DIAGRAM CYPA BEFORE (L) & AFTER (R)

Figure 12 shows the working environment before any action was undertaken. There is no clear visualization, material is spread around the table, and there is no defined place for anything. This obviously results in variability. Figure 13 exemplifies the spaghetti diagram that was drawn by the team members. The spaghetti on the left represents the initial state. It has marked on it, the different processes that the technician performs and the movements it is forced to do in order to conclude a working cycle. The spaghetti diagram on the right represents the final state and the contrast between both diagrams is visible. The new solution pretends obviously to facilitate the work cycle, to correctly sequence the necessary operations, and to adjust the existing layout.

## Standard Work: Improvement Possibilities

By confronting the above displayed spaghetti diagrams one can understand the existence of chaos and disorder on the left and an orderly and solid scheme on the right. The simple task of turning movements visible increased the awareness towards the potentials hidden behind the daily working reality of the laboratory.

The improvement possibilities that were identified can be summarized in the following table:

TABLE 11 - IMPROVEMENT POSSIBILITIES AT UNILABS CYPA

| | ***Improvement Possibilities*** |
|---|---|
| ***1.*** | Acquire new shelves in order to put all necessary material in the proximity of the technician. |
| ***2.*** | For a specific process where lames are glued there is the need to acquire an automatic machine. |
| ***3.*** | Tools and equipment has to be changed to the actual working place eliminating high walking distances. |
| ***4.*** | Implement a new procedure to supply the material to that stage in the global process (previous department is involved). |
| ***5.*** | Rewrite the new standard concerning the work procedure. |

The improvements suggested simply dislocated material and equipment where they were truly needed. Additionally there was the need to substitute a slight amount of manual work and increase efficiency through the use of automated equipment. Finally, the team believed that the supply of the material was not being performed in the best possible manner, reorganizing it by involving the affected department.

## Standard Work: Performed Activities

The team engaged in the implementation of their improvement needs under the supervision of the Kaizen Institute. As was mentioned, materials were brought closer to the working post, additional shelves installed, and colored tags put everywhere necessary.

FIGURE 14 - FINAL STATE COLORATION ROOM CYPA

The goal kept in mind by performing this action was always to eliminate any source of waste, especially excessive movements, and to create flow. This was possible by re-

arranging the layout and trying to create an adequate sequence of operations that would minimize waste.

### Improvements and Future Perspectives

The improvements that were attained by the 5S action are visible and the laboratory staff feels that there is a different environment. They feel less stressed, access the needed tools or equipments without losing time in searching activities, and the level of internal motivation is higher, because people start caring more for their working environment when it looks neat. As was mentioned before, trends in the TAT and in the number of customer calls started to show up in a decreasing tendency. Within time they will be more evident and it will be possible to associate concrete results to the performed 5S action. Furthermore, by auditing themselves regularly they will have the chance to assess their status constantly and spot new improvement opportunities.

The Standard Work contributed to the progress of the laboratory as well. It happened in a specific part of the value chain but incredible results were obtained. Through the simple implementation of the referred actions and a layout enhancement the team lowered the total operation time from 38 minutes to 14.5 minutes, representing a decrease of almost 62%. The coloring operation is performed four times every day meaning that the total time saved sums up to 1 hour and 33 minutes. For a daily working shift of eight hours this represents a total of 22%.

The team is highly motivated and convinced about the effects of the Kaizen tools. More importantly, it is motivated to perform follow up actions and plan further improvement projects autonomously, keeping the Kaizen philosophy going. The team leader had undoubtedly an enormous impact on the success of the project, by giving a clear commitment example and showing constant support towards the employees.

## *Example 2: Unilabs Coppet (Pre-Analytics Department)*

The laboratory of Coppet is located in the French speaking part of Switzerland. It is the largest within the Unilabs group and is, therefore, a vital element. The project happened at their modern facilities and involved, in a first stage, the team leaders of the different departments: Pre-Analytics, Clinical Chemistry, Hematology, Special Chemistry, Serology, and Microbiology. These were introduced to the Lean Principles and trained in Kaizen methodologies. Next, an intensive debate session among all, and under the supervision of the Kaizen consultant, was launched. Worries, complaints, suggestions, solutions, or ideas were put on the table and discussed. As in the previously referred examples, the entire team went to the *gemba* in order to understand their processes and visualize them with a modified mindset. After that activity, the processes of the different departments were mapped and key potential areas were identified. A vast action plan for the upcoming months was elaborated including clear responsibilities and time frames. However, it was decided that the first department to initiate deeper improvement actions, under the guidance of the Kaizen Institute, was the Pre-Analytics. This department was chosen once it receives all the incoming samples, and by transforming it there is the possibility of granting flow throughout the entire laboratory. In the Pre-Analytics the sample bags coming from the medical offices are collected. They contain a form that was filled out by the doctor indicating the set of tests he

pretends, and the sample tubes. A bag can contain any type of tube with blood or other body fluids. The goal of the technicians working in this department is to insert the data on the forms into the LIS and to set the tubes ready for the remaining departments.

FIGURE 15 - INITIAL STATE PRE-ANALYTICS COPPET

## Initial State

As one can visualize in the picture, on the lower-right corner, the layout of the department was organized by arranging all the posts in a parallel manner and by extending the tables over the entire room, from one side to the other. Everyone was working on the same line of tables. In front of the working posts there was another row of tables where the express service deposited the incoming samples. This means that, every time when technicians had to supply themselves with new sample bags, they had to move around all tables or hope for a colleague to be passing by to give them a help.

