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Development of a Framework for Personal Excellence in Lean Logistics for Shop Floor Employees

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Abstract

The concepts and techniques of lean manufacturing have changed the world of production in the last two decades. Those changes have major implications on the support structure of manufacturing processes, namely administration and logistics.

The shift of requirements in the logistics environment has increased the demand for a well trained workforce on the shop floor level and in many places created a gap between required and actual qualifications.

It was the goal of this work to assist the LOPEC Project to analyze that gap and deduct enough information in order to create a program that helps shop floor employees overcome it. In order to do so, trainee characteristics, training design, work environment and training content were identified as factors that could influence the success of the program. Recommendations for the betterment of the training program were made after further investigation of those factors. It proved to be important for potential trainees to have not only a certain level of technical competence, but also social and leadership competence. Additionally, more general characteristics such as high motivation and general mental ability turned out to be important. In the chapters concerning training design it was found that a combination of class room lectures, programmed instruction and simulations within a learning factory should be used to deliver the material. The most crucial factors in the training environment were proven to be supervisory support and the ability to use learned knowledge. The training content was determined to include the basics of lean logistics, analysis tools, process design methods, process optimization methods and tools for quality, customer management and organizational behavior. A detailed matrix showing the training content and the required depth of knowledge for each topic was created.

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1 Introduction

In a knowledge society where demands for skills, competencies and knowledge constantly increase and change, lifelong learning is a key strategy. It is of significant importance to adjust people's performance capabilities to new requirements to improve employability in the workforce. Good examples for the increasing demands are the current changes in the logistics environment.

For numerous manufactures growing sales has been an increasingly difficult task lately, due the 2008 financial crisis and the following years of recession. This makes it more important than ever for these companies to improve efficiency by identifying and eliminating waste throughout the whole organization, which leads to innovative trends such as the transfer of lean manufacturing to the area of logistics.

Additionally, new services and processes that were originally part of production are consistently being shifted into the portfolio of logistics departments and enterprises. Hence the daily tasks for the skilled worker are changing continuously.

To skilled workers of the secondary educational level, the know-how to understand these new lean systems usually remains undisclosed, which in turn creates an discrepancy between required and actual skills. This gap of knowledge could be closed by the participation in tertiary education. However, this is usually not possible due to educational laws and certification requirements connected with the existing school education.

The LOPEC Project[1] aims to close the gap by developing and offering special-tailored training for lean logistics and required basic skills for skilled workers on the shop floor level.

The main goal of this work is to define a framework to train shop floor employees in lean logistics. This includes the discussion of what should be taught to whom under what circumstances.

1.1 LOPEC Project

The LOPEC Project was founded by a consortium consisting of Fraunhofer Institute Austria, the ESB Business School from the University of Reutlingen, the University of Dortmund, the University of Split and Eurofortis SA.

[1] Adam Europe, 2013, www.adam-europe.eu

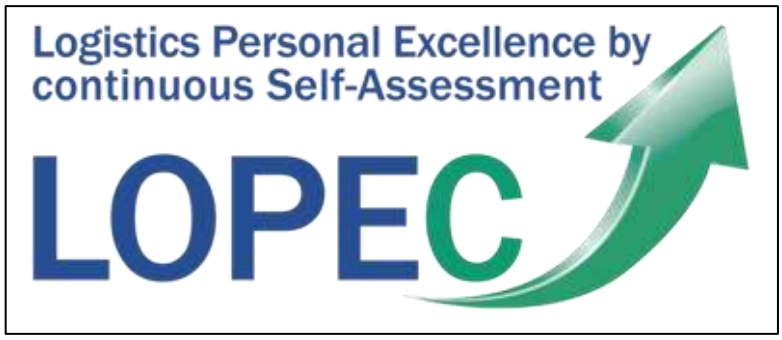


Figure 1 - LOPEC logo

LOPEC aims to close the gap between desired and required knowledge of workers in lean logistics organizations by developing and offering special-tailored training for lean logistics and required basic skills for shop floor workers. Required know-how will be taught in a special training program, which also can be used as credit for further education, such as a job related bachelors program. Another aspect of LOPEC is the development of a personal excellence self-assessment that allows a person to assess and thus improve his/her own level of maturity in employability skills. To reach this goal, LOPEC will build up on the self-assessment software solution of the SAETO project family which “translated” EFQM for use within the education and training sector.

As a result, LOPEC will provide training modules for post-secondary education in the area of lean logistics and offer transparency of personal excellence with a personal self-assessment software solution, regarding the personal maturity level of hard and soft skills at any time. It can be used as an innovative tool for monitoring personal lifelong learning routes.

Besides the development of supporting learning materials to transfer the knowledge, closing the gap between the secondary and tertiary education for skilled workers in the area of logistics the aim of the project is as well is to support the introduction of the idea of “personal excellence” with the aim of "lifelong learning".

The project receives financial support from the Leonardo DA VINCI program of the European Union, innovation transfer for vocational training and is based on the results of SAETO and Trans-SAETO. LOPEC will be transferred to several countries of the European Union, piloted in Austria, Croatia and Latvia and will be available in the respective national languages. In addition, there is a version in English language as well as free entrance modules.[2]

[2] Adam Europe, 2013, www.adam-europe.eu

1.2 Structure of the Thesis

The first challenge in the creation of this work was to find out what structure the thesis should have, what topics it should include and what topics it should not include. In order to do this the following mind map created. It illustrates the first draft for the structure of this thesis:

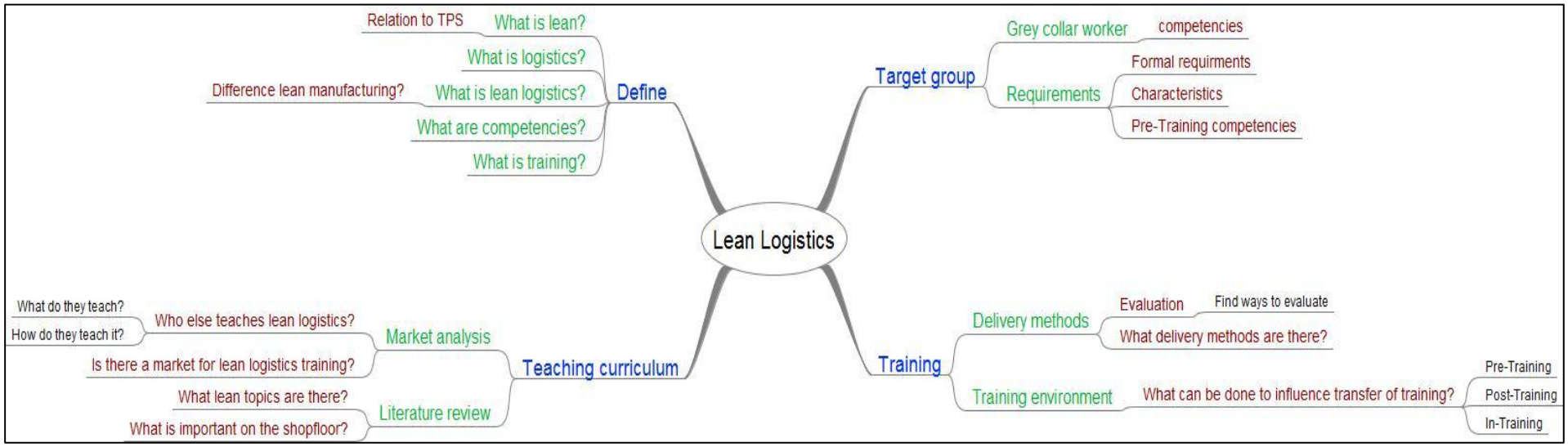


Figure 2 - Project mind map (compiled by the author)

It was soon clear that a significant part of the thesis will be of theoretical nature and that an extensive literature review will be at the core of this work. After some additional data was gathered to obtain an overview and some more structuring was done, the basic outline was then broken down into the following work packages:

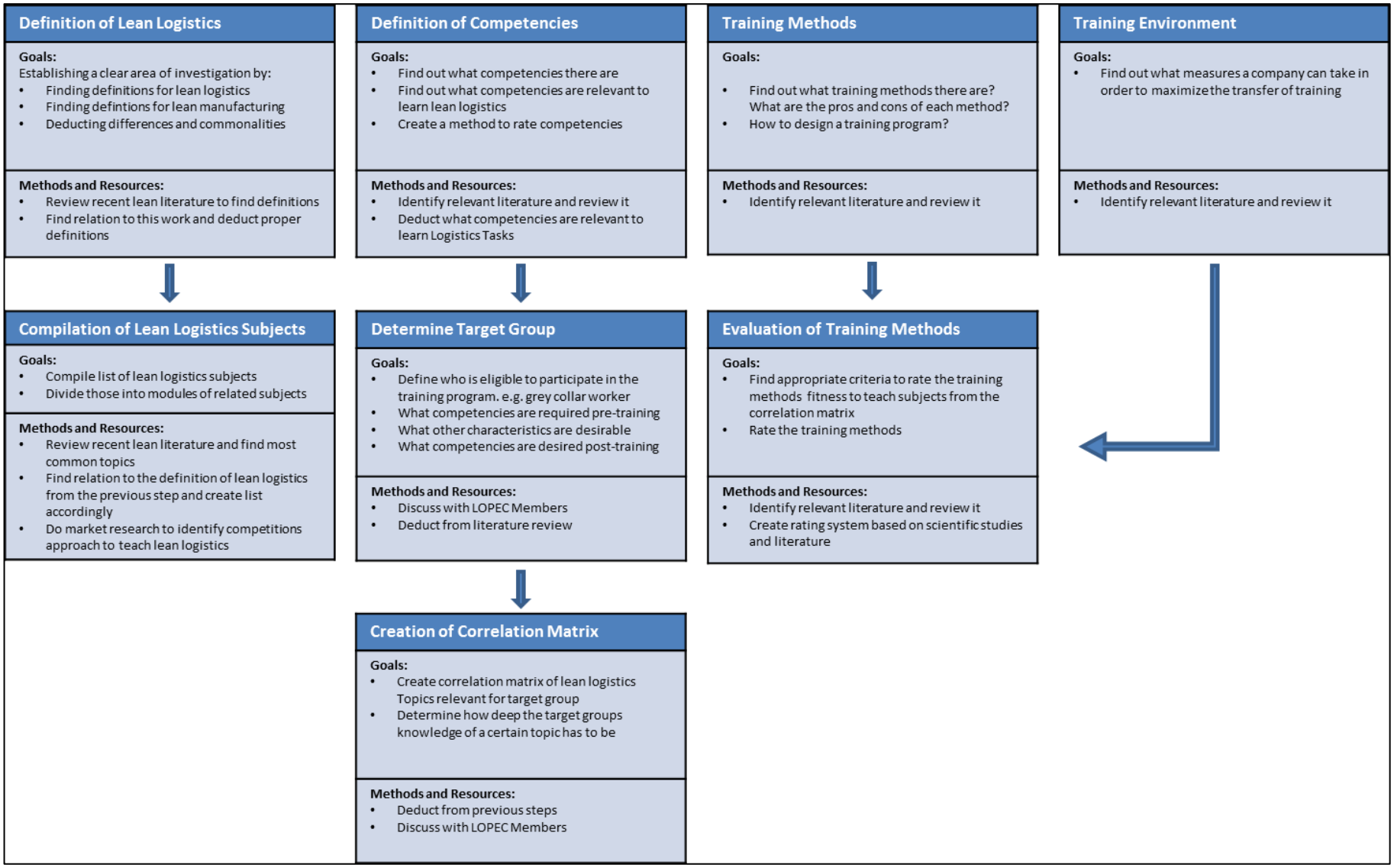


Figure 3 - Thesis divided into work packages (compiled by the author)

1.2.1 Definition of Lean Logistics

Academics and practitioners have only recently started to recognize the discipline of lean logistics. The term lean logistics is not defined clearly yet. A proper definition that relates to the goals of this work has to be found. The definition will serve as a basis to the compilation of topics to be taught. Therefore it is also important to establish a clear line between the lean disciplines. This chapter will be based on a review of the most recent lean literature.

1.2.2 Definition of Competencies

In order to define a target group in the next chapter the term competencies has to be examined more closely. Some research has to be conducted to determine if there is a mutually accepted definition of competency, what types of competencies there are and which ones might be relevant to find the target group for the training program. The most promising sources seem to be journals on psychology.

1.2.3 Determination of a Target Group

After competencies have been defined the target group can be discussed. One aspect of the target group is predefined by the LOPEC project. It consists of grey collar workers. It will be explained what a grey collar worker is and what competencies he possesses. Other aspects of the target group, such as trainee characteristics can and will be defined independently.

1.2.4 Compilation of Lean Logistics Subjects

After a definition is found, lean logistics is distinguished from lean manufacturing and lean administration, a list of relevant topics to be taught to shop floor employees can be created. This will be done by examination of recent lean literature. It will also be helpful to do a market analysis to see which companies offer lean logistics trainings at the moment and what their approach is.

1.2.5 Training Methods

In this work package information about the different training methods will be gathered. An overview of methods will be provided and the strengths and weaknesses of each method shall be discussed. A section will be included that explains the best practices of training program design.

1.2.6 Training Environment

Here it will be discussed what an organization can do to maximize the effects of training. There will be a section for training preparation and for post training measures.

1.2.7 Correlation Matrix

After the target group and the general area of lean logistics is defined the two can be connected by creating a correlation matrix. It has to be determined what topics from the previous steps are relevant for the target group and how deep the knowledge of those topics has to be.

1.2.8 Evaluation of Training Methods

In a final step the training methods that are most suitable to teach lean logistics have to be found. The challenge here will be to create a rating system that has a scientific basis.

1.3 Research Questions

Summarized, this work can be broken down into the following questions:

1. What is lean logistics?
   1.1. What are the differences and commonalities between lean logistics, lean manufacturing and lean administration?
2. What types of competencies are there and how do they relate to problem solving and learning?
3. What type of lean logistics knowledge does the shop floor employee need? What are the concrete topics he/she needs to know about?
4. What is the target group of the program? What competencies and characteristics does the group need to have?
5. What are some factors that influence transfer of training and how can the effect of training be maximized by manipulating the work environment?
6. What are the best training methods to deliver the lean curriculum?

2 Definition of Lean Logistics

In the following chapter the term lean logistics and all underlying terms will be defined.

2.1 Logistics

Logistics is concerned with the organization, movement, and storage of material and people. The term logistics was first used by the military to describe activities associated with maintaining a fighting force in the field and, in its narrowest sense, described the housing of troops. The term gradually spread to cover business and service activities.[3]

Consumers and companies need products, material and other physical objects at a time and a place where they are generally not produced. This leads to the task of operative logistics or the four rights of logistics:

> *"Logistics has to provide the right quantities of goods most efficiently at the right place in the right order within the right time."*[4]

This definition does not specify what the nature of the good is. A more accurate one would be:

> *"Logistics is design, planning, control and handling of all flows of material, goods and information in line with market conditions to carry out customers' orders."*[5]

According to Kannt this is the most accepted definition of logistics. However it still focuses on the flow of material. The council of supply chain management professionals offers a more complete definition taking servicers into consideration:

> *"Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements."*[6]

Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfillment, logistics network design, inventory management, supply/demand planning, and management of third party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production

[3] Goetschalckx, 2011, p.2
[4] Gudehus & Kotza, 2012, p.3
[5] Kannt, 2002, p.5
[6] CSCMP Supply Chain Management, 2013, www.cscmp.org

planning and scheduling, packaging and assembly, and customer service. It is involved in all levels of planning and execution--strategic, operational and tactical. Logistics management is an integrating function, which coordinates and optimizes all logistics activities, as well as integrates logistics activities with other functions including marketing, sales manufacturing, finance, and information technology.[7]

2.2 Toyota Production System

A discussion on lean logistics would not be complete without mentioning the Toyota Production System.

The technique that is called the Toyota Production System (TPS) was born through various efforts to catch up with the automotive industries of western advanced nations after the end of World War II, without the benefit of funds or splendid facilities.

Above all, the most important purpose was increased productivity and reduced costs. To achieve this purpose, Toyota put their emphasis on the notion of eliminating all kinds of unnecessary functions in their factories. The approach has been to investigate one by one the causes of various “unnecessaries” (sic) in manufacturing operations and to devise methods for their solutions, often by trial and error.[8]

To achieve cost reduction, production must promptly and flexibly adapt to changes in market demand without having wasteful slack time.