In the upper-right corner one sees a technician operating. The available space is reduced and it is important to pay special attention to the rack containing the tubes. In fact, the working methodology here allowed batch thinking. Technicians used to store up to ten sets of sample bags before delivering them to the next departments. Worse, a single technician did not perform all activities. They divided work among them by completing only part of the process each. Before going deeper into that let us try to understand in greater detail the sequence of this work: (1) Tubes are delivered by the express service in bags, each bag containing a form and several tubes (each bag represents a patient), (2) doctors have the choice to decide if their request is urgent, priority, or normal implying that the first two cases are treated immediately, (3) technicians get themselves

a box of bags by filling it up with up to twenty bags, (4) at the working post, and according to the initial working methodology, a specific technician starts the first stage of the process by opening the bag, removing the form and the tubes and creating a new entry in the Laboratory Information System (LIS) by scanning the bar code on the form, (5) next, the data on the form is inserted into the system, either manually or, if possible, by scanning the form, (6) the next set of tasks is performed by the second technician and starts with the arrangement of the tubes on a rack, that were removed from the bag by the previous technician. Once the scanning process takes some time to effectively upload the data into the system, the first technician keeps opening bags and scanning forms reducing, therefore, the waiting time. As the files are sequentially uploaded the second technician keeps performing the second set of activities. (7) By re-scanning the bar code of the scanned form, the file shows up in the system and the technician can print the labels, (8) these are then put on the form and on the correspondent tubes, (9) finally, the tubes are delivered to the next departments and the forms are stored in an office. These steps are important in order to understand the future state.

The initial state supported the division of tasks, allowed batch thinking and excessive WIP, the working environment did not respect ergonomics, people worked inefficiently and, as the picture on the lower-left corner indicates, everything was possible: computers standing on boxes or keyboards on printers.

A further aspect to be considered is the amount of interruptions that the technicians were subjected to. Interruptions could happen due to: (1) Non-Conformities which were immediately checked by the technician by bringing the case to the customer service and leaving their own work on stand-by; (2) Verification of the forms (this matter is discussed next); (3) Phone calls from doctors checking for results, asking to add tests to their initial request or inform about the urgency of their demand; (4) Excessive movement when collecting or transporting material.

Coming back to the verification process, it is important to know that this task was carried out by an adjacent office, integrated into this department. Only the most qualified technicians had the ability to undertake a verification process. This task was performed whenever there were uncertainties during the data collection from the forms. Often, doctors do not indicate the correct billing information, for example. This required the laboratory to investigate to which insurance company the bill has to be addressed, amongst other similar problems. Summarized, it is bureaucratic work that could eventually be addressed in the near future.

To translate their global efficiency in numbers, the entire Pre-Analytics department was producing at a rate of 6.7 bags per hour per technician. This means that each technician could treat almost seven patients every hour. A truly huge potential was hidden within this initial state.

### Improvement Possibilities

The goal was to increase the hourly production rate up to 30 bags every hour. This might seem impossible to attain due to the chaotic nature of the initial state. Improvement was planned on a gradual basis and the first step was to think of a serious layout transformation.

Secondly, the lack of stability in the working environment and the initial working habits were addressed. Batch thinking had to be eliminated and people needed to understand the importance of crating flow. It was also relevant to spur common working methodologies and, ultimately to eliminate waste by reducing significantly the number of interruptions each technician faces on a daily basis.

## Performed Activities

The performed activities can be summarized in the following stages: (1) Layout Transformation, (2) 5S and Standard Work action, (3) Implementation of a Mizusumashi, (4) Follow up and consolidation.

The new layout groups sets of four tables in a total of twelve tables as shown on the figure below.

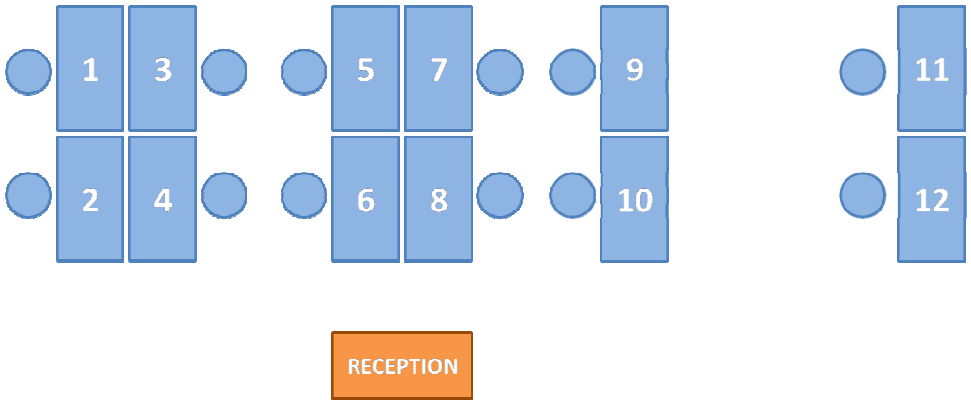


FIGURE 16 - FINAL LAYOUT PRE-ANALYTICS COPPET

This disposition allows people to have more space and less walking distances to achieve any point in the department. The sample reception is done at a new table, adjacent to the entry door, and the boxes with the samples are distributed from there.

After the layout transformation, the people's habits were addressed. It was vital to change batch thinking, decide that each technician would perform the entire process that was described before, and start to think about ways to eliminate the constant interruptions. This was undoubtedly linked to variability which could be reduced by introducing standards and improving the working methodologies.

First, a 5S and Standard Work action was undertaken. Both, the working and the reception posts were changed in order to create stability and establish clear working methods. All materials that are used were identified and labeled, and the entry and exit of samples was unmistakably defined. In the end, a standard was produced and set on the table. This would grant the technician to always respect and slowly apprehend the standard.

FIGURE 17 - WORKPLACE STATE PRE-ANALYTICS COPPET BEFORE (L) & AFTER (R)

The picture above shows the organization at the working place before and after. Below a set of picture turns the improvements even more evident by showing the details.

FIGURE 18 - WORKPLACE FINAL STATE PRE-ANALYTICS COPPET IN DETAIL

The first picture shows two racks (one for Clinical Chemistry, another for Hematology) and a box (for microbiological samples) where the labeled samples are put, ready for delivery. The second picture shows the table from a lateral perspective. Once again the green box and the racks for sample collection are recognizable. Next to it there is a blue box that defines the entry of the bags. When possible, there should always be two boxes of bags in order to keep the working pace elevated and eliminate the need to search for more bags upon finish. In the central picture one can also recognize a recipient holding a form. It was designed for non-conformities to be put aside when occurring and not to worry anymore about them. As we will see, that responsibility was transferred to another person. On the last picture one can identify another recipient with a form. Those forms constitute the general stock of the forms of the bags already finished. It was decided that all forms should be gathered, even if some of them needed verification by the adjacent office. One again, it will be another person to collect those forms and bring them to the referred office. In fact, the verification process was simplified by instructing all technicians about the majority of the occurring situation (diminishing the work load

in the office) and by implementing an informatics support that would eliminate the need of bringing the form personally to the office and explaining what the problem was about and indicate the forms that effectively needed verification or not.

At this point, the reception of the incoming samples, their distribution among the different working posts, the collection of non-conformities and their transportation to the customer service department, and the collection of the forms to be verified, was performed by a so-called transporter, a provisory substitute for the future *mizusumashi*.

People started to be less interrupted and even, if the transporter was not standardized yet the working environment started to improve.

The next step was the *mizusumashi*. For its implementation there was the need for three things: (1) a route, (2) specific tasks, and (3) a cycle time. The route was obviously associated to the tasks and consisted of the following stages: (1) Sort the incoming bags in urgent, priority, normal, and microbiology boxes; (2) Every box should contain a maximum of ten bags in order to reduce the WIP at the working place; (3) Delivery a box at each post and, if possible, leave a second one; (4) Collect the empty boxes, the non-conformities, the stocked forms and most importantly the labeled samples. At this point it is important to refer that on the cart the *mizusumashi* is transporting, there are three boxes, corresponding each one to the divisions made to the exiting material on the table (Clinical Chemistry, Hematology, and Microbiology). Next, (5) the *mizusumashi* transports the labels to the respective departments, (6) leaves the pile of forms at the adjacent office, (7) takes a photocopy of the non-conformity forms and delivers them at the customer office, (8) and starts over again. The cycle time of each round should equal ten minutes. This time was chosen because in one of the departments, the centrifuges work on a ten minute basis. If it would be possible to feed the centrifuges every ten minutes, an optimal flow could be attained.

Technicians working can now fully concentrate on their tasks and all the wasteful activities they used to perform before are now absorbed by the *mizusumashi*. Currently, the department leader and the Kaizen Institute are present to help stabilize the process. It is important to consolidate all these improvements before other activities are undertaken.

## Improvements and Future Perspectives

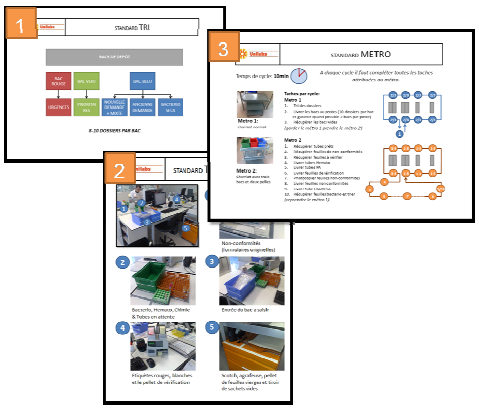


FIGURE 19 - STANDARDS PRE-ANALYTICS

A total of three standards were implemented. The first defines the sorting activity at the reception table and sets the rule for the maximal quantity of bags per box. This quantity is important once it influences the working pace.

The second standard is located at each post to remember people how the working environment has to look like.

The third standard defines the tasks and responsibilities of the *mizusumashi*.

The standards have a very important and concrete goal. They will always be visible when people are on the *gemba* and progressively, their content will be apprehended by them. Automatically, new working habits are created and stability in the processes achieved.

It is important to establish quantitative measures and check the entire improvement process. After all, besides employee morale, motivation, and an improved working environment, what have been the effects?

The production rate has been increased from 6.7bags/h per technician to approximately 25bags/h per technician. In the short term it is expected to increase that value even more.

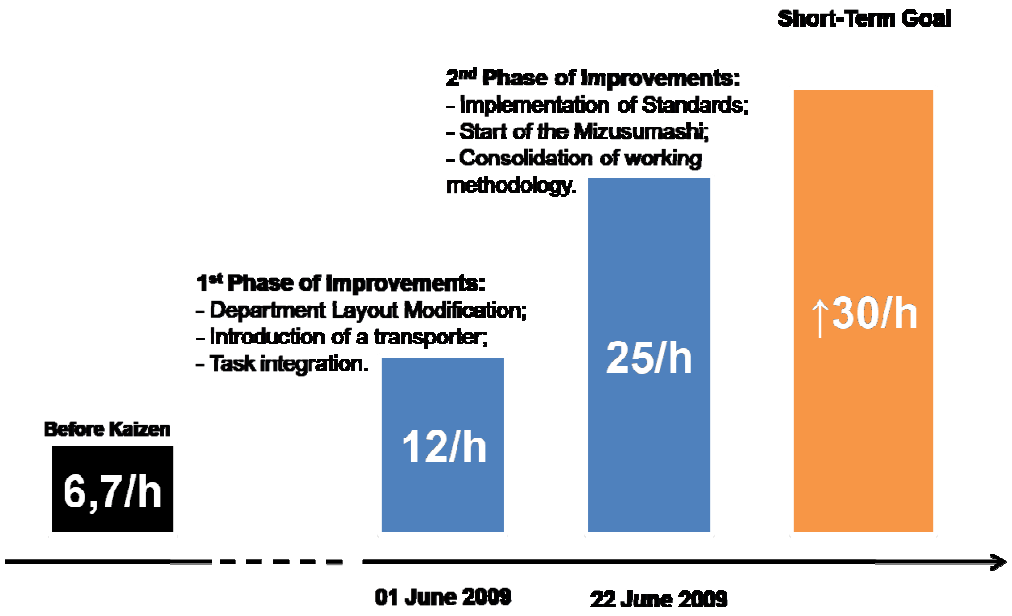


FIGURE 20 - IMPROVEMENTS PRE-ANALYTICS COPPET

Other activities are happening in parallel are: (1) Standardization of forms in order to reduce verification process and render an easier data collection. Currently there are over fifty different types of forms and it is vital to reduce that number significantly. (2) The LIS still presents an excessive amount of possible interfaces and the IT department is working hard to improve the system and facilitate the daily routine of the technicians. (3) Each type of non-conformities will have an associated code and the checking request sent to the customer service will be done electronically.