Such an ideal is accomplished by the concept of Just in Time (JIT): producing necessary items in the necessary quantities at the necessary time. At Toyota, the Kanban system has been developed as a means of dispatching production during a month and managing JIT.

Production smoothing to level the quantities and varieties in the withdrawals of parts by the final assembly line is needed for implementing the Kanban system.

Such smoothing will require the reduction of the production lead time, since various parts must be produced promptly each day.

This can be attained by small lot size production or one-piece production and conveyance.

The small lot production can be achieved by shortening the setup time, and the one-piece production will be realized by the multi-process worker who works in a multi-process handling line.

[7] Goetschalckx, 2011, p.3
[8] cf. Ohno, 2011, foreword

A standard operations routine will assure the completion of all jobs to process one unit of a product in takt time. The support of JIT production by 100 percent “good” products will be assured by autonomation (Poka Yoke).

Finally, improvement activities (Kaizen) will contribute to overall process by modifying standard operations, remedying certain defects, and finally, by increasing worker morale.[9]

In his book the “Toyota Way” Jeffrey Liker compiled that Toyotas Management culture into the 14 principles listed below.[10]

1. Base your management decisions on a long-term philosophy, even at the expense of short term financial goals.
2. Create continuous process flow to bring problems to surface.
3. Use "Pull" systems to avoid overproduction.
4. Level out the work load.
5. Build a culture of stopping to fix problems, to get quality right the first time.
6. Standardized tasks are the foundation for continuous improvement and employee empowerment.
7. Use visual controls so no problems are hidden.
8. Use only reliable, thoroughly tested technology that serves your people and processes.
9. Grow leaders who thoroughly understand the work, live the philosophy and teach it to others.
10. Develop exceptional people and teams who follow your company's philosophy.
11. Respect your extended network of partners and suppliers by challenging them and helping them improve.
12. Go and see for yourself to thoroughly understand the situation.
13. Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly.
14. Become a learning organization through relentless reflection and continuous improvement.

[9] cf. Monden, 2011, p.24
[10] cf. Liker & Jeffrey, 2004, p.35ff

Figure 4 shows a framework that illustrates how the aspects and goals of the TPS are related.

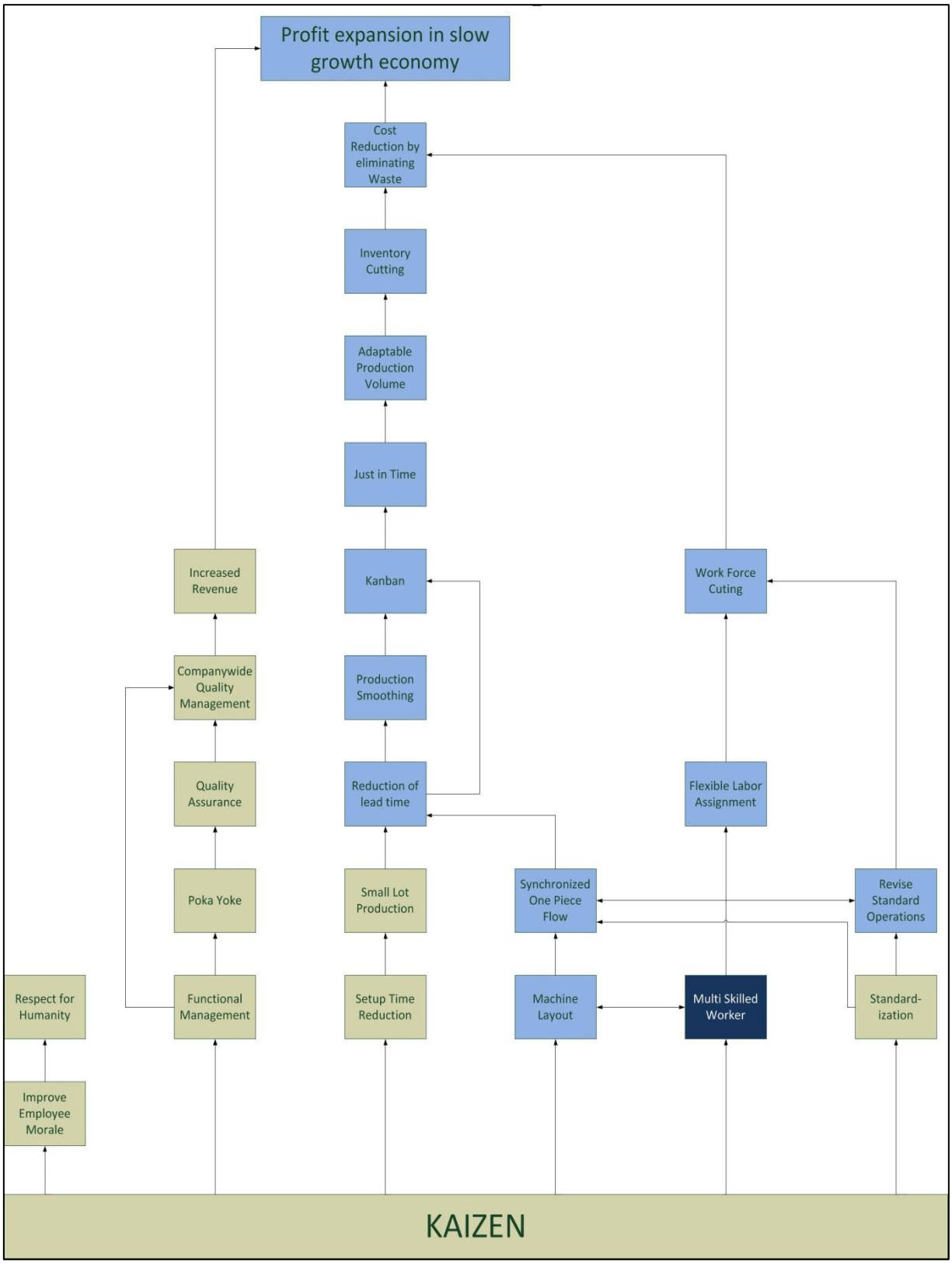


Figure 4 - The framework of the Toyota Production System (compiled by the author)[11]

[11] Adapted from Monden, 2011, p.7

In relation to this work it is important to notice two things. Firstly, most of the activities listed in this framework are of either logistical nature, pose challenges to or are somehow connected to logistics.

Secondly, the multi skilled (i.e. well trained worker) is at the origin of the system and a direct or indirect prerequisite for most other activities. The corresponding activities are marked blue in the graphic.

2.3 Lean

Lean is the Westernization of the Toyota Production System.[12] Two important books popularized the term lean:

- *The Machine that Changed the World*, by James Womack and Daniel Jones published by Simon & Schuster in 1990.
- *Lean Thinking*, by James Womack and Daniel Jones published by Simon & Schuster in 1996.

Like the TPS, lean's aim is to increase profits by reducing production cost and improving customer value. Figure 5 illustrates this:

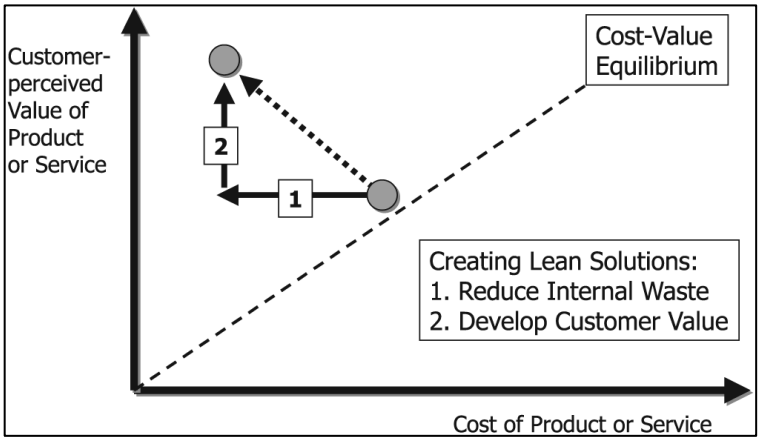


Figure 5 – Relation of value cost and waste[13]

According to Womack and Jones the five lean principles are:

- *Value:* "The capability provided to the customer at the right time at an appropriate price, as defined in each case by the customer."
- *The Value Stream:* "Specific activities required to design, order, and provide a specific product, from concept to launch, order to delivery, and raw materials into the hands of the customer."

[12] cf. Plenert, 2007, p.145
[13] Jones et al, 1997, p.997

- *Flow:* "The progressive achievement of tasks along the value stream so that a product proceeds from design to launch, order to delivery and raw materials into the hands of the customer with no stoppages, scrap or backflows."
- *Pull:* "The system of cascading production and delivery instructions from downstream to upstream in which nothing is produced by the upstream supplier until the downstream customer signals a need."
- *Perfection:* "The complete elimination of muda (waste) so that all activities along a value stream create value."[14]

Figure 6 illustrates the five principles as five circular steps. It is supposed to be a guideline for implementing lean.

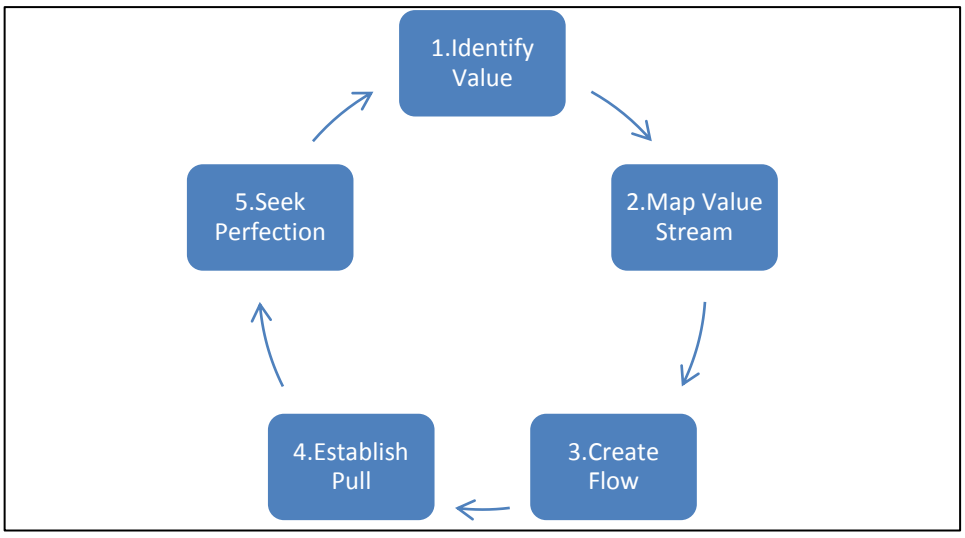


Figure 6 - Wheel of lean[15] (compiled by the author)

Although lean principles are rooted in manufacturing, they are being applied universally. Lean outgrew the factory and can today be found in offices, hospitals, universities and many other places.

2.4 Lean Manufacturing

There is a common assumption that the Toyota Production System and lean manufacturing are synonymous. It is true that lean tools, such as Kanban and Poka Yoke are derived from TPS, but TPS itself is more than just a set of tools.

As mentioned before the main aim of TPS is to maximize profit in a slow growth economy. In the highly mature, competitive automotive industry, Toyota believes they cannot dictate price, and the market decides how many units will sell in the long run. Hence, the only lever they have to control is cost, so all effort is made to manufacture

[14] cf. Womack, 2003, p.306ff
[15] cf. Lean Enterprise Institute, 2013, www.lean.org

in such a way as to reduce cost; otherwise the company will go out of business and not earn the right to grow and provide higher wages etc. to employees.[16]

Lean implementations tend to de-emphasize this key measure and thus become fixated with the implementation of TPS concepts such as "flow" or "pull". But of course implementing tools without a good foundation will result in failure. When Taiichi Ohno started Toyotas transformation in 1955, he had an extremely sound quality control system in place. In fact, the first application of Toyota's jidoka system predated the Toyota Motor Company. It was done in the Toyoda Spinning and Weaving Company in 1902. Today, few companies have this same solid and mature foundation of quality when they embark on a lean initiative. Thus they must simultaneously work themselves out of a serious quality problem while trying to implement quantity control measures. Lean efforts today have become synonymous with not only quantity control but also quality control, which was never an issue with Ohno.[17]

Furthermore, lean uses many tools that where "made-to-measure" for certain challenges that Toyota encountered. They might not be as effective once they are adapted to solve other problems. For example value stream mapping is great to analyze the flow of materials but it might not be the perfect choice to resolve anything related to profits.

Perhaps the most important difference is TPS' focus on company culture. Toyota has not only been an innovator in improving manufacturing techniques, but they have sustained this excellence for over 50 years. They have done this by not only implementing lean techniques, but also by managing the culture in such a way as to sustain these gains through every kind of change and challenge imaginable. They manage their culture consciously, continuously, and consistently.[18] They do not rely on single change agents or black belts. Instead they create a culture of self-improvement using the 14 principles described in Chapter 2.2, including every supervisor and production manager. As a result, Toyota employees generate over one million process improvement ideas annually. The more astonishing number is the fact that 90 per cent of those ideas are implemented.[19]

In many companies implementing lean, the reverse set of priorities is true. Emphasis is put on developing the specialist, while the supervisor skill level is expected to somehow develop over time on its own.[20]

[16] Smalley, 2013, www.superfactory.com
[17] cf. Wilson, 2010, p.31
[18] cf. Wilson, 2010, p.31
[19] Farmer, 2008, p.71
[20] Smalley, 2013, www.superfactory.com

Ivan Kochnev wrote a paper comparing the 14 cultural principles of the Toyota way with lean literature.[21] He concluded that TPS principles 1, 4, 8, 9, 11 and 13 are not reflected or are significantly different in the lean literature. Like Plenert he speculates that lean is an adaptation of the Eastern philosophy of Toyota to the Western thinking; lean is putting the Toyota principles to work in a way that is easier for the Western culture to understand and apply.

The lesson learned from this chapter should be that it is important to teach underlying principles and not only tools. Trainees not only need to have professional competence to know how to apply a tool, but they also need the methods competence to know its limitations. Furthermore lean transformation has to be accompanied by a transformation in company culture. Therefore a motivational module must not be missing in this training curriculum. The practice of restricting the training to high potentials has to be questioned, since this practice does not affect company culture in a significant way.

For an extensive list of lean manufacturing tools please refer to Chapter 7.

2.5 Lean Administration

In this work the lean administration will refer to the administrative structure that supports lean manufacturing and lean logistics and the application of the lean principles to the administration process itself. The lean administration is responsible for performing analysis, evaluating data, providing oversight of logistics and production activity and regulating the flows of physical product, information, and cash.

Many companies are turning to technological solutions to provide improved oversight and ease of administration. Take warehouse management systems (WMS), for instance. A capable WMS can not only help the warehouse employee perform tasks more effectively, but can also provide ready measure of that employee's performance by tracking productivity and accuracy in warehouse execution.[22]

For an extensive list of lean administration tools please refer to Chapter 7.

[21] cf. Kochnev, 2013, p.1ff
[22] Goldsby & Martichenko, 2005, p.53

2.6 Lean Logistics

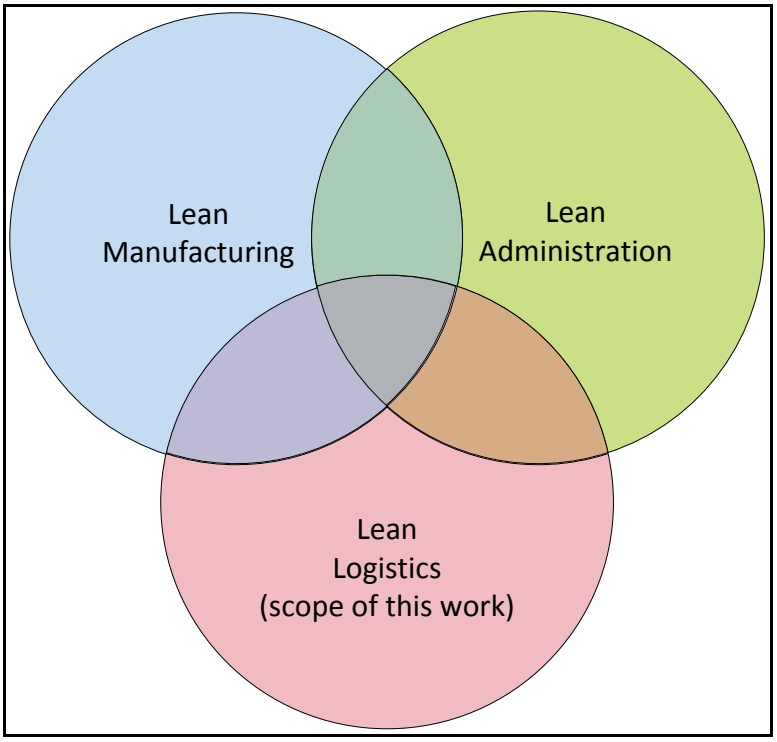


Figure 7 – Lean Venn diagram (compiled by the author)

The scope of this work is concerning lean logistics. In today's literature the term lean logistics is ambiguously defined and the differentiation between lean logistics and lean manufacturing is not very clear.