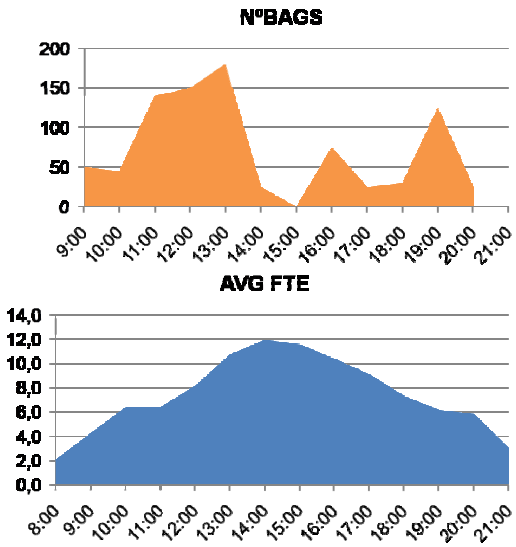


FIGURE 21 - COMPARISON BETWEEN DAILY SAMPLE ARRIVAL AND DAILY FTE AVERAGE

The charts (Figure 21) show another problem that will have to be addressed in the short term. The bags that arrive at the laboratory fluctuate significantly during the day and currently, there are Kaizen activities taking place at the express service's headquarters. Furthermore, the daily arrival pattern does not match appropriately the number of technicians (Full Time Equivalents) available during the day. The amount of available FTE's varies during the day because of different work schedules and several shifts.

These activities would, once again, contribute towards the creation of flow. If the expected number of bags per hour will be achieved, and considering the standardized functioning of the *mizusumashi* and all the other standards, one could expect to deliver every ten minutes the equivalent to 50 bags (considering an FTE equal ten). The total amount of bags processed every day is currently equal an average of 1200. At an hourly rate of 300 bags the laboratory would dispose of sufficient additional capacity to easily augment their daily production. The most important principle, however, is the creation of flow. That is the true enabler of such achievements. By creating flow the work balance is constant, people work continuously at the same pace and efficiency is achieved.

The next fundamental step is to keep improving and maintain a strong leadership. Eventually, Kaizen will progress into the remaining departments of the laboratory.

## 3.3. E-LAB

The laboratory environment that was looked at until now is rather standardized and typified. Doctors or Hospitals retrieve samples from the patients and send them to the pretended laboratory. For this purpose there is a logistic service provided freely by Unilabs. Then, laboratories usually receive incoming samples through the Pre-Analytics department where sample data is introduced into the Laboratory Information System (LIS) and the samples are prepared for labeling, decantation and aliquot preparation. After that initial phase, samples go through the necessary departments (Hematology, Immunology, Chemistry, Special Chemistry or Microbiology) and finally, the results are obtained. Results are sent to the recipients via telephone, fax, email or postal service (Figure 22).

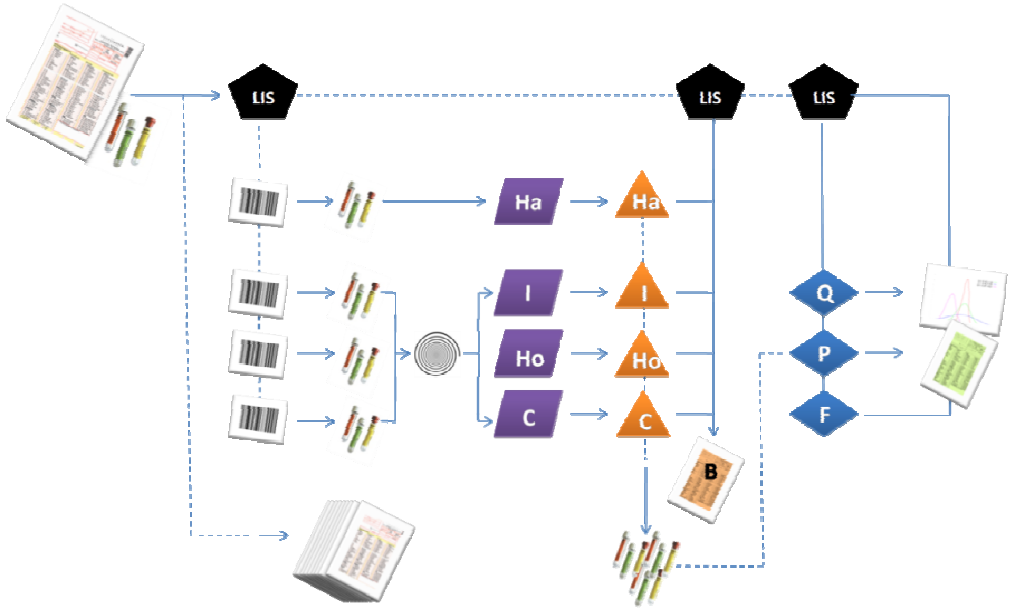


FIGURE 22 - TRADITIONAL LABORATORY MODEL

### Part I

The forms are filled out by the doctors, sent to the laboratory and received by the Pre-Analytics department. There, the information on the forms is introduced into the LIS. Automatically, labels are printed and put on the samples. The forms are checked and the doctors are contacted if necessary due to lack of information or unclear data (forms are filled out by hand). The forms are then archived. In the meanwhile the samples are delivered to the next stage to continue through the required departments.

### Part II

The samples are centrifuged if there are required tests for Chemistry (C), Homeostasis (Ho), and Immunology (I) analysis. Hematology (Ha) does not require centrifugation. The analyses are performed and the results are automatically delivered into the LIS. Tubes are stored from one week up to several years for future test repetitions. The results are sent to the doctors via different means: electronically, fax, telephone or postal service. Finally the bill (B) is prepared.

### Part III

The LIS keeps all information. If necessary billing (F) information will have to be re-checked due to data inaccuracies. Ultimately it is sent to the patient or the assurance company. Quality (Q) control and Plausibility (P) checks are also performed by the lab. This means that test repetition, supplementary test, result archiving, medical interpretation of results, and all data storage, is done by the lab.

By analyzing the above displayed stream of activities one understands that the laboratory assumes a vast spectrum of wasteful and unprofitable activities. Doctors only have to fill out a form by hand and send it together with the sample that was removed from the patient. Once received at the laboratory, technicians have to analyze the form and interpret it. Often the handwriting is a mess and data is missing. Sometimes the analyses were not correctly crossed and doubts arise about if the doctor pretended that specific analysis or not. In other cases doctors prefer not to choose the code matrix of analysis available on the form and write them by hand, causing, once again, a lot of trouble and delays. A huge amount of administration work is required for the forms to be checked but, after all, it is a service that the laboratory is willing to offer.

In the second part the samples enter the analytical phase and results are produced. The results are then sent to the doctors as was referred before and the bill is prepared. The last phase involves another considerable amount of administrative work. Quality checks, Plausibility checks and Billing are the main activities to be concluded. Samples are stored in special refrigerators in temperatures below minus 20ºC and are available for any necessity that could arise during the following years. Initial forms are stored as well, and any office work surrounding a re-testing, a supplementary testing, a technical or medical validation, or archiving, is the lab's responsibility. The service level that the laboratory is offering their customers inevitably includes all these activities. The truth however, is that a huge amount of costs are hidden behind the material and human resources put at the disposal of it. Traditionally, laboratories are organized in this manner. Independently, of the quality of the forms delivered to the doctors, the variety of tubes sold or the schedules of the express service, the main milestones of a traditional laboratory are represented in Figure 22. Unilabs, as was described in the Practical Example of the Coppet Laboratory, is making efforts to standardize forms to diminish checking procedures, reduce the amount of tubes sold to the doctors to have a more efficient sample handling, and adjust better their express service. However, in order to maintain their business competitive, and their service attractive, all three stages have to be performed by the laboratory.

After almost twenty years, an independent team that is now partly integrated into the Unilabs organization started developing the E-Lab concept. It was introduced into the market three years ago. Its main goal is to offer an alternative to the traditional approach of laboratories. All its key features and advantages are discussed below. One could risk naming this concept as the ultimate lean laboratory because it eliminates all waste and unnecessary tasks.

Until now, this concept has resulted in four laboratories that work in parallel with all remaining laboratories of the Unilabs group. The market share attained by it is still progressing at a very slow pace. In the German speaking area of Switzerland it has achieved 30%, and in the French speaking area, 7% of all current and potential customers. They are current customers of the group because no efforts have been made yet to sell the concept beyond their customer data base. And they are potential customers because only one third of them represent doctors with private offices. This system is not yet foreseen for public hospitals or private institutions, which represent the remaining two thirds.

For a customer to obtain their analyses through E-Lab they have to work exclusively with their system and order everything through their online portal (www.e-lab.ch). The entire spectrum of analysis is available on the online information system. However, only fast and routine analyses, which represent the majority, are performed at the E-Lab facilities. The remaining, more complex and delicate procedures, are re-sent to the Unilabs facilities from the E-Lab. In any case, for the doctor, the only existing interface is the online portal. E-Lab owns their express service and works totally independently from the Unilabs laboratories. In fact, E-Lab could be considered a customer of Unilabs once special requests are re-sent to their facilities.

In order to understand what the main differences are between the traditional approach and the E-Lab concept one can interpret the figure below.

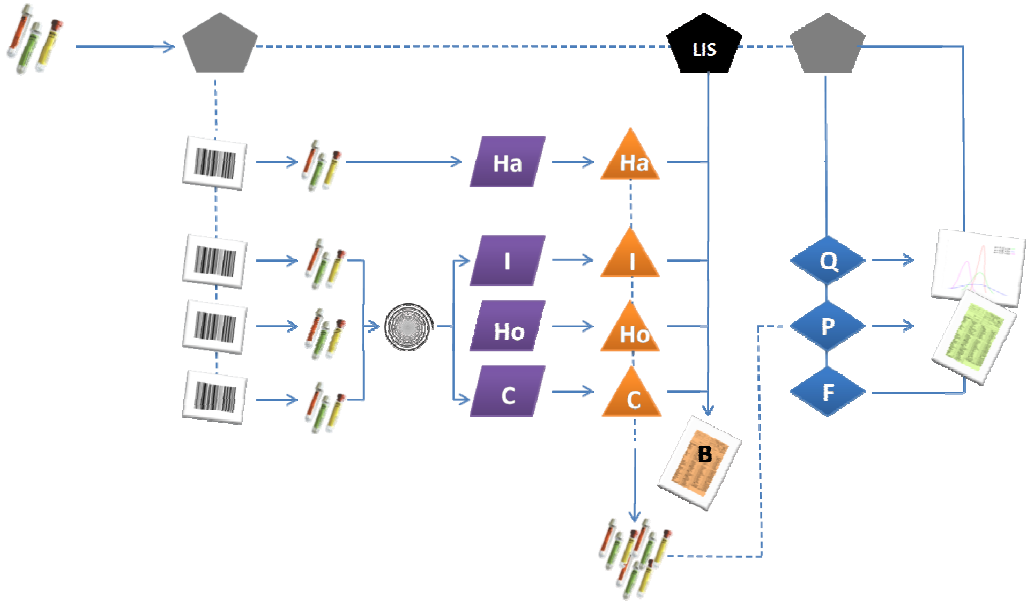


FIGURE 23 - E-LAB MODEL

This figure (Figure 23) is almost identical to the previous one (Figure 22) and it is divided in two distinct types of areas. The blue areas represent the doctors' responsibilities, while the red area represents the responsibilities of the E-Lab. Below the details of the entire system and the existing procedures are explained.

As a customer, the doctor receives an online account and the E-Lab online platform is installed on his computer. Access is then possible through username and password. The platform allows the doctor to scroll through his list of patients and view their history of analyses and results, or create new patient profiles, inserting their personal data (name, date of birth, contact, insurance, billing information, etc).

After removing a sample from a patient the doctor selects on the online platform which analyses he pretends. Every analysis type has a correspondent tube color which is visible for the doctor. This way, the doctor collects the sample into the right tube. The color is important for the E-Lab to easily distribute the tubes among the several analysis areas once they are received at the laboratory.

The doctor can also decide a schedule for the express service to pick up the samples at the medical office, or, in urgent cases, to request an immediate picking service. The system automatically creates the necessary labels for the doctor to identify the sample tubes. At this point the tubes can be collected at the medical office and be delivered to the laboratory.