Generally speaking production are the operations that are necessary to make goods or to perform a service. Logistics is comprised of all the operations needed to deliver goods or services except making the goods or performing the services.

So for example bringing work pieces, fixtures or tools to the production line is considered logistics, but cutting metal is not. Logistics include bringing a plane to the gate, getting passengers on and off, arranging for a crew to be available, loading and unloading luggage, etc., but not piloting the plane.[23]

Baudin defines lean logistics as the logistics dimension of lean manufacturing and states that it could also be applied to services,[24] therefore implying that it is not just a subordinated part of lean manufacturing but an own entity.

Yen-Chun Jim Wu came up with a more specific definition:

[23] cf. Baudin, 2004, p.10
[24] cf. Baudin, 2004, p.28

"*Lean logistics refers to the superior ability to design and administer systems to control movement and geographical positioning of raw materials, work-in-process, and finished inventories at the lowest total cost.*"[25]

While more specific, this definition still does not mention by what means these efficient systems are designed and it does not mention any of the lean principles. Moving items at low costs might also be achieved by increasing volume or by automation. Therefore the search for an appropriate definition of lean logistics will be continued.

In his book "The Lean Enterprise" Alexander C. Tsigkas defines lean logistics as follows:

"The term lean logistics refers to the use of a lean flow method in the (…) supply chain. The purpose is the reduction and the elimination of all activities which do not add value to the value stream of the (…) logistics through formalizing the logistics activities."[26]

This definition mentions three of five (value, value stream, flow) lean principles and does not restrict logistics to the movement of physical goods.

In relation to this work the term lean logistics refers to the application of the five lean principles to shop floor logistics. More accurately:

"Lean logistics refers to the use and constant improvement of a lean flow method in the supply chain. The purpose is the reduction and the elimination of all activities which do not add value to the value stream from a customer's perspective."

Since a lean transformation on the shop floor requires changes in supplier behavior and distribution, lean logistics may not be viewed as an isolated, internal endeavor. This work will try to take the whole supply chain into consideration. It will mainly deal with lean warehousing and lean supply chain management as these are undisputable parts of lean logistics. It will also address the interfaces and overlaps to lean manufacturing, lean administration and traditional logistics.

For an extensive list of lean logistics tools please refer to Chapter 7.

[25] Wu, 2002, p.19
[26] Tsigkas, 2012, p.110

2.6.1 Logistics and Manufacturing

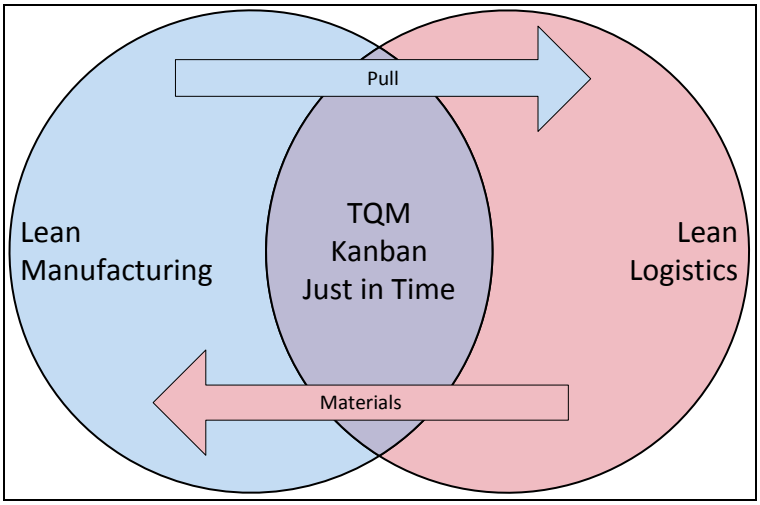


Figure 8 - Relation between lean manufacturing and lean logistics (compiled by the author)

A distinguished feature of lean systems is the closer alignment between manufacturing processes through logistics. The upstream suppliers and the downstream manufacturers are linked and dependent, which significantly reduces warehouses space and work-in-process inventories. The lean system succeeds by sharing information, such as pull signals to assure the coordinated movement of materials from process to process on a just in time basis. In this static, but coupled system, the role of logistics is to link individual processes to their nearest neighbors so that lean manufacturing can operate as a "pull" system.[27] A smooth one piece flow is only possible if machines are supplied with the right amount of the right materials at the right time. Therefore methods like Kanban, TQM and just in time have to be well known by production workers and logistics employees. On the other hand methods that are exclusive to manufacturing such as SMED or cell design might turn out to be less interesting for lean logistics employees and methods exclusive to logistics such as milk runs might be less useful for manufacturing workers.

Furthermore lean logistics and lean production share some common lean methods. Logistics equipment, such as forklifts, has to be maintained just like the manufacturing equipment, using TPM, continuous improvement can be facilitated using Kaizen, and waste may be analyzed using the 3mu method.

[27] cf. Swamidass, 2006, p.32

2.6.2 Logistics and Administration

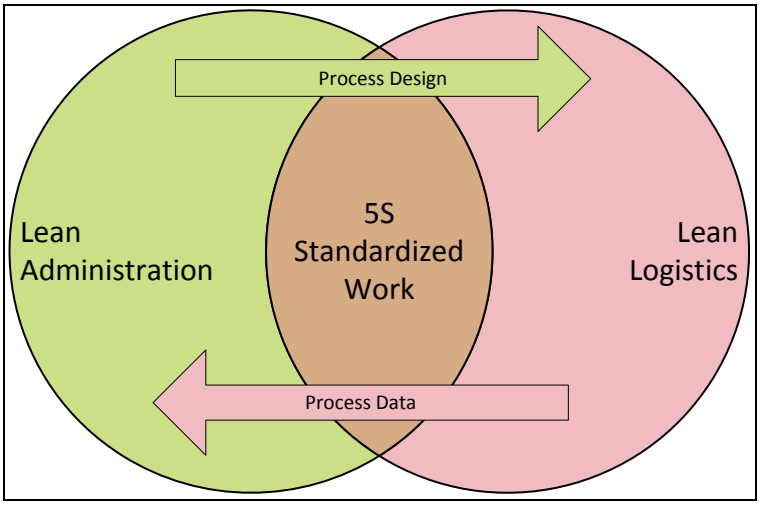


Figure 9 - Relation between lean logistics and lean administration (compiled by the author)

All business processes can be classified as either material (manufacturing) or non-material (administration). In manufacturing companies those two go hand-in-hand. Every manufacturing process has to be supported by an administrative process.[28] The first step of a lean transformation is usually a value stream analysis which can be considered an administrative process. Business processes and analysis designed and performed by the administration are the basis for any lean logistics organization. According to Myerson as much as 60 to 80 per cent of a product or service lead time can be found in the office environment. This may include functions as diverse as customer service, order management, quoting, engineering and R&D.[29]

Lean logistics and lean administration also share some methods such as 5S, standardized work or analytical tools like 5-Why.

Sailer named the differences between lean administration and lean manufacturing as follows:[30]

- *Non-material products:* Non-material goods are of course invisible. Therefore they always require a medium to be made visible. Those media are numerous; forms, letters, computers, calculations, protocols to just name a few. This makes it harder to track the value stream.
- *Invisible processes:* There is a similar situation concerning processes. Bottlenecks or scrap cannot be as easily seen in an office environment.
- *Collecting process data*: Due to the two previous points mentioned it is hard to collect process data.

[28] cf. Sailer, 2012, p.6
[29] Myerson, 2012, p.14
[30] cf. Sailer, 2012, p.9ff

- *No setup times:* In office environments there usually aren't any machines that require set up. This means that workers in administration can quickly transition between processes.
- *Process changes*: Can be attained much quicker in an administrative environment because they normally don't require the physical movement of things (e.g. tools, productions lines, raw material etc.).

The differences between lean administration and lean logistics can be deducted from that list. In fact when observing Wu's definition restricting lean logistics to the movement of physical goods, the list also applies for lean logistics.

If the flow of information within logistics is taken into consideration the dynamic changes and the problems concerning invisible goods (information) also applies for logistics.

2.6.3 Lean Logistics and Traditional Logistics

Just like traditional logistics, lean logistics is comprised of all the operations needed to deliver goods or services, except making the goods or performing the services. However the way this is done differs. The main characteristics that distinguish lean logistics from traditional logistics are:

- *Focus on the customer:* In traditional logistics "the business people who run the companies involved in a supply network are trained to focus on customers, not suppliers."[31] So parts of the organization are focused on the customer. Distribution might be very customer orientated, but the effect on the rest of the supply chain is not considered.[32] What distinguishes lean logistics from traditional logistics is the consequent implementation of customer orientation in all the processes of the supply chain. One method to achieve this is the concept of the internal customer, a concept not known in traditional logistics. Traditional logistics might even use a push oriented "we sell what we make" distribution. The exact opposite of the demand based pull supply chains in lean logistics.
- *Process orientation:* In traditional logistics organizations, supply chains are often viewed as a collection of functional areas. This may result in a situation where the single parts of the supply chain don't know why they perform a certain task.[33] Furthermore processes are neither standardized nor stable. In modern logistics that use the lean approach, a company is viewed as a combination of highly integrated processes. Additionally, processes are

[31] Baudin, 2004, p.14
[32] cf. Baudin, 2004, p.15
[33] cf. Goldsby et al, 2005, p.57

viewed as assets requiring investment and development as they mature.[34] A mean to achieve this is Kaizen.

- *Material flow*: In traditional logistics material does not flow through the supply chain continuously. One reason for this is that there are no organized methods to analyze and avoid waste. Hence waste is accumulated in the form of excessive safety stocks and waiting time preventing that constant flow. Lack of customer orientation makes it impossible to move inventory in synchronized tact. Suppliers are not well integrated in the supply chain making it impossible for them to deliver in appropriate tact.
- *Systems orientation*: As mentioned above supply chains are not viewed as a system of processes in traditional logistics. They are viewed as the sum of its parts and each part is optimized and viewed as isolated.[35] The problem with that is that improving one activity might cause trouble in another activity. E.g. decreasing transportation costs by consolidating shipments to bigger batches might increase warehousing costs due to larger stocks and inhibit flow. That's why modern lean logistics aims to view the supply chain as a whole.
- *Flexibility:* The stable and standardized processes of lean logistics are the prerequisite for supply chain flexibility.[36] The lack thereof in traditional logistics makes flexibility unlikely to be achieved.

2.6.4 Role of Workers in Lean Logistics

The social relationship within the work team is extremely important for lean production to be effective. Peer relationships among team members, and the quasi-coach, quasi-staff support provided by the team leader, replace the traditional foreman whose rule was authoritarian in style and rule-based.

In its place is the interdependence that accompanies a multi-skilling strategy and a "no buffer" philosophy that eliminates utility workers, so that absenteeism for one worker affects the workload of his or her teammates. The peer controls that emerge in such a situation can easily turn poisonous if there is not some degree of group cohesion, some process of close-to-the-source dispute resolution, personal influence that is based on expertise rather than seniority, and incentives that align team member interests with each other and with other teams in the plant.[37]

[34] cf. Lockamy & McCormack, 2004, p.272
[35] cf. Jones et al, 1997, p.154
[36] cf. Goldsby et al, 2005, p.32
[37] Babson, 1995, p.57

3 Training Methods

3.1 Definition of Training

Industrial psychology literature defines training from trainee and trainer perspectives. From a trainee perspective, training is the systematic acquisition of skills, rules, concepts, or attitudes that result in improved performance in another environment and whose effectiveness stems from a learning atmosphere systematically designed to produce changes in the working environment.[38]

From a trainer's perspective, including the organization providing the training, training is a planned effort by an organization to facilitate the learning of job-related behavior on the part of its employees; the term "behavior" includes knowledge and skills acquired by the employee through practice.[39]

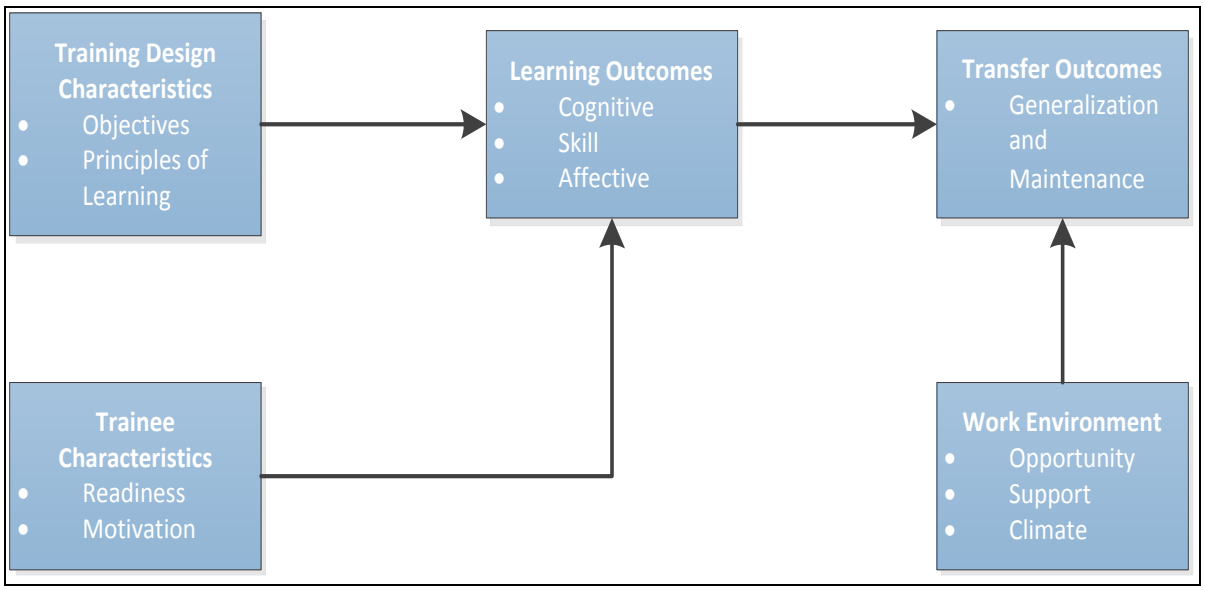


Figure 10 - Characteristics affecting learning and transfer outcome[40] (compiled by the author)

As Figure 10 shows the characteristics affecting the learning and transfer of training outcome, according to Baldwin and Ford, are trainee characteristics, training design and work environment. In following chapters those characteristics will be investigated more closely.

[38] cf. Goldstein, 1986, p.1ff
[39] cf. Wexley, 1984, p.519
[40] cf. Adapted from: Baldwin & Ford, 1988, p.65

3.2 History of Employee Training

Training as an activity was formally recognized as early as the Industrial Revolution. The spurt of industrial activity, however, did nothing to support workforce training, partly due to the fact that machines were considered far more efficient than the worker, and partly due to the social legislation that existed in the 18th and 19th centuries in England.[41] Even towards the end of the late 19th century, industries considered training workers a waste of resources. Frederick Taylor[42] changed attitudes towards worker training with his scientific management methods; he advocated the selection of the best workers for different tasks, followed by extensive training for such tasks.