When entering the lab, the samples are distributed by the color code. The analysis is performed by the existing equipment and only limited human intervention. If the samples require a more complex analysis, they are sent to Unilabs where more sophisticated equipment exists. Ultimately, the results are gathered electronically and immediately put available on the online platform. The doctor can visit his account and access the requested analysis. There he visualizes the current status of the analysis, for example, if the tests are still waiting for medical validation. If there is the need for further tests or even re-testing, the doctor disposes over a period of one week to act. After that period the samples are destroyed.

Compared to the traditional concept, E-Lab manages to implement a paper-free, electronic, and waste-free system that grants the three fundamental pillars of a laboratorial organization: (1) Speed, (2) Reliability, and (3) Economy. Errors and misinterpretations are almost totally avoided, administrative work is replaced by a sophisticated online system, and human intervention is minimal. If we compare E-Lab and the already introduced Unilabs laboratory at Coppet, we would confront 5 human resources treating a daily average of 200 patients, and over 130 human resources treating a daily average of 1300 patients, respectively. The difference is clear, not to speak about the total lead time which, in the case of E-Lab, ranges from 2-4 hours, when in other laboratories, it could take up to 24 hours. E-Lab reduces the global functioning of a laboratory to strictly the core activities, marked by the red area on the above figure.

Success in the long-term is granted, but certain questions arise: (1) “Why has this concept achieved such a slow progress yet?”, and (2) “If Unilabs is to maintain their core laboratories, what improvements should be introduced in the short-term?” But before that, it is important to understand the nature of the Swiss Health Care System.

The potential market of laboratories in Switzerland represents a total of 1.5 billion Swiss Francs. It is divided, as referred before, in three equal parts: (1) Private Medical Offices, (2) Public Hospitals, and (3) Private Institutions. Medical offices, which represent the market of interest for this matter, have the right to perform sample collections. This means that doctors are legally entitled to collect, for example blood, from patients and, additionally, invest in equipment, to perform their own analyses. Recalling the newly released law by the Swiss Government, clinical test prices suffered an average decrease of 20%. For anyone who performs analyses this has a strong economic impact. Laboratories will be able to handle this reduction due to the large volume of samples analyzed every day. Doctors, however, will face difficult times to amortize their equipment and render a profitable service. That is why doctors are heavily against this law. In the short-term, they inevitably will have to outsource that activity to professional laboratories. In what way is this related to E-Lab?

It is important to withdraw at least three relevant conclusions: (1) Contrarily to the French or Portuguese market, doctors in Switzerland are legally able to perform the collection and analysis of patient samples, (2) The activity of performing clinical analysis can be economically profitable and for doctors, when deciding about outsourcing it, a price of opportunity has to be considered, and finally (3) the laboratories' true customers are the doctors and not the patients.

This has a major implication: When laboratories are deciding about the level of service to offer their customers, the doctors, they have to consider not only the highly competitive market, but also the doctors' cost of opportunity. By limiting the range of action of the laboratory to strictly the necessary and transferring more responsibility to the doctors, these have to be compensated for that. It is relevant to understand that what happens in this scenario is the simple sharing of the entire stream of necessary activities, among doctors and the laboratory. A thorough study, performed by the initial development team of the E-Lab concept, listed the monetary equivalent for each minute spent by the doctor to assume part of the responsibilities, for each type of clinical test. Doctors are responsible for an average of 30% of the entire value stream and have to be compensated accordingly. For each minute doctors receive an equivalent to 0.98 Swiss Francs (before the new law the value corresponded to 1.64 Swiss Francs). The amount of minutes varies per type of test.

This brings us to the first question about the slow progress of the E-Lab concept. Laboratories function in an extremely competitive market. It is a hostile environment where laboratories have to set up creative strategies to conquer customers. And other reasons contribute as well. First, the doctors' mentality is still generally incompatible with sophisticated technologies and not willing to embrace new solutions as the E-Lab, preferring to rely on the traditional system where everything they have to do is to fill out a form and send it with the respective sample. The younger generations are starting to subscribe this concept and that explains the still reduced market shares in the German and French areas. Secondly, once doctors are able to render a profitable analysis service by their own, why be concerned with laboratories. Even when margins are very slim, serious efforts have to be made to convince them about the benefits and still, compensate them monetarily for their efforts. When in the future, doctors will not bother to perform a reduced number of analyses every year and avoid investments in equipment, reagents and material, and once the market is ready to fully adapt to this innovative and technological solution, E-Lab will certainly achieve success.

The second question concerns Unilabs. As explained before, E-Lab works independently. Unilabs has still to make effort to become a lean organization and eventually come up with some technological improvement as well. Let us look at the figure below and try to frame the collaboration between E-Lab and Unilabs and some of their initiatives to be implemented soon.

Figure 24 summarizes some of the previous contents. It also introduces four new concepts: (1) E-Prescription, (2) POC 1, (3) POC 2, and (4) Gyn-Online.