The World Wars promoted systematic training and selection of personnel for the wars. Subsequently, the United Kingdom promulgated the Industrial Training Acts of 1964 and 1973. Training was thus formally recognized as an important activity.[43] In the United States, Federal legislation such as the Area Redevelopment Act of 1961, the Manpower Development and Training Act of 1962, the Vocational Education Act of 1963, and the Economic Opportunity Act of 1964 recognized the importance of training the workforce for improving the economic choices of the workers.[44] Title VII of the 1964 US Civil Rights Act resulted in consideration of training and training benefits as employment decisions. According Mealiea and Duffy,[45] employers in the United States have, by and large, pursued a training philosophy (organization identifies the deficiencies in workers and trains them to improve performance), rather than a selection philosophy (organization identifies individuals with strong potential and prepares them for positions in which they are expected to advance). The pursuit of a `training philosophy', as opposed to a `selection philosophy', and the emphasis towards training as a tool to facilitate employee learning is reflected in McGehee's and Thayer's[46] definition of training. According to McGehee and Thayer, "training in industry is the formal procedures which a company uses to facilitate employee's learning so that their resultant behavior contributes to the attainment of the company's goals and objectives." In the event that training is used as an employee selection tool, the United States case law requires that performance during training correlates significantly with job performance. Training programs are now considered vital instructional systems that meet specific learning and behavior needs of the workforce.[47]

[41] cf. Downs, 1986, p.2ff
[42] cf. Taylor, 1911, p.1ff
[43] cf. Latham, 1988, p.545ff
[44] cf. Walsh, 1967, p.1ff
[45] cf. Mealiea & Duffy, 1985, p.3ff
[46] cf. McGehee & Thayer, 1961, p.10ff
[47] cf. Pennathur, 1999, p.295

3.3 Benefits of Training

Overall, training leads to acquiring new skills and/or improvements in existing skills.[48] These, in turn, lead to two distinct economic benefits:

- improvements in individual choices and earnings, and
- cost savings for the organization

Economic benefits of training for organizations include significant improvements in productivity through improvements in quality, reduction in scrap and waste, reduction in throughput time, greater flexibility to respond to needs, and a competitive advantage of employers in general.[49]

People with low skills or a lack of skill that are in demand on the job market have limited choices and low earnings.

The United States Department of Labor has reported that formal worker training introduced in 180 manufacturing firms in the United States increased overall productivity by 17% in 3 years when compared to industries that did not introduce any training program. The Department of Labor also reported that another survey of 157 small manufacturers observed a drop of 7% in scrap and an increase of 20% in the productivity of production workers.[50]

Furthermore, training makes manufacturing personnel develop an understanding of the products, processes and systems that they are required to manufacture or operate.

There is now a general consensus among industries, governments, researchers in academia, and industrial practitioners that for a manufacturing entity to be competitive in the global market, the development of the human resources base in manufacturing is critical.[51]

3.4 Delivery Methods

This chapter should provide a general overview of delivery methods. Later it will be discussed what methods are fit to train the shop floor workforce and what method or combination of methods is well suited to teach lean logistics.

[48] cf. Carnevale & Goldstein, 1990, p.2
[49] cf. Mital et al, 1999, p.173ff
[50] cf. US Department of Labor, 1993, n.p.
[51] cf. Pennathur, 1999, p.296

3.4.1 Class Room Training

Traditional class room training is the most commonly used training method today.[52] It typically involves a group of students that are instructed by one teacher. It has the advantages of interactivity and face-to-face communications. However, quality of class room training depends on the group size[53] and employees are required to dedicate a particular period of time to prepare and attend the classroom training, which can interrupt the regular schedule in production.[54] It is also heavily instructor dependent, which often results in a variance of instructional quality.

3.4.2 On the Job Training

One the job training (OJT) at its most fundamental level can be defined as two people working closely together so one person can learn from the other one.

OJT is one of the oldest forms of teaching and a significant part of human capital is accumulated through on-the-job training and, over their lifetimes, workers acquire most of their new and improved skills on the job.[55]

In response to quality standard ISO 9000 and budget constraints; companies have been “organizing” the OJT process. Specific employees are designated OJT trainers, checklists of required skills are used to ensure that all employees receive the same training and the training effort is tracked and recorded. Because an organizational structure supports the training, this is called structured OJT. OJT is more efficient than unstructured OJT and in some reports companies relate a 60 to 80 percent decrease in training time.[56]

3.4.3 Conventions, Conferences and Trade Shows

Conferences will generally have speakers who will address certain hot topics in their respective fields, or they will provide training in the particular response area. Additionally, at many conferences, trade shows are going on simultaneously. These trade shows will generally have new products on display, which provide an excellent opportunity to discuss new and evolving technology. Conferences also enable employees to interface with other people that may face similar challenges on their shop floor.[57]

[52] cf. Dolezalek, 2004, p.20ff
[53] Barbazette, 2006, p.100
[54] cf. Köster-Abad, 2008, p.1
[55] cf. Almeida et al, 2011, p.105
[56] cf. American Society for Training & Development, 1998, p.171
[57] cf. Bennett, Gregory, 2010, p.150

3.4.4 Self-Study

Independent study or self-study is individualized instruction. Participants may use a set of guidelines to seek out their own material or they may participate in a form of programmed instruction. Both self-study techniques are self-paced, flexible, and generally available on demand. Programmed instructions may come in the form of printed self-instructional materials or teaching machines.[58]

3.4.5 Discussion

In the discussion method, the trainer and the participants exchange ideas about a given topic. This is a more active form of learning and is better for teaching analytical skills than the class room method. Here virtually everyone participates. Discussions can employ structured group techniques such as the nominal group technique to facilitate brainstorming, or they may work together on a less formal basis.[59]

This method generally works better in smaller groups. Most authors recommend a group size from five to seven.[60]

Group discussions may encounter problems when some participants are not accustomed to this style of instruction and are therefore afraid to ask questions or speak up. It is therefore recommendable separate staff and supervisors.

3.4.6 Job Rotation

Job rotation involves shifting individuals from one position to another to gain a more well-rounded experience. Employees rotate through a number of job positions that are at approximately the same level and have similar skill requirements. Job rotation is a type of cross-training in that employees learn to complete several tasks, or jobs, not just one. Job rotation has proven particularly beneficial in manufacturing settings.[61]

3.4.7 Simulations

A simulation is a form of experiential learning. Simulations are instructional scenarios where the learner is placed in a "world" defined by the teacher. They represent a reality within which students interact. The teacher controls the parameters of this "world" and uses it to achieve the desired instructional results.[62]

[58] cf. Hannum et al, 1989, p.143
[59] cf. Hannum et al, 1989, p.142
[60] cf. Cragan & Wright, 1999, p.150
[61] cf. Lewis, 2006, p.193
[62] Saskatoon Public Schools, 2012, http://olc.spsd.sk.ca

Simulations can be used to teach both procedural and problem solving skills. For the teaching of procedural skills, simulations can provide a cheaper and safer environment than on the job training. With this method participants can practice behaviors and receive feedback via models or mock-up situations.[63]

Simulations can come in a number of forms. They may contain elements of a game, a role-play, or an activity that acts as a metaphor. The chief element is that they have context. Learning factories are a type of simulation. The primary distinctions between a game and a simulation are the nonlinear nature and the controlled ambiguity. Participants must make decisions within its context.

Virtual reality can be a very helpful and valuable tool for the simulation of manufacturing systems.

A notable type of simulation that is relevant to this thesis is the learning factory. It typically is a mockup factory where trainees can apply new learned skills in a safe but realistic environment.

3.4.8 E-Learning

E-Learning is a general term used to describe education where the medium of instruction is computer technology. In practice e-learning is synonymous with Internet-mediated instruction. E-teaching processes typically include a variety of applications of Internet tools, for example, online study groups, web-released tests and quizzes, and instructional use of communications tools. In companies, e-learning refers to strategies that use the company network to deliver training courses to employees.[64]

3.4.9 Exchange Programs

Exchange programs are mostly used by educational organizations, but could also be applied to a manufacturing setting.

An employee switches to another group, department, city, or any other division in the company for some time. There, the employee gains exposure to the culture, employees, and methods of that location.

The aim is the exchange of ideas between different similar branches of a company.

[63] cf. Hannum et al, 1989, p.144
[64] cf. Iskander, 2010, p.61

3.4.10 Role Play

Role play permits participants to learn by pretending. A role that approximates real life situations may be acted out individually or as a group. Role playing can be designed to give people the opportunity to make new behaviors habitual through practice. Participants may also be asked to reverse roles which can lead to greater empathy for the perspectives of others. This method is good for teaching interpersonal and practical skills in areas such as counseling, interviewing, customer relations, effective selling, or conflict management.

While this technique is very effective in helping people to recognize that there is seldom one best solution to any problem or conflict, it can be a time consuming method. Participants may additionally feel uncomfortable if they are unfamiliar with the role or unaccustomed to expressing their emotions in front of other people. Role-Playing may also be perceived as artificial, as is sometimes the case with simulations.[65]

3.5 Learning Methods and Perceptual Modes

Adults learn through a variety of different means. Some may learn better from listening; others might be visual and prefer to read instructions; someone else may need a demonstration. According to W.B. James and M.W. Galbraith, a learner may prefer one of the following six perceptual modes:[66]

- Visual
- Print
- Aural
- Interactive
- Tactile
- Kinesthetic

A variety of different learning styles might be represented in the training attendees. Therefore a good training program has to accommodate such different styles, to ensure that the needs of every trainee are being addressed.

Another important consideration is that people generally learn by doing, not by being told to do something.[67]

[65] cf. Hannum et al, 1989, p.145
[66] cf. Lawson, 2012, Chapter 2, para. 6
[67] cf. Lawson, 2012, Chapter 2, para. 9

3.6 Designing a Training Program

After the trainees have been chosen and the training objectives have been identified, the next step is to design a training program. This should take into account learning objectives, trainee characteristics, current knowledge about learning processes, and practical considerations such as constraints and costs in relation to benefits.

Baldwin & Ford[68] did a review of organizational training literature in 1988 and found that much of the research on learning principles (e.g. identical elements, stimulus variability, conditions of practice) was done with college students on short-term memory tasks and simple motor tasks. In 1999 Pennathur et al[69] did a similar review and concluded that very little training-related work exists in engineering and that the bulk of training research in the behavioral sciences has dealt with non-manufacturing occupations, such as music, police work, training in the military, and languages.

As result, these learning principles have limited utility for designing training to develop the complex skills required in most organization jobs. However according to Tannenbaum & Yukl[70] there are at least five universal training principles that can also be applied to a manufacturing setting. These are:

1. The instructional events that comprise the training method should be consistent with the cognitive, physical, or psychomotor processes that lead to mastery. For example, the training method should guide the learner to the most appropriate encoding operations for storing information in memory.
2. The learner should be induced to produce the capability actively (e.g. practice behaviors, recall information from memory, apply principles in doing a task). The more active the production the greater the retention and transfer (e.g. restating or applying principles rather than just imitating it repeatedly in the same situation.)
3. All available sources of relevant feedback should be used, and feedback should be accurate, credible, timely and constructive.
4. The instructional processes should enhance trainee self-efficacy and trainee expectations that the training will be successful and will lead to valued outcomes. For example, training should begin with simple behaviors that can be mastered easily, then progress to more complex behaviors as trainees become more confident.
5. Training methods should be adapted to differences in trainee aptitudes and prior knowledge.

[68] cf. Baldwin & Ford, 1988, p.63
[69] Pennathur et al, 1999, p.303
[70] Tannenbaum & Yukl, 1992, p.404

3.6.1 Picking Delivery Methods

A number of typologies have been offered for categorizing skills and tasks.[71] [72] [73] Given the fair amount of overlap between them, they can all be summarized into a general typology that classifies both skills and tasks into three broad categories:

- *Cognitive;* related to the thinking, idea generation, understanding, problem solving, or the knowledge requirements of the job.
- *Interpersonal*; related to interacting with others in a workgroup or with clients and customers. They entail a wide variety of skills including leadership skills, communication skills, conflict management skills, and team-building skills.
- *Psychomotor*; involve the use of the musculoskeletal system to perform behavioral activities associated with a job. Thus, psychomotor tasks are physical or manual activities that involve a range of movement from very fine to gross motor coordination.

After the training subjects have been categorized the trainers can match them with the delivery methods. For a specific task or training content domain, a given training method may be more effective than others. Because all training methods are capable of, and indeed are intended to, communicate specific skill, knowledge, attitudinal, or task information to trainees, different training methods can be selected to deliver different content information. Thus, the effect of skill or task type on the effectiveness of training is a function of the match between the training delivery method and the skill or task to be trained. Wexley and Latham[74] highlighted the need to consider skill and task characteristics in determining the most effective training method. However, there has been very little, if any, primary research directly assessing these effects.[75] In the design and development of the training program, it would also be worthwhile to consider immediate, short-term, and long-term skill requirements.

3.7 Evolving the Program

In order to constantly improve the training program, a PDCA-Cycle can be used. In this case the cycle starts with “check”. The current knowledge inventory is evaluated with the methods described in Chapter 3.6. Based on the evaluation the initial training program is created (plan) and executed (do). After training, the effectively and efficiency is measured (check). Those measurements are the base for a deviation analysis and for the adjustments in the training plan (Act).[76]

[71] cf. Gagne et al, 1992, p.14
[72] cf. Rasmussen, 1987, p.95
[73] cf. Schneider, 1985, p.54
[74] cf. Wexley et al, 2002, p.43
[75] cf. Arthur, 2003, p.236
[76] cf. Schleiffer, 2011, p.21

4 Definition of Competencies

There is no mutually accepted definition of the term competence. Various models are proposed or discussed by different authors.[77] [78] [79] [80] The LOPEC-Project will use the following definition:

"Competence implies that individuals are able to successfully apply their traits, skills and knowledge in combination with experiences, values and norms in a self-organized fashion to novel situations."[81]

LOPEC will use a tailored competency model for this project. It looks like this:

Figure 11 – Competencies (compiled by the author)

As shown in Figure 11 the competencies are divided into three subcategories.

4.1 Technical Competence

This category is further divided into another three subcategories as illustrated in Figure 11. These categories are:

Professional competence is the general knowledge of a certain concept. E.g. knowing what Kanban is and how it works.

[77] cf. Boyatzis, 1982, n.p.
[78] cf. Edmunds & The, 1994, p.6ff
[79] cf. Rifkin et al, 1999, p.53
[80] cf. Whiddett & Hollyforde, 1999, n.p.
[81] cf. Erpenbeck & Heyse, 2007, n.p.

Methods competences in industrial engineering according to Andreas Jaeger "span from the ability to apply the methods of methods-time measurement (or similar systems) and production system for the definition of target states and standards as well as for the deriving of ergonomically relevant data (i.e. stress data) and range to the design of state of the art business process and methods of operation (along the value stream)." In plain language it could be said that methods competence is simply an individual's ability to apply his/her theoretical knowledge of a procedure or method to real life situations.

Systems competence is defined by Jaeger as "the comprehensive of overall flow and individual performance on a systems level, in order to guarantee a goal-oriented alignment and prioritization of activities."[82] So systems competence is the understanding of how the system works, or how a certain process or action affects other processes in the system, for instance; an individual with systems competence knows why Kanban is necessary to run a pull based manufacturing system. A person with mere methods competence might know how to pull a Kanban card and that pulling the card results in replenishment, but he is not able to see how Kanban affects the production system as a whole.

Problem solving competence is "providing the necessary competence for a goal oriented problem solving and hence the realization of a systematic and continuous improvement process on the basis of a PDCA-cycle."[83]

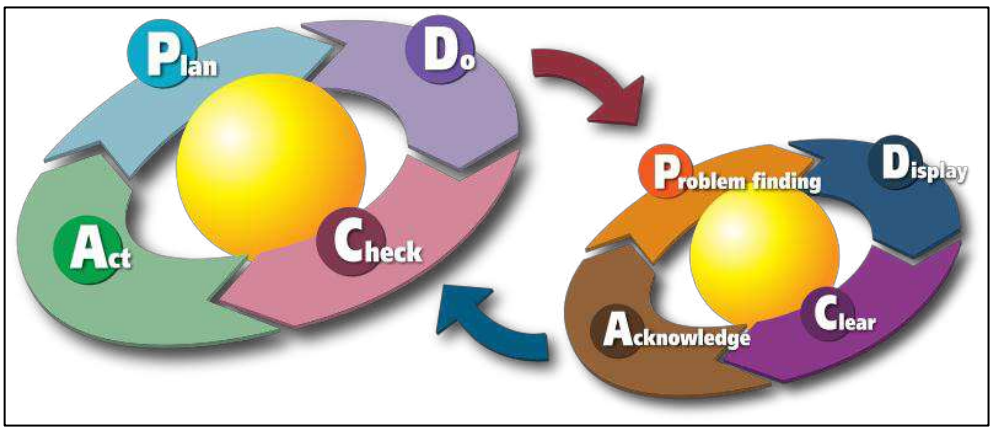


Figure 12 - PCDA cycle[84]

In order to apply problem solving skills an individual has to combine professional, method and systems competence as shown in Figure 13.