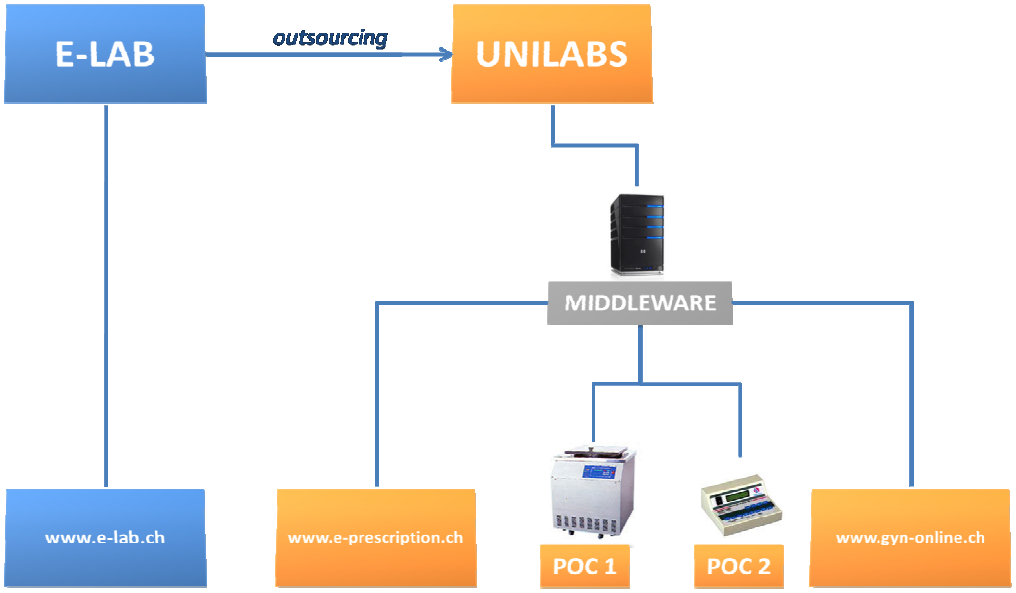


FIGURE 24 - E-LAB & UNILABS

E-Prescription is almost identical to the E-Lab concept. The main difference is that it was launched by Unilabs and intends to work exclusively with their own facilities. It is important to recall that, despite being partly integrated into the Unilabs organization, E-Lab is still a separate business unit with their own facilities. E-Prescription intends to offer the identical service to customer in proximity areas. E-Lab is present in four locations in Switzerland and this alternative grants Unilabs wider market coverage.

Point Of Care 1 (POC 1) is an equipment able to perform a small variety of routine analysis. It was designed to be installed at minor hospitals and intends to serve them during night shift or week-ends when laboratories are normally closed. Currently, Unilabs provides laboratories working 24/7 every day of the year. This little equipment would grant hospitals the chance to perform urgent analysis when required and avoid a considerable amount of costs for Unilabs.

Point Of Care 2 (POC 2) is a similar equipment. It intends to serve private medical offices and performs a limited range of tests. For routine and simple analysis the doctors would keep the chance to perform their own tests on site. This system constitutes an additional advantage in the service that Unilabs offers their customers.

Gyn-Online is an online portal identical to E-Lab, or E-Prescription but specialized in the domain of gynecology. Gynecology is a very particular area and includes an enormous variety of possible tests, in its majority, costlier than the regular type. This means that the market hides a huge potential and can be very profitable. Most of gynecologists still opt to perform their own tests, but with the transformation the market is currently undergoing, Unilabs hopes to offer an attractive alternative and attain increasing market shares.

All these systems will be connected through reliable middleware and that is currently the challenge for the group. Unilabs will install these physical and online systems at the customer's sites, additionally, everything will be connected and route back to Unilabs' own servers. From there, results are gathered and stored and set available for the customer. This means that the installed analysis equipment, POC 1 and POC 2 for example, when processing the samples, sends the information immediately to the laboratories' own system. Customers are connected to that system and can visualize results through it. The middleware is currently a challenge because a great heterogeneity in software exists. To break that barrier the laboratory will have to put efforts in creating efficient Enterprise Application Integration (EAI) systems that can connect the several automates and software interfaces.

Ultimately it is important to understand the strategic nature of the group's ambition. E-Lab and their facilities will exist in specific locations, small or medium populated areas. It will be a strategic low cost mean to grant geographical proximity to local doctors and market coverage. In parallel, the E-Prescription concept will advance using Unilabs' facilities and serve the more populated areas for those ready to accept this new tool. POC 1 and POC 2 are equipments, free of charge for doctors and hospitals that grant a higher service level, and allow Unilabs to close down their permanence centers, currently functioning during night times and week-ends. Finally, Gyn-Online will be a customized tool for gynecologists in specific offering them a convenient, reliable and fast service.

These systems work exclusively in Switzerland or similar countries where state legislation offers doctor's these kinds of liberties. Places, where the true customer of the laboratory is the patient, one would have to rethink the entire concept.

# CHAPTER 4

## 4. CONCLUSIONS

The lean journey at Unilabs delivered us with diversity in several domains: working environments, challenges and possibilities towards the optimal laboratory concept. Each laboratory had its distinct characteristics: leadership, specialties and analytical domains, geographical area, business culture, language, motivational levels and morale, or infrastructures. Each visit was certainly different and people's attitudes towards the urging need for improvement, as well.

Unilabs was facing enormous challenges. The entire group had strong ambitions to grow and expand their activity, but in fact, was heading in the opposite direction. Customers were complaining increasingly or even abandoning collaboration, the service level was deteriorating, and the competition was gaining market share. The recent acquisition operation by the proprietary group of Unilabs weakened the entire organization in Switzerland and dispersed leadership's presence and action. People's morale was affected and uncertainties rose about what the organization was aiming for. In those critical moments the group acted and decided to strive for a lean vision. The Kaizen Institute entered that vision as a fundamental partner to help with their long-term experience and their solid Kaizen methodologies.

The literature analyzed offered us a vast collection of perspectives and tools. The Lean Principles, most importantly, constituted a solid base used throughout the entire project. These principles were contained in all the used tools, every improvement action, or any of the concepts designed for the future. They are truly universal and can have tremendous effects once apprehended and integrated into our mindset: (1) Specify Value; (2) Value Stream; (3) Flow; (4) Pull; and (5) Perfection. They constitute a virtuous cycle of continuous progress by rendering the necessary foundations to create

constant awareness of our current state and the will to engage in improvement initiatives. These principles were complemented and enriched by introducing the Kaizen Management System (KMS). One could compare these two dimensions by saying that the KMS is the exploitation, description, or extension, of each one of the Lean Principles. However, it is truly important to know how to use the KMS as well, once it grants us a fundamental factor: sustainability. In fact, besides the tools and the systems, it contains that vital resource that will assures the success of any transformation process and that is the true challenge when pointing towards a lean future state.

The entire project was built upon that fundamental stone: sustainability. It is important for The Kaizen Institute to grant continuity after the terminus of their collaboration. Therefore, it undertook intensive training workshops before starting any transformation. It was key to first address people's paradigms and beliefs, and work for acceptance towards the Lean Principles. It was all about transferring the right mindset to embrace the challenges Unilabs was facing.