[82] Jaeger et al, 2012, p.3
[83] Jaeger et al, 2012, p.3
[84] Wikimedia, 2013, commons.wikimedia.org

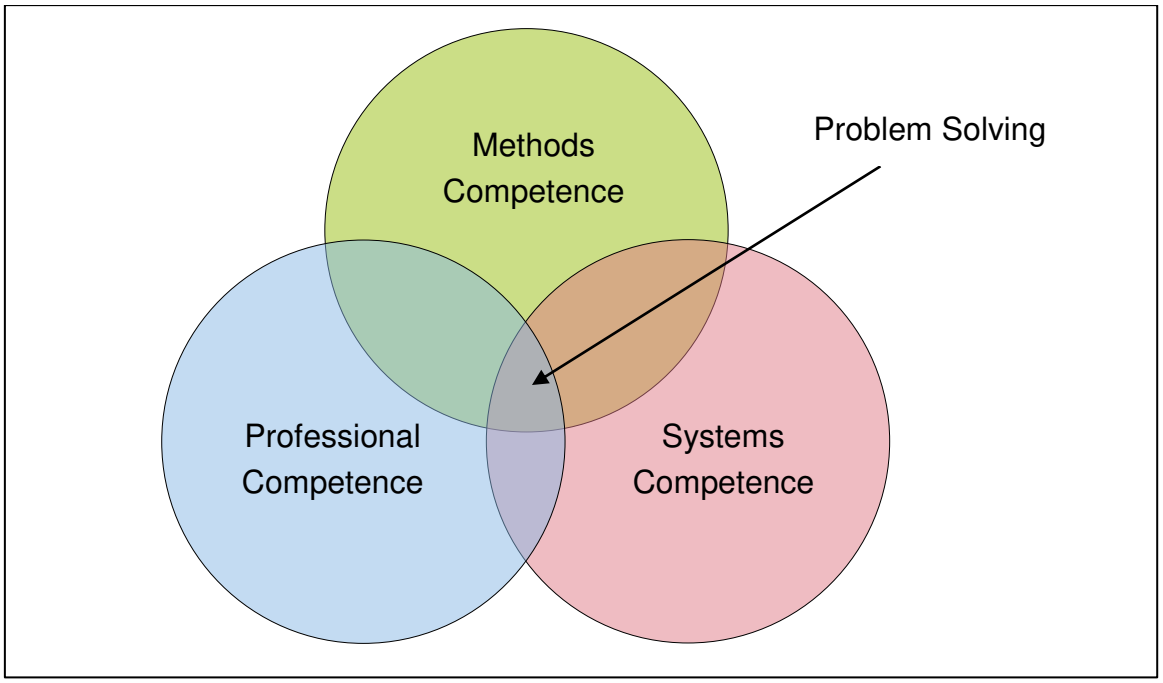


Figure 13 - Technical competences and problem solving (compiled by the author)

One might argue that there should also be a social aspect included since many problem solving activities are team efforts, but the ability to solve problems in a social context will be defined separately, as leadership competence and social competence respectively.

4.2 Social Competence

Social competence refers to the ability of social interaction. At the center of the ability of social interaction are information and communication competencies. Social competence facilitates constructive conflict solving[85] and coordination of interaction partners to achieve intended goals, ability to perceive others accurately, and persuade others to change views or behavior. Mutual support can be another sign of social competence.[86] There are several models to assess social competency.[87] [88] [89]

For the sake of simplicity social interaction with oneself and the company will also be included into this category, meaning work ethics, time management and self-motivation.

[85] cf. Gerig, 1998, n.p.
[86] Kauffeld & Grote, 2002, p.42ff
[87] cf. Goldfried & D'Zurilla, 1969, p.151ff
[88] Crick & Dodge, 1994, 74ff
[89] Cavell, 1990, p.22ff

4.3 Leadership Competence

Hackman and Walton define leadership as follows:

> *"The leader's main job is to do, or get done, whatever is not being adequately handled for group needs. If a leader manages, by whatever means, to ensure that all functions critical to both task accomplishment and group maintenance are adequately taken care of, then the leader has done his or her job well."*[90]

One of the most cited models of for leadership is the three skill approach from Katz.[91] He suggests that leadership competence or effective administrations as he calls it, is based on technical, human and conceptual skills. What is interesting in relation to this work is that Katz distinguishes the importance of those skills for different levels of management. He acknowledges that leadership on a supervisory level requires different skills that leadership on a top management level.

Technical skill refers to proficiency based on specific knowledge, in a particular area of work. Katz states that technical skills are most important at the supervisory levels of management, less important for middle managers and least important for top managers.

Human skills are proficiency in working with people based on a person's knowledge about people and how they behave, how they operate in groups, how to communicate effectively with them and their motives, attitudes and feelings. According to Katz human skills are required at all three levels of management: supervisory, middle management and senior management.

Conceptual skills are required to work with ideas. Leaders with high levels of conceptual skills are good at thinking through the ideas that form an organization at its vision for the future, expressing these ideas in verbal and written forms and understanding and expressing the economic principles underlying their organizations effectiveness.[92] This skill according to Katz is most important for high level executives, less important for middle management and least important for supervisory level leaders.

It is obvious that technical skill and human skill are basically paraphrases of what was defined earlier as technical and social competence. Therefore it can be deducted that leadership competence is not an entirely separate entity, but builds on social and technical skills.

[90] Hackman & Walton, 1986, p.25
[91] cf. Katz, 1974, n.p.
[92] Rowe et al, 2012, p.82

Another question that is relevant in the context of this work is what a leader has to do in order to facilitate group maintenance and accomplish tasks. Mumford et al came up with a definition explaining just that:

"Leader's performance is a function of whether he or she can identify goals, construct viable goal paths, and direct others along these paths in a volatile, changing socio-technical environment. Leaders must not only be able to define departmental, unit or organizational missions, they must be able to coordinate the activities of others motivating them to meet mission requirements. Additionally, they must circumvent or resolve issues impeding progress towards accomplishing organizational goals. Selection and implementation of actions to bring about goal attainment represents a form of problem solving making the generation, evaluation, and implementation of proactive and reactive solutions key to leader effectiveness."[93]

This confirms that leadership builds on social competency and technical competency. In fact Mumford et al. state that "leadership represents a complex form of social problem solving."[94] Figure 14 illustrates the mechanics of leadership:

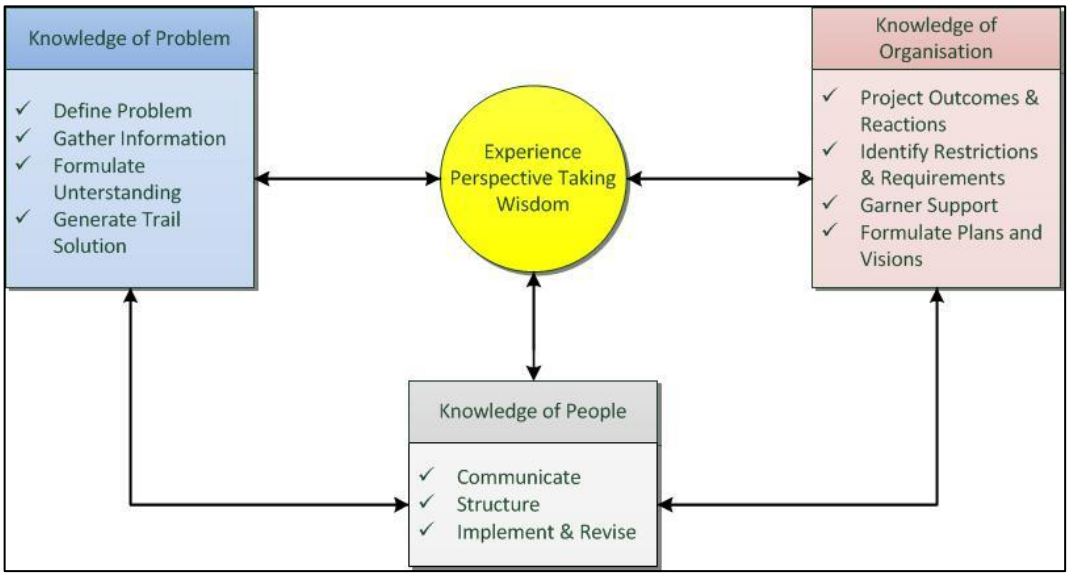


Figure 14 - Leadership problem solving[95]

To make the distinction between social competence and leadership competence in the context of group work a little clearer social competence will be defined as the ability to participate in group based problem solving in an effective way through the means of social interaction, while leadership competence shall refer to the ability to steer the group (e.g. identify goals, construct viable goal paths, and direct others along these paths, etc.). Our definitions outside the context of group work stay as stated above.

[93] Mumford et al. 2000, p.13
[94] Mumford et al, 2000, p.14
[95] Mumford et al, 2000, p.14

5 Determination of the Target Group

It will now be discussed who should be considered for the training program.

5.1 Definition of the Grey Collar Worker

Traditionally the work force is divided into two categories.

- *The blue collar worker*; a person who performs manual labor, typically in construction, manufacturing or mining.
- *The white collar worker*; a person who performs administrative work, typically in an office environment.

Another notable, more recent classification is the pink collar worker referring to someone who works in the service oriented industry.

The target group for this work is the so called grey collar worker. The term refers to someone that can neither be classified as blue collar worker, nor as white collar worker.

Table 1 - Classification of workers (compiled by the author)[96]

Position	Shop floor Worker	Shop Floor Worker	Shop Floor Manager	Employee	Employee	Department Head	Plant Manager
	Blue collar / Non-skilled Worker	Blue collar / skilled Worker	Team Leader Shop Floor	White-collar Worker	White-collar Worker	Team Leader	Executive Manager
Job title examples	Material Handler	Assembly Operator	Technican	Purchaser	Secritary	Logistics Coordinator	Director Corporate Logistics
	Packaging Worker	Machine Operator	Maintenance Manager	Designer	Assistant	Logistics Controller	Regional Logistics Manager
	Forklift Driver	Welder	Engineer	Suppy Chain	Support	Lead Buyer Logistics	Lean Team Leader
Directon of expertise	Non-skilled	Technical		Economical	Administrative	Technical and/or economic + leadership & finance	

Grey Collar Worker

In the LOPEC Project the grey collar worker is classified as an individual that acquired technical or economical skills through training or apprenticeship. Furthermore the grey collar worker has to have the required social skills to promote lean change within his group. That means he is already a team leader and organizes people and resources toward the effective and efficient pursuit of predetermined objectives and has potential to stimulate the group to high performance, or he has shown the potential to be a become a team leader by working well with others in a

[96] LOPEC, 2013, www.esb-lopec.eu , (site was still under construction during creation of this work)

group setting and making productive contributions through talent, knowledge and good work habits.[97]

Before the grey collar workers competencies can be defined it has to be clarified what a competency actually is and how competencies can be classified.

5.2 Competencies of the Grey Collar Worker

With the core competencies defined the required skills of the grey collar worker can now be exanimated more closely. To provide more clarity a rating system for competence will be introduced. There are the three categories mentioned in the previous chapter; technical, social and leadership. The rating ranges from 1 (basic competence) to 5 (excellent competence).

5.2.1 Leadership Competence

The grey collar worker will act as a change agent in his team. Therefore *some* leadership competence is required. On Katz scale of leadership levels mentioned in Chapter 4.3, the grey collar working would be placed on the supervisory level. Ergo, while it is not necessary for him to be able to identify goals and construct viable goal paths on a large scale, he has to have the ability to motivate and direct his co-workers and team mates to incorporate the lean principles and respond to resistance productively. Therefore the leadership competence requirement will be rated 2 out of 5.

5.2.2 Social Competence

McDuffie noted that “the most important social relationship in lean production is with the company: identification with company goals around performance, competitiveness and survival pulls workers towards identifying their interests as overlapping with managers at their company.”[98] The grey collar worker also has to have the ability to express his ideas accurately in order to transfer knowledge to his team mates. The grey collar worker has to serve as a role model for his peers; therefore he will need excellent work ethics. Overall the social competence requirement will be rated 4 out of 5.

5.2.3 Technical Competence

The main focus is, of course, to develop the grey collars workers technical competence. In order for the training to be fruitful he has to have some initial knowledge of general logistics and the lean concept. This knowledge might have

[97] LOPEC, 2013, www.esb-lopec.eu , (site was still under construction during creation of this work)
[98] MacDuffie, 1995, p.57

been acquired through an apprenticeship or prior professional experience. The prerequisite for technical competence should be at least 3 out of 5. The aim is to develop it to 5 out of 5.

Figure 15 shows the desired progress.

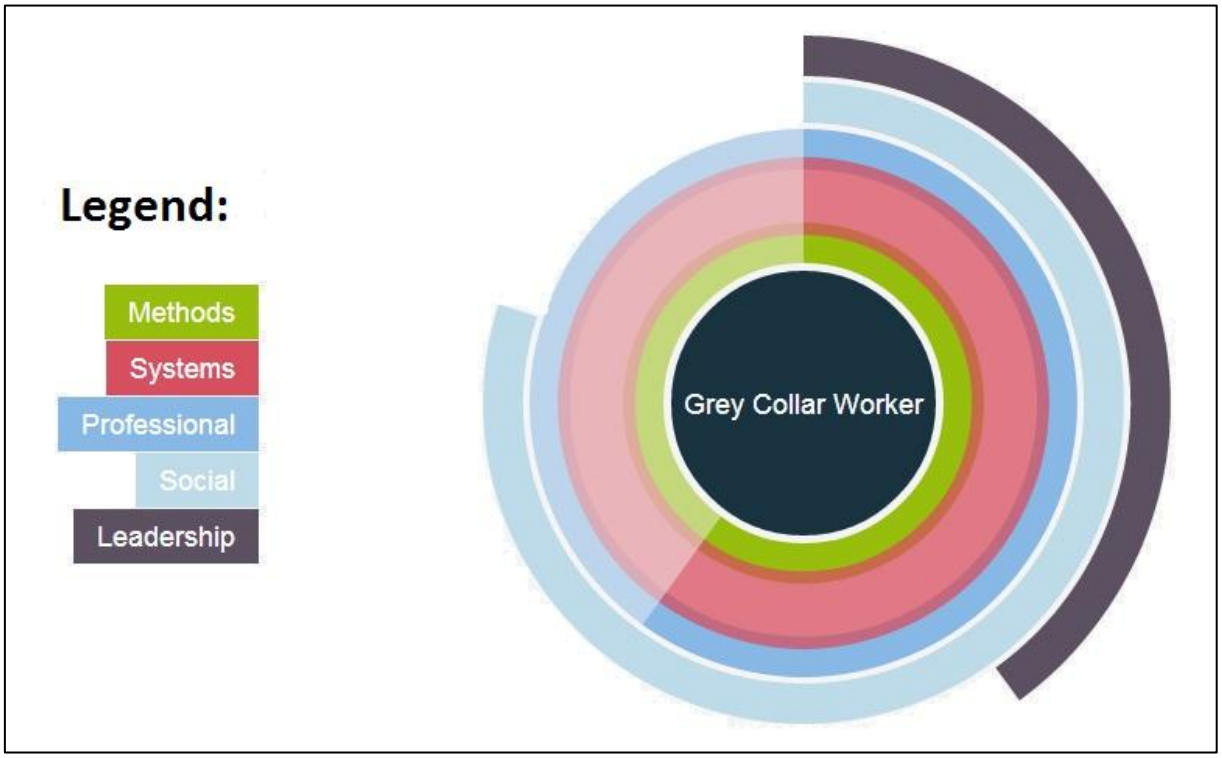


Figure 15 - Pre and post-training skills (compiled by the author)

5.3 Other Trainee Characteristics

Apart from the different types of training media, instruction and learning methods training design requires consideration of the training environment and the trainee behavior. The factors that affect a trainee's behavior before training include trainee readiness and trainee motivation. Trainee readiness involves both maturational and experimental factors in the learner background. [99]

5.3.1 Trainee Readiness

Trainee readiness refers to whether employees have the personal characteristics necessary to acquire knowledge from a training program and apply it to the job.[100] In order to find the appropriate trainee for the LOPEC program companies might want to assess their grey collar workers according to the following criteria.