The initial training period was followed by workshops that brought them closer to their own reality: they confronted, mapped, analyzed, and finally understood it and then, suggested potential improvements. Many of the planned improvements that took place are reported in this work. They were strongly supported by the involvement of the local staff and their own convictions that lean can truly work. It was their motivation and team spirit, and the participation of leadership that attained such significant results in that short period of time. One might be doubtful about the displayed results, but lean is all about simplicity and merely eliminating waste and following the principles, and in this way of thinking any improvement can have a deep impact. Obviously, that the expertise and solid experience of The Kaizen Institute had a fundamental role, because, even if businesses know what to do, they still don't know how to do it, and that is where the great contribution of The Kaizen Institute resides.

After all, the progress attained at the different locations contributed strongly towards their stability and that is the necessary criteria, upon which a success strategy can reside. Unilabs is slowly but securely gaining in confidence and necessary conditions to achieve excellence and World Class Performance. In the mid-term, Unilabs will possess a solid business culture, trained in the Lean Principles, aligned towards common goals, and certainly pioneer the lean revolution in the laboratorial domain.

The Swiss Health Care System displays several differences when compared to the Portuguese, French, or Spanish Health Care System. Lean Principles apply everywhere, because their intents are, most importantly, about waste elimination. But by taking the lean concept a little further it is the Swiss that will benefit the most. Laboratories work for three main groups of customers: (1) Private medical offices; (2) Public hospitals; and (3) Private institutions. Patients do not decide where to undertake their analysis. When a sample is collected from a patient it will be sent to the laboratory working with that healthcare provider. This allows laboratories to engage in strategic alliances and transform the value chain beyond their borders.

The E-Lab concept grew based on that. It is innovative, entirely lean, and benefits totally from the advantages that only the Swiss market can offer. The business model is paper-free, grants reduced lead times, automated processes, and a single technician is

able to perform a higher volume than the equivalent processed at the traditional laboratories by an entire staff of people. This business model does not mean the extinction of the traditional laboratory, once it has a lot of other advantages to offer, but it proves the universal applicability of the Lean Principles, and most importantly, that at the normal lab, there is still a long way to go in terms of waste reduction.

Could a concept like E-Lab work elsewhere? The fundamental principles of E-Lab dictate the existence of an electronic interface between two parties and an efficient and standardized picking procedure: the right tubes, the correct labels and the timely express service. Eventually, general public entities could benefit from the idea and apply it to their interacting units within the Health Care domain. The application of the E-Lab concept in any other country would obviously depend on the specificities of the Health Care System and would require, though, a thorough assessment period.

The E-Lab concept is truly innovative and it brings us to a delicate question that has to be addressed. As was previously referred in this work, automation or information systems help to secure manual procedures, reduce errors, and improve efficiency – everything the E-Lab is about. However, caution is fundamental at this point. Lean is about creating solid and long-lasting improvements and if one is seeking for sustainability it is the mindset that is the most important factor. Once again, we return to the importance of a Total Change Management culture that grants the correct culture and attitude among those willing to defy systems in deficit.

The global trend is clearly indicating a strong development of lean in the healthcare domain. In the end, it is the patients' health that is under the scope of hospitals or laboratories. Our health is a fundamental right and it is unreasonable to expect errors or an unworthy service from these institutions. Unhappily, still today, the literature indicates great worries concerning public hospitals and their quality [in Weltwoche, Nummer 25, 2009]. Doctors or laboratory technicians often commit serious mistakes compromising the quality of their service or even endangering the patients' life. Nonprofit organizations, for example, are showing increasing commitment in this process of turning healthcare implicitly lean. They aim for waste reduction in the healthcare domain and to make lean thinking part of its future. Entities, such as the Lean Enterprise Institute and the ThedaCare Center for Healthcare Value, for example, have joined forces to be active players in the transformation of today's healthcare reality. Undoubtedly, the lean revolution in the healthcare domain has pulled off.

## REFERENCES

**ASH**, K. Owen. Impact of cost cutting on laboratories: new business strategies for laboratories. *Clinical Chemistry 42:5, 822-826.* 1996.

**BROAD** S.A. LIMS – A catalyst for re-engineering. *Laboratory Automation and Information Management 33 (1997) 9-12*. Vol. 33, No. 1, June 1997, ISSN 1381-141X.

**COIMBRA** Euclides A. Total Flow Management: Achieving Excellence with Kaizen and Lean Supply Chains. *The Open Polytechnic of New Zealand.* 2009. ISBN 978-0-473-14659-7.

**DIE WELTWOCHE**: Schweizer Spitäler können Ihre Gesundheit gefährden. *Die Weltwoche Verlags AG.* Nummer 25, 2009.

**IMAI** Masaaki. Gemba Kaizen: A Commonsense, Low-Cost Approach to Management. *McGraw-Hill 1997.* ISBN 0-07-031446-2.

**MELANSON** Stacy E. F., Neal I. Lindeman, Petr Jarolim. Selecting Automation for the Clinical Chemistry Laboratory. *Arch Pathol Lab Med*. 2007. 131:1063-1069.

**THE KAIZEN INSTITUTE**. KMS – Kaizen Management System. *Kaizen Institute Consulting Group Ltd.* 2009.

**THE KAIZEN INSTITUTE**. KMS – Kaizen Management System: KMS Quick Reference Guide. *Kaizen Institute Consulting Group Ltd.* 2009.

**URBANCE** Randy. The Machine that Changed the World by James Womack, Daniel Jones & Daniel Ross. *ESD.83 Book Review.*

**VONDERSCHMITT** J. Laboratory Organization – Automation. *Clinical Biochemistry 4*. Walter de Gruyter & Co. 1991.

**VON EIFF** Wielfried. Heinrich's Gesetz, Risk Management und Kaizen. *CKM im Dialog: Informationen, Fakten, Management-Trend im Gesundheitswesen.* Ausgabe 1, 2001.

**WOMACK** James P., Daniel T. Jones. Lean Thinking: Banish Waste And Create Wealth In Your Corporation. *Simon & Schuster UK Ltd.* 2003. ISBN 0-7432-3164-3.

**WOMACK** James P., Daniel T. Jones. Lean Solutions: How Companies and Customers Can Create Value And Wealth Together. *Simon & Schuster UK Ltd.* 2005. ISBN 0-7432-7778-3.