[99] cf. Pennathur, 1999, p.299
[100] Landy & Contel, 2007, p.321

5.3.2 General Mental Ability

Multiple studies that span across several industries show the correlation between general mental ability and performance in training. In a meta-analysis spanning 85 years, Schmidt and Hunter found that general mental ability had a validity of +0.56 in predicting training outcomes.[101] A meta-analysis of 90 German studies indicated that validity of GMA was comparable to results found in U.S. samples.[102]

5.3.3 Goal Orientation

Goal orientation has shown to be another indicator of trainee performance. There are two contrasting types of goal orientation. Individuals with a performance orientation are concerned about doing well in training and being evaluated positively. They perceive their abilities as somewhat fixed, and they are generally not open to learning environments in which errors and mistakes are encouraged. They direct their energy toward performing well on tasks, often at the expense of learning.[103]

In contrast, individuals with mastery orientation are concerned with increasing their competence for the task at hand, and they view errors and mistakes as part of the learning process. Mastery-oriented individuals are flexible and adaptable in learning situations, which is particularly critical for learning dynamic tasks and complex decision making.[104]

Clearly mastery orientation is more useful in a training environment. Bell and Kozlowski[105] showed this in their study. Noe and Colquitt[106] found several ways to foster mastery orientation, set goals around learning, de-emphasize competition with other trainees and encourage trainees to make errors and experiment with new knowledge.

5.3.4 Experience Level

According to Fleischman and Mumford[107] trainee experience level can be an indicator of readiness. Inexperienced trainees with lower ability generally benefit from longer and more structured training programs. In contrast experienced trainees with high ability thrive in shorter, less structured training programs.[108]

[101] cf. Schmidt & Hunter, 1998, p.262
[102] cf. Hülsheger et al, 2007, p.3ff
[103] Landy, 2007, p.322
[104] Landy, 2007, p.322
[105] cf. Bell & Kozlowski, 2002, p.497
[106] cf. Noe & Colquitt, 2002, p.53ff
[107] Fleischman & Mumford, 1989, p.201
[108] cf. Landy, 2007, p.323

5.3.5 Locus of Control

Locus of control refers to a generalized expectancy about the extent to which there is a contingency between an individual's behavior and subsequent outcomes, and has been identified as a precursor to trainee motivation.[109]

Individuals with an internal locus of control tend to attribute life events as a result of their own behaviors, whereas individuals with an external locus of control tend to construe events as determined by power, luck, or fate.[110] As individuals with an internal locus of control are more likely to believe that their effort will lead to better training outcomes than those with an external locus of control, they are more likely to be more motivated to learn.[111]

5.3.6 Trainee Motivation

Several pre and post training measures can affect a trainee's motivation.

For a more detailed discussion please refer to Chapter 6.

5.3.7 Pre-Training Knowledge

Another thing to consider is the skill inventory of the trainee that is available pre-training (what they already know). This can be evaluated using interviews, surveys and other data collection instruments. The assessment of the gaps between the available skills inventory and the required skill sets (identified in Chapter 3.2) will result in the skill gaps that would need to be filled by appropriate training.

[109] Weissbein et al., 2011, p.423
[110] cf. Strickland, 1989, p.1ff
[111] Weissbein, 2011, n.p.

6 Training Environment

This chapter will deal with the environment an organization has to establish in order to allow smooth employee training, favor training transfer and to have that training initiate lasting change, ensuring that an organization continues to innovate and progress toward a waste-free value stream. The term learning environment in this context refers not only to the physical environment but also to the organizational structure.

6.1 Pre-Training Environment

Tannenbaum and Yukl suggest that events prior to the training can influence training effectiveness.[112] They suggest that the environmental cues and signals within an organization influence employee motivation. Employees start to learn about the way training is viewed in the organization early in the socialization process[113] and continue to gather with each course they attend. Some actions signal to trainees whether training is important (e.g. supervisory and peer support, resource availability, and post training follow-up). Other actions reveal to employees the amount of control, participation, or input they have in the training process (e.g. advance notification, participation in needs assessment, and degree of choice in attendance).

6.1.1 Supervisory Support

Cohen[114] did a study across five companies and came to the conclusion that trainees with more supportive supervisors entered training with stronger beliefs that training would be useful. Supervisors can show their support for an upcoming training course by discussing the training with the employee, establishing training goals, providing release time to prepare, and generally encouraging the employee.[115] The discussion may include an explanation of why goal-setting is important (definition of goals), a description of the goal-setting process, characteristics of effective goals (for example, challenging and specific), an explanation for the effectiveness of goals, examples of how goal-setting has been used in other organizations, and examples of how goal-setting could be effective in one's own organization or department.[116]

Cohen found that trainees who set goals prior to training entered training with higher levels of motivation to learn.

[112] Tannenbaum & Yukl, 1992, p.417
[113] cf. Feldman, 1989, p.101ff
[114] cf. Cohen, 1990, p.91ff
[115] Tennenbaum & Yukl, 1992, p.418
[116] Richman-Hirsch, 2001, p.105ff

6.1.2 Briefing

Baldwin & Magjuka[117] found that those trainees who had received information about the training ahead of time reported a greater intention than others to apply what they learned back on the job. Alderfer[118] et al found that trainees who had received more information prior to the training had more positive reactions at the conclusion of the training. Hicks & Klimoski[119] found that trainees who received a realistic description of the training reported more motivation to learn than trainees who received a traditional positive portrayal of the training.

6.1.3 Voluntariness

Several studies[120] [121] [122] have shown that voluntary participation is related to higher motivation, greater learning and more positive trainee reactions than mandatory attendance.

6.1.4 Expectation of Assessment

Baldin & Magjuka[123] found that trainees who entered training expecting some form of follow up activity or assessment afterward reported stronger intentions to transfer what they learned back to the job. The fact that their supervisor would require them to prepare a post training report or undergo an assessment meant that they were being held accountable for their own learning and apparently conveyed the message that the training was important.

6.1.5 Recommendations

- Participation in the program should be voluntary.
- Each trainee should have a mentor that helps him to establish and evaluate goals.
- Trainees should be provided with sufficient information about the program, its benefits and the post training activities and evaluations before it starts.

6.2 Post-Training Environment

The effectiveness of a training program can be influenced by events that occur after a trainee returns to the job. Some employees leave training with new skills and with strong intentions to apply for those skills to their job, but limitations in the post

[117] cf. Baldwin & Magjuka, 2006, p.25ff
[118] cf. Alderfer, 1992, p.1259ff
[119] cf. Hicks & Klimoski, 1987, p.542ff
[120] cf. Cohen, 1990, p.91ff
[121] cf. Hicks & Klimoski, 1987, p.543ff
[122] cf. Mathieu et al, 1990, np.
[123] cf. Baldwin & Magjuka, 1991, p.28ff

training environment interfere with the actual transfer of training. Elements of the post training can encourage (e.g. rewards, job aids), discourage (e.g. ridicule from peers), or actually prohibit the application of new skills and knowledge on the job (e.g. lack of necessary equipment).[124]

6.2.1 Opportunity to Use New Skills

Clarke[125] found that limited opportunity to perform new skills on the job was the highest impediment to successful training transfer. Notably, opportunity to use the trained skills was rated as the highest form of support for learners and the lack of opportunity to use training was rated as the biggest obstacle to transfer.[126] To provide opportunities, managers should consider modifying their employees' normal workload to allow them to practice new skills on the job[127] [128] to further enhance transfer results.

6.2.2 Post-Training Goal Setting

Similar to pre-training goal setting, the trainee and the supervisors can work out a set of goals for the transfer of training knowledge to the work environment.

Richman-Hirsch[129] reported positive effects for a post training goal-setting intervention, particularly in supportive work environments.

6.2.3 Self-Management Training

Self-management training, involves teaching people to assess potential obstacles to performance, monitor ways in which the environment facilitates or hinders performance, plan coping responses when faced with those obstacles, and administer rewards upon successfully avoiding or overcoming obstacles.[130]

Research examining self-management training as a post training intervention indicates that it is effective in enhancing transfer[131] [132] and may have long-term effects.[133]

[124] Tannebaum & Yukl, 1992, p.420
[125] cf. Clarke, 2002, p.146
[126] cf. Lim & Johnson, 2002, p.36
[127] Clarke, 2002, p.150
[128] cf. Gregoire, 1994, p.69
[129] cf. Richman-Hirsch, 2001, p.105ff
[130] Richman-Hirsch, 2001, p.107
[131] Frayne & Latham, 1987, p.387
[132] Gist et al, 1991, p.837ff
[133] Latham & Frayne, 1989, p.411

6.2.4 Learn by Teaching

The idea that teaching others is a powerful way to learn is both intuitively compelling, and one that has garnered support in research literature.[134] [135] For example, Bargh and Schul[136] found that people who prepared to teach others to take a quiz on a passage learned the passage better than those who prepared to take the quiz themselves. The literature on tutoring suggests a similar conclusion in that tutors have been shown to benefit as much from tutoring as their tutees.[137] [138] Biswas, Schwartz and Bransford[139] report that students preparing to teach made statements about how the responsibility to teach forced them to gain a deeper understanding of the materials. These students focused on the importance of having a clear conceptual organization of the materials. Beyond preparing to teach, actual teaching can tap into the three critical aspects of learning interactions – structuring, taking responsibility, and reflecting.[140]

6.2.5 Peer Support

Research[141] [142] has found that the support of peers diminishes in the presence of an unsupportive supervisor. A recent study by Harry J. Martin[143] shows that peer support can be especially beneficial in helping to overcome the effects of a negative climate. Thus, the effect of environmental variables appears to vary with proximity to the trainee with distal factors having less of an influence on training transfer than more proximal factors.

6.2.6 Post-Training Evaluation and Accountability

The importance of post training evaluation has been acknowledged by the majority of authors.[144] [145] According to Bates[146] "assessment of transfer makes trainees, trainers, and others accountable for transfer success and helps create a culture that values learning and its application to the job." Longnecker's[147] survey of 278 managers indicated that a primary learning imperative to increase transfer of learning is enhancing accountability for application, such as requiring a trainee's report post

[134] cf. Chi et al, 1994, p.439
[135] cf. Papert, 1993, n.p.
[136] cf. Bargh & Schul, 1980, p.593ff
[137] cf. Graesser et al, 1995, p.495ff
[138] cf. Chi et al, 2001, p.471
[139] cf. Biswas et al, 2001, p.71ff
[140] Leelawong & Biswas, 2008, p.181
[141] cf. Birdi & Warr, 1997, p.845ff
[142] cf. Hawley & Barnard, 2005, p.65ff
[143] cf. Martin, 2010, p.87ff
[144] cf. Kirkpatrick, 1998, p.77ff
[145] cf. Hayes, 2008, p.250
[146] cf. Bates, 2003, p.264
[147] cf. Longnecker, 2004, p.4

training. Russ-Eft[148] also includes supervisory sanctions as a situational element that can enhance responsibility to transfer.[149]

Since LOPEC already has an evaluation system in place discussion on the methods of training evaluation is outside the scope of this work.

6.2.7 Recommendations

- Have the trainee train his peer group after he returns. This has several advantages. Firstly, as previously shown, “Learn by teaching” improves the trainee’s skills. Secondly this method helps spread lean knowledge through all ranks of the organization and affects company culture.
- If possible, encourage companies to send employees to training in pairs or small groups. While this might pose a challenge to human resources, trainees can benefit from the buddy system and increased peer support.
- Find a way to make sure that trainees can apply skills immediately upon return to their work place.

6.3 Learning Organization

While the training methods proposed in the previous chapters are a good and necessary way to sow knowledge, long term benefits can only be harvested if an organization provides fertile ground for that seed of knowledge to grow. Companies such as 3M recognize the limits of formal training programs to achieve this, and have built a major part of its knowledge development into the day to day operations of the organization.[150]

The frame of reference will be the learning organization model proposed by Peter Senge. The model will be explained and its relation to the lean philosophy will be discussed.

6.3.1 Benefits of the Learning Organization

The establishment of a Learning Organization has several benefits. It helps the company to remain competitive while maintaining its levels of innovation. The organization is better placed to respond to external pressures.[151] Further benefits include having the knowledge to better link resources to customer needs, improving

[148] cf. Russ-Eft, 2002, p.45
[149] Burke & Hutchins, 2007, p.263
[150] cf. Ghoshal & Bartlett, 1998, n.p.
[151] cf. McHugh, 1998, p.209

quality of outputs at all levels, improving corporate image by becoming more people oriented and increasing the pace of change within the organization.[152]

Mark Farell comes to the conclusion that organizational learning may be the only source of sustainable competitive advantage, and that organizational learning may be the key to future organizational success.[153] Many other academics and practitioners have asserted that the greatest business value in an organization now lies not in physical assets, but in the various elements of intellectual capital that has been developed.[154] [155]

6.3.2 Characteristics of the Learning Organization

Peter Senge defines the learning organization as follows:

"Learning organizations [are] organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together."[156]

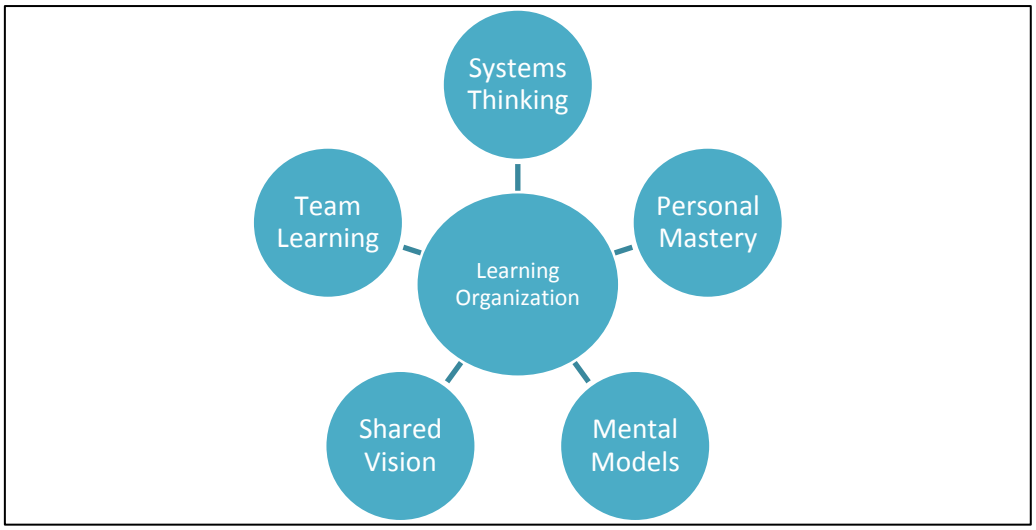


Figure 16 - Learning organization framework[157] (compiled by the author)

According to Senge the learning organization consists of five component technologies:[158]

[152] Pedler et al, 1997, n.p.
[153] Farrell, 2000, p.201
[154] Bontis, 1996, p.43
[155] Cascio, 1998, p.12
[156] Senge, 2006, p.3
[157] cf. ID Reflections, 2011, http://idreflections.blogspot.co.at
[158] cf. Senge, 2006, p.7

- *Systems Thinking* – Business and other human endeavors are systems. They are bound by invisible fabrics of interrelated actions. Individuals tend to focus on snapshots of isolated parts of such systems. Systems thinking is a conceptual framework, a body of knowledge and tools that has been developed, to make full patterns clearer and to help us see how to change them effectively.

- *Personal Mastery* – Mastery means a special level of proficiency. People with a high level of personal mastery are able to consistently realize the results that matter most deeply to them. They approach their life as an artist would approach a work of art, by becoming committed to their own lifelong learning. The discipline of personal mastery starts with clarifying the things that really matter to us, of living our lives in line with our highest aspirations.

- *Mental Models* – Mental models are deeply ingrained assumptions, generalizations, or even pictures of images that influence how we take action. Very often, we are not consciously aware of our mental models or the effects that they have on our behavior. Many insights into new markets or outmoded organizational practices fail to get put into practice because they conflict with powerful, tacit mental models. Institutional learning is the process whereby people change their shared mental models of the company, their markets, and their competitors.

- *Building Shared Visions* – If any one idea about leadership has inspired organizations for thousands of years, it's the capacity to hold a shared picture of the future we seek to create. When there is a genuine vision, people excel and learn, not because they are told to, but because they want to. But many leaders have personal visions that never get translated into shared visions that galvanize an organization. All too often, a company's vision revolves around the charisma of a leader, or around a crisis that galvanizes everyone temporarily. But, people must pursue a lofty goal, not only in times of crisis but at all times. What is needed is a discipline for translating individual vision into shared vision – not a "cook book" but a set of principles and guiding practices.

- *Team Learning* – The discipline of team learning starts with "dialogue," the capacity of team members to suspend assumptions and enter into a genuine "thinking together." Dialogue also involves learning how to recognize the patterns of interaction in teams that undermine learning. The patterns of defensiveness are often deeply engrained in how a team operates. If unrecognized, they undermine learning. If recognized, they can actually accelerate learning.

The unitary flavor of Senge's influential work recurs throughout the organizational learning literature. For example, according to Stata,[159] organizational learning requires individuals to have common beliefs and goals in order to learn together, Schein[160] asserts that organizational learning requires the evolution of shared mental models that cut across the subcultures of the organization; and Marsick and Watkins[161] observe that employees at all levels share their learning with others so that it becomes part of the organization's memory.

6.3.3 Lean Thinking and the Learning Organization

At first it appears that lean thinking incorporates some features of the learning organization. System thinking appears to be encouraged thanks to concepts like takt, flow and the value stream. Group learning and personal mastery are accomplished by Kaizen events. Hines, Holweg and Rich[162] investigated the development of lean from its origin until 2004 and found that lean has significantly evolved during that time span. By investigating different organizations, they could identify four different stages of development. This implies that lean encourages at least some form of organizational learning.

However some authors argue that a lean environment hinders organizational learning. Their main argument is that the practice of standardizations restricts the exploration of new ideas. For example, Wang and Wuzzard[163] did a case study on the impact on lean thinking on organizational learning and concluded that: "lean production, with its emphasis on standardization, could be said to hinder certain types of learning as the encouragement of conformity to norms was clearly in conflict with the challenging of such norms. The latter, of course, is an essential aspect of double-loop learning and learning through exploration."

Ergo the answer to research question 8 turns out to be: No, while lean has some features favoring organizational learning, it is not an optimal environment.

[159] cf. Stata & Almond, 1989, n.p.
[160] Schein, 2003, p.27
[161] Marsick & Watkins, 1994, p.353
[162] Hines et al, 2004, p.994
[163] Wang & Huzzard, 2011, n.p.

7 Compilation of Lean Logistics Topics

The following chapter provides an overview of the subjects to be taught and lists a couple of learning objectives for each subject.

Table 2 - Initial compilation for correlation matrix proposed by the author shows the compilation of lean logistics topics. It was created by the author and is based on an extensive literature review and market research. The single modules are explained in chapters 7.2.1 to 7.2.11.

Table 2 - Initial compilation for correlation matrix proposed by the author

		social	practical	theoretical	social	practical	theoretical	social	Practical	Theoretical	social	practical	theoretical
Module	**Topic**	**Material handlers**			**Operators**			**Management**			**Engineers**		
General	Bottlenecks												
	Kanban Theory												
	Waste												
	Pull Systems												
	Standardization												
Workplace	5S												
	Visual workplace												
	Work cells												
	Total Productive Maintenance												
	Transportation within the plant												
	In-Plant Milk runs												
Manufacturing	SMED / Quick Changeover												
	Batch Size Reduction												
	Poka Yoke												
	Quality at source / internal customer												
Scheduling	Heijunka												
	order shuffling												
	Decentralized scheduling												
	production planing and forecasting												
Business Relations	Supplier relations												
	3 PL												
	Supplier Milk runs												
	Cross Docking												
Kanban	Scheduling Kanban												
	Impementing Kanban												

Analytical tools	check sheets												
	scatter diagrams												
	fishbone diagrams												
	Pareto rule												
	5 why												
	Histograms												
	Value stream mapping												
Kaizen	Kaizen Events												
	3 Mu												
Warehousing	Warehouse visibility												
	Slot allocation and indexing												
	Tracking inventory												
	Security and access control												
	Finished goods stores												
	Storeage devices												
	Supermarkets												
	Water spiders												
	Body on Sequence												
	VMI												
	Packaging and returnable containers												
Technology	WMS												
	RFID												
	DRP												
	ERP												
	TMS												
	EDI												
Leadership	Glass Wall Management												
Module	**Topic**	**social**	**practical**	**theoretical**	**social**	**practical**	**theoretical**	**social**	**Practical**	**Theoretical**	**social**	**practical**	**theoretical**
		Material handlers			**Operators**			**Management**			**Engineers**		

7.1 Market Situation

A Google trends analysis shows that the interest in lean logistics has been fairly stable since 2004, the United States and Germany being the countries conducting the most searches. It could be deducted that the market for lean logistics training has not significantly grown or shrunk in the last 9 years.

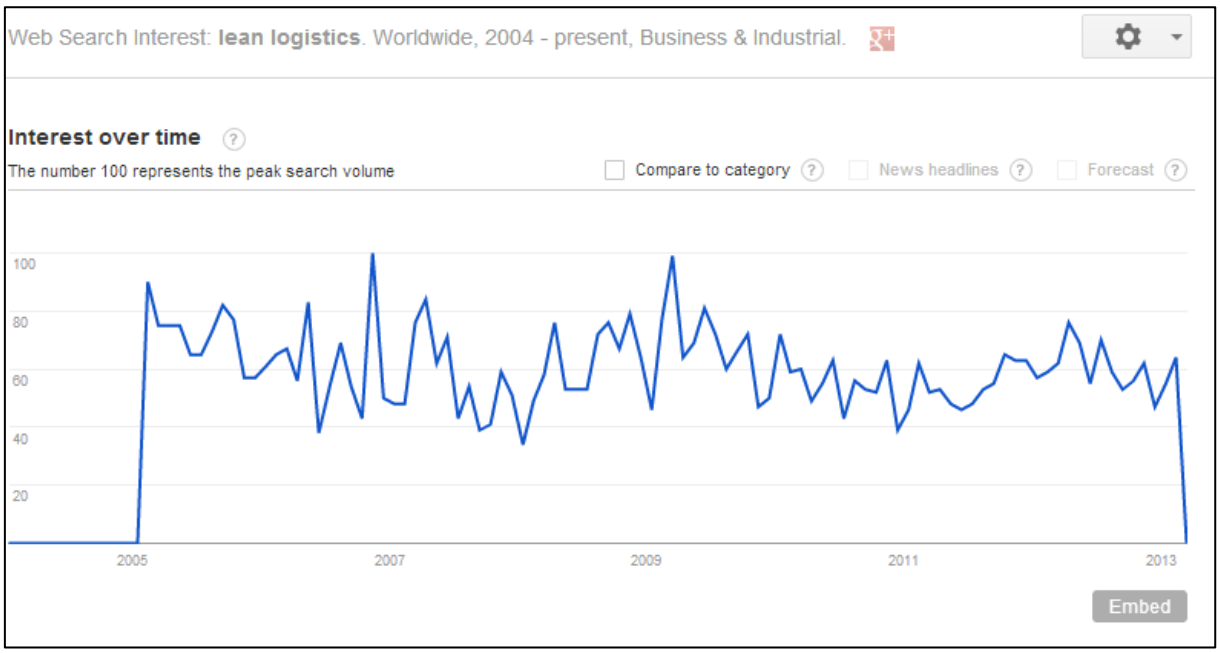


Figure 17 - Google trends graph for the term lean logistics

Doing the same Google trend analysis for the term lean manufacturing (blue graph) and lean six sigma (red graph) reveals a different image:

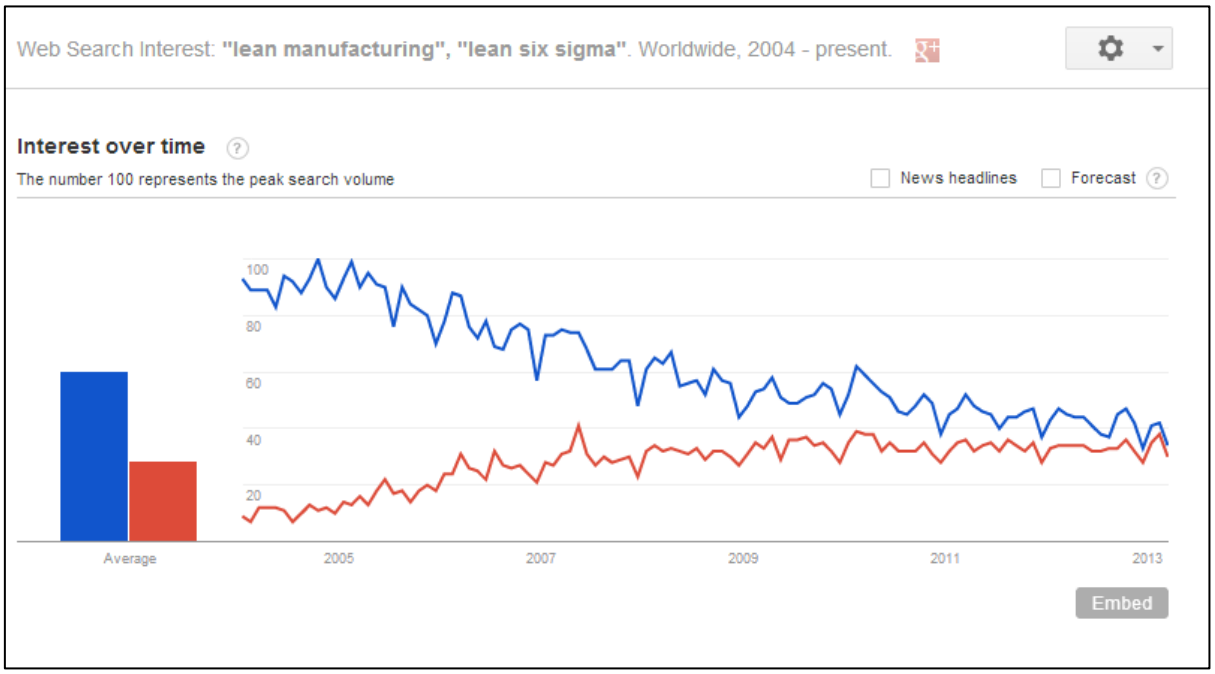


Figure 18 - Google Trends analysis for the terms lean manufacturing and lean six sigma

So it appears that interest in plain lean manufacturing is actually decreasing, while the interest in lean six sigma is increasing. As mentioned in previous, chapters lean manufacturing is a measure of quantity control and does not really relate to quality control very much. It can be hypothesized that practitioners were missing this quality control dimension in lean manufacturing and therefore turned to the more holistic approach of lean six sigma. This would imply that adding a teaching module on quality control would be beneficial in the eyes of the customer.

Generally it seems that the market for lean logistics training has been stable in size since 2004.

While there are a lot of companies offering lean manufacturing training and workshops, there are only very few providers offering workshops that specifically deal with lean logistics.

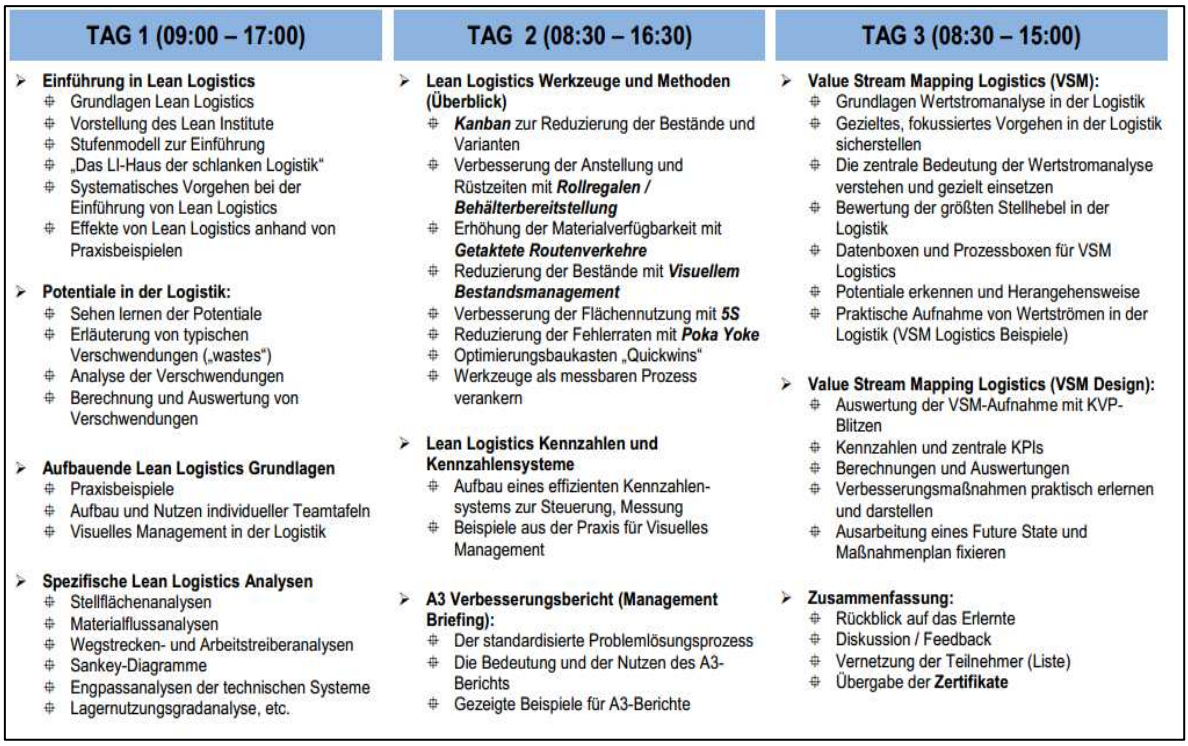
In Germany and Austria only four providers could be identified: Impuls training[164] center offers a two day workshop. It covers a broad spectrum, ranging from basic concepts like Kanban, to lean warehousing and container management. Their method of delivery consists of classroom training supported by simulations and games. There also is a learning factory available. The program is also aimed at shop floor employees and therefore has to be considered competition for LOPECs program. The charge is 1300€ per person for a two day workshop.

Another provider is called D-cap.[165] They offer a one day training course that takes place within a lean factory. The curriculum is quite basic and deals with topics like lean thinking and value stream mapping. The course fee is 490€. It is aimed at middle and upper management.

Then there is the Bundesverband für Materialwirtschaft und Einkauf.[166] The BME charges 1049€ for a one day workshop. They too deal with basic topics like 5S and VSM. Their methods of delivery are classroom training, case studies and group discussions. The target group of this program is management as well.

Lastly there is the lean institute[167] based in Germany, offering a three day seminar. Figure 19 shows an overview.

[164] Impuls Training, 2013, www.impuls-trainingscenter.de
[165] D-Cap, 2013, www.d-cap.de
[166] Bundesverband für Materialwirtschaft und Einkauf, 2013, www.managerseminare.de
[167] lean Institute, 2013, www.vpk-engineering.de



TAG 1 (09:00 – 17:00)	TAG 2 (08:30 – 16:30)	TAG 3 (08:30 – 15:00)
Einführung in Lean Logistics Grundlagen Lean Logistics Vorstellung des Lean Institute Stufenmodell zur Einführung „Das LI-Haus der schlanken Logistik" Systematisches Vorgehen bei der Einführung von Lean Logistics Effekte von Lean Logistics anhand von Praxisbeispielen	**Lean Logistics Werkzeuge und Methoden (Überblick)** ***Kanban*** zur Reduzierung der Bestände und Varianten Verbesserung der Anstellung und Rüstzeiten mit ***Rollregalen / Behälterbereitstellung*** Erhöhung der Materialverfügbarkeit mit ***Getaktete Routenverkehre*** Reduzierung der Bestände mit ***Visuellem Bestandsmanagement*** Verbesserung der Flächennutzung mit ***5S*** Reduzierung der Fehlerraten mit ***Poka Yoke*** Optimierungsbaukasten „Quickwins" Werkzeuge als messbaren Prozess verankern	**Value Stream Mapping Logistics (VSM):** Grundlagen Wertstromanalyse in der Logistik Gezieltes, fokussiertes Vorgehen in der Logistik sicherstellen Die zentrale Bedeutung der Wertstromanalyse verstehen und gezielt einsetzen Bewertung der größten Stellhebel in der Logistik Datenboxen und Prozessboxen für VSM Logistics Potentiale erkennen und Herangehensweise Praktische Aufnahme von Wertströmen in der Logistik (VSM Logistics Beispiele)
Potentiale in der Logistik: Sehen lernen der Potentiale Erläuterung von typischen Verschwendungen („wastes") Analyse der Verschwendungen Berechnung und Auswertung von Verschwendungen	**Lean Logistics Kennzahlen und Kennzahlensysteme** Aufbau eines effizienten Kennzahlen-systems zur Steuerung, Messung Beispiele aus der Praxis für Visuelles Management	**Value Stream Mapping Logistics (VSM Design):** Auswertung der VSM-Aufnahme mit KVP-Blitzen Kennzahlen und zentrale KPIs Berechnungen und Auswertungen Verbesserungsmaßnahmen praktisch erlernen und darstellen Ausarbeitung eines Future State und Maßnahmenplan fixieren
Aufbauende Lean Logistics Grundlagen Praxisbeispiele Aufbau und Nutzen individueller Teamtafeln Visuelles Management in der Logistik	**A3 Verbesserungsbericht (Management Briefing):** Der standardisierte Problemlösungsprozess Die Bedeutung und der Nutzen des A3-Berichts Gezeigte Beispiele für A3-Berichte	**Zusammenfassung:** Rückblick auf das Erlernte Diskussion / Feedback Vernetzung der Teilnehmer (Liste) Übergabe der **Zertifikate**
Spezifische Lean Logistics Analysen Stellflächenanalysen Materialflussanalysen Wegstrecken- und Arbeitstreiberanalysen Sankey-Diagramme Engpassanalysen der technischen Systeme Lagernutzungsgradanalyse, etc.		

Figure 19 - Lean institute seminar plan

The target group of the program is management. The costs are 1595€.

There are a few lean logistics programs offered in North America[168] and Australia.[169] Most of them put emphasis on lean warehousing. Figure 19 shows a summary of the main characteristics.

[168] Michigan College of Engineering, 2013, http://isd.engin.umich.edu
[169] Inspirative, 2013, http://inspirative.edu.au

Table 3 - North American lean logistics trainings

University of Michigan	Lean logistics overview	Classroom, simulation, games	2 Weeks	5202	Directors, Managment, Staff
	Inventory management within the lean warehouse				
	Macro value stream mapping				
	Supplier selection, evaluation and global sourcing				
	Value chain integration				
	Mass customization principles				
	Third party logistics providers				
	Distribution system design for lean warehouse processes				
	Lean warehouse processes				
	IT in lean logistics				
	Managing distribution and transportation within the lean warehouse				
	Rapid assessment of logistics and supply chains				
	Tracking metrics for reducing lead time cost and improved quality				
	Proving the impact of lean concepts to warehouse scenarios				
	Applying standardized work for lean warehouse processes				
	Improving flow to reduce waste and minimize congestion				
Georgia Tech	Lean Warehouse Overview	Classroom	3 days	2104	Management
	Supply Chain Implementation Framework				
	Lean Storage Planning Approach				
	Application of a Lean Storage Location Sizing Method				
	JIT Implementation Approach				
	How To Develop Standard Work Batches				
	Generation of an Operational Diagram				
	Creation of a Daily Operational Work Load Plan				
	Development of a Progress Control Board				
Lean Enterprise Institute	Understand the critical elements of the building the Lean Fulfillment Stream	Classroom, gemba excursions	2 days	1227	Management
	Value-Stream Map the extended enterprise				
	Calculate "total cost of fulfillment" for the entire supply chain				
	Uncover areas of waste to reduce lead time and inventory levels				
	Develop customer and supplier measurement systems and accountability processes				
	Break down cross functional barriers for effective supply stream collaboration				
	Implement pull systems to drive material replenishment				
	Implement the concepts of increased delivery frequency, lot size reduction, and leveled flow				
	Implement lean tools to establish supply chain visibility				
	Create an optimized logistics network and implementation roadmap				

Productivity Inc.	Overview of Supply Chain Management	Classroom, simulation, games	2 day to 1 week	N/A	Management & shopfloor employees
	Logistics management vs. supply chain management				
	The goal of supply chain management				
	Customer relationship management				
	Supplier relationship management				
	What makes the supply chain lean				
	The Supply Chain Game – a simulation				
	Overview of Logistics and Lean Application				
	Transportation Management Exercise				
	Transportation Management System				
	Logistics costs				
	Cost and service considerations				
	Transportation facts and decision making				
	Carrier selection criteria – The Core Carrier Concept				
	Inventory Management System				
	Determining inventory carrying cost				
	Inventory turns and carrying costs				
	Key measures				
	Traditional inbound logistics				
	Milk runs				
	Crossdocking				

Several things can be noted. There are only a few lean logistics workshops and trainings available on the market right now. Most of them are geared towards management. The average charge is 500€ to 700€ per person per day. Most programs last less than one week.

Only one provider states that their program is appropriate for shop floor employees. Impuls training offers the only program that can be considered a direct competitor, even though their program is not nearly as extensive as the one LOPEC is intending to create. Impuls is also the only provider using a learning factory. The most common method of delivery is classroom training combined with some practical component like exercises, games or case studies.

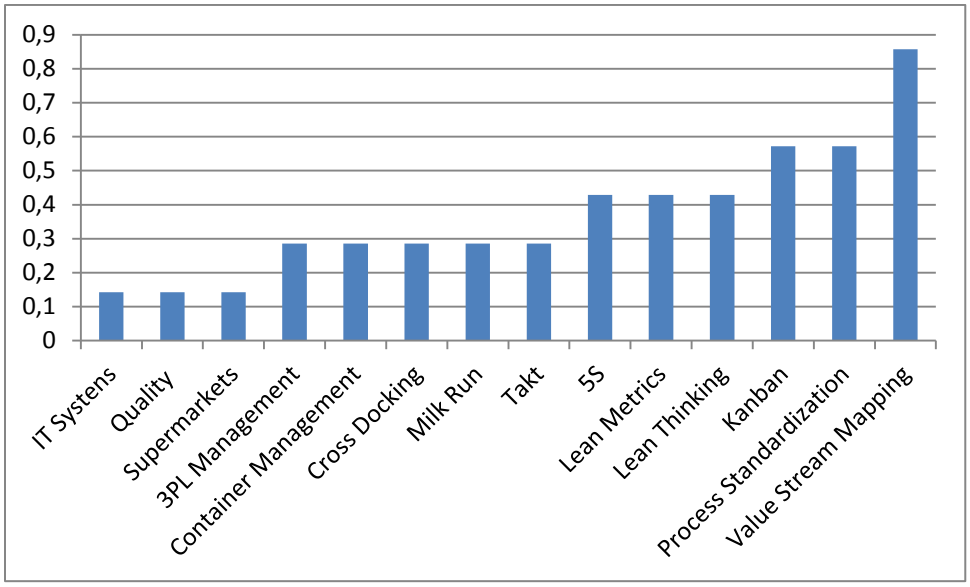


Figure 20 - Training topics

Figure 20 shows what topics are taught in the investigated programs. Almost all programs mention value stream mapping. Process Standardization and Kanban are popular topics as well. Quality and IT-Systems appear to be overlooked by most providers. Herein lays a possibility for LOPEC to distinguish itself from the competition.

7.2 Description of Modules

7.2.1 Motivation

This module should be taught at the beginning of the curriculum. It will be designed to show the differences between past practices and future practices.

7.2.1.1 Waste

Basically waste are non-value-added activities. The most common way to describe these is by using the concept of the seven wastes that Taiichi Ohno coined in his book “The Toyota Production System.”[170] The seven wastes include transportation, (excess) inventory, (excess) motion, waiting, overproduction, overprocessing and defects or errors. Some Authors[171] [172] also like to add an eighth waste, namely behavior (or underutilized employees) to this list as it can sometimes be the biggest waste of all.

[170] cf. Ōno, 1988, p.19
[171] cf. Myerson, 2012, p.19
[172] cf. Ortiz, 2010, p.1

7.2.1.2 The Bullwhip Effect

The Bullwhip effect teaches us that inventories grow inversely in the supply chain as a function of the amount of information that is shared among supply chain partners. A way to combat this effect is to calculate the requirements of the supply chain backwards starting with the customer. Indeed, this is the heart of lean and pull replenishment.[173]

7.2.1.3 Bottlenecks

Bottlenecks determine the through put in a supply chain. A bottleneck (or constraint) in a supply chain means the resource that requires the longest time in operations of the supply chain for certain demand. Usually, phenomena such as increase of inventory before a bottleneck and insufficiency of parts after a bottleneck are often seen.[174]

7.2.1.4 Standardization

Lean organizations standardize best work practices. The idea is to make work safe and repeatable with as little variations as possible.[175]

7.2.1.5 Pull System

As mentioned earlier, the term pull system refers to: “The system of cascading production and delivery instructions from downstream to upstream in which nothing is produced by the upstream supplier until the downstream customer signals a need.”

7.2.1.6 Kanban Theory

Kanban is a method used to control Just-In-Time processing.[176] The operators use visual signals to determine how much they run and when to change over. The Kanban rules also tell them what to do when they have problems and where to go to when these problems arise.

7.2.2 Workplace

7.2.2.1 5S

5S, which stands for sort out, set in order, shine, standardize, and sustain, is a tool that results in a well-organized workspace complete with visual controls, improved layout, and order. It is an environment that has “a place for everything and everything in its place, when you need it.”[177]

[173] cf. Goldsby, 2005, p.183
[174] cf. Imaoka, 2004, p.12
[175] cf. Myerson, 2012, p.42
[176] cf. Ohno, 1988, p.27
[177] cf. Myerson, 2012, p.48

7.2.2.2 Visual Workplace

The concept of visual controls is a major part of any lean manufacturing system. Developing, sustaining and improving a visual factory will result in the removal or reduction of significant amounts of waste.[178] Simple visual signals give operators the information to make the right decision. They are efficient, self-regulating and worker-managed. Examples include visual job aids, signs, lines on the floor designating storage areas, aisles, work areas, “andon” lights, labels, and Kanbans.[179]

7.2.2.3 Work Cells

Work cells rearrange people and equipment that would typically be located in various departments into one group so they can focus on making a single product or providing a single service or a group of related items or services.[180] They can be seen as mini companies.

7.2.2.4 Total Productive Maintenance

Total Productive Maintenance focuses on equipment-related waste. In TPM operators are trained to do basic maintenance tasks by themselves, while more demanding tasks are still carried out by a central maintenance department.

The goal of TPM is to maximize equipment efficiency. This should be achieved through the establishment of a continuous system of productive maintenance that concerns the whole life span of a machine.[181]

7.2.2.5 Internal Milk Runs

Internal milk runs are similar to supplier milk runs. They usually only occur within the plant, e.g. to supply production lines with materials. The recurrence period is in tens of minutes rather than hours and the pickup and delivery quantities range from single pieces to bins, as opposed to pallets.

Furthermore they are managed within a single department of a single company, as opposed to one Customer Company, multiple suppliers, and possibly a 3rd party logistics provider. Usually internal milk runs are also more reliable since the shop floor is not affected by weather or traffic conditions.[182]

7.2.2.6 Transportation within the Plant

In-plant transportation differs from inbound and outbound in that the greatest improvements are achieved by eliminating trips rather than by reducing distances. The identification of the most heavily traveled routes, and the tabulation along these routes of such parameters as the number of times the materials are touched or the

[178] cf. Ortiz et al, 2011, p.1
[179] cf. Myerson, 2012, p.47
[180] cf. Myerson, 2012, p.65
[181] cf. Matyas, 2008, p.214
[182] cf. Baudin, 2004, p.69

number of times they move vertically and horizontally reveals improvement opportunities that are obvious in hindsight.

7.2.3 Manufacturing

7.2.3.1 Quick Changeover

The primary obstacle to small batch sizes is changeover time and costs. The goal is to minimize changeover time and cost, so that smaller batches are run more frequently, resulting in better flow.[183]

7.2.3.2 Batch Size Reduction

The ultimate goal of lean manufacturing is a one piece flow.[184] While this might be practically unattainable, a small batch size is the way to go. Smaller batch sizes reduce overall cycle time for any one item and WIP is reduced as well.

7.2.3.3 Poka Yoke

Poka Yoke is a Japanese term for mistake proofing. A Poka Yoke is a way to design a process so that it is virtually impossible to pass on a defective part or piece of information from one process to another[185] as it involves carrying out 100 per cent inspections and requiring immediate feedback when errors or defects occur.[186]

7.2.3.4 Quality at Source – The Internal Customer

The idea here is that the next step in any process is the customer, and you want to make sure that you deliver perfect products to that customer.

7.2.4 Scheduling

7.2.4.1 Heijunka

Heijunka is the leveling of production by both volume and product mix. This system does not build products according to the actual flow of customer orders. Heijunka takes the total volume of orders in a period and levels them out so the same amount and mix are being made each day.[187]

7.2.4.2 Order Shuffling

The approach to accommodating rush orders from favored customers is to shuffle the orders prior to releasing them to the shop floor. Once released, no shuffling is possible, and they should be thought of like passengers on a chair lift.[188]

[183] cf. Myerson, 2012, p.59
[184] cf. Myerson, 2012, p.57
[185] cf. Myerson, 2012, p.65
[186] cf. Shingō, 1986, p.92
[187] McBride, 2004, www.emsstrategies.com
[188] cf. Baudin, 2004, p.274

7.2.4.3 Decentralized Scheduling

The pull system eliminates the need to direct the work of the entire plant from a central location, as is attempted with MRP/ERP dispatch lists. By regulating the high-level flows between lines, departments and plants, the pull system reduces the challenge to that of locally scheduling tens of units of a few machines or stations each. As long as each of these units delivers the demand expressed by the flow of pull signals, it may have its own, unique approach to scheduling. And because each unit is small, the methods can be better tailored to its needs than if a single method had to be applied to the entire plant.[189]

7.2.4.4 Production Planning and Forecasting

In many plants the flow of customer orders seems chaotic and first needs to be filtered into a demand placed on production that is sufficiently stable for the combination of leveled sequencing and pull systems to work, while making and keeping promises that are attractive to customers. This module should describe several approaches used for this purpose.[190]

7.2.5 Business Relations

7.2.5.1 Supplier Relations

As is the case in all lean-related endeavors, the drivers behind supplier relationship management focus on continuous improvement and the elimination of waste. Within that framework, the basic principles of the approach are as follows:

- Strategic collaborations with raw materials suppliers on all facets of procurement, from component design to final delivery.
- Rationalization of supplier networks and the creation of open-book partnerships.
- Long-term relationships as opposed to short-term contracts.
- Recognition of the profit motive, with an emphasis on cost reductions.[191]

7.2.5.2 3 PL

Third party logistics (3PL) involves the outsourcing of many logistics services beyond transportation, including fleet management, network design, EDI, materials handling, traffic management, and even supplier management. Manufacturers usually turn to 3PL when the objectives of limiting their investments and reducing their costs take priority over control. 3PL providers should not be used where product knowledge is

[189] cf. Baudin, 2004, p.272
[190] cf. Baudin, 2004, p.312
[191] Gardner, 2004, p.46

required, as is the case in kitting parts for assembly, checking quality, or performing last-minute customization.[192]

7.2.5.3 Supplier Milk Runs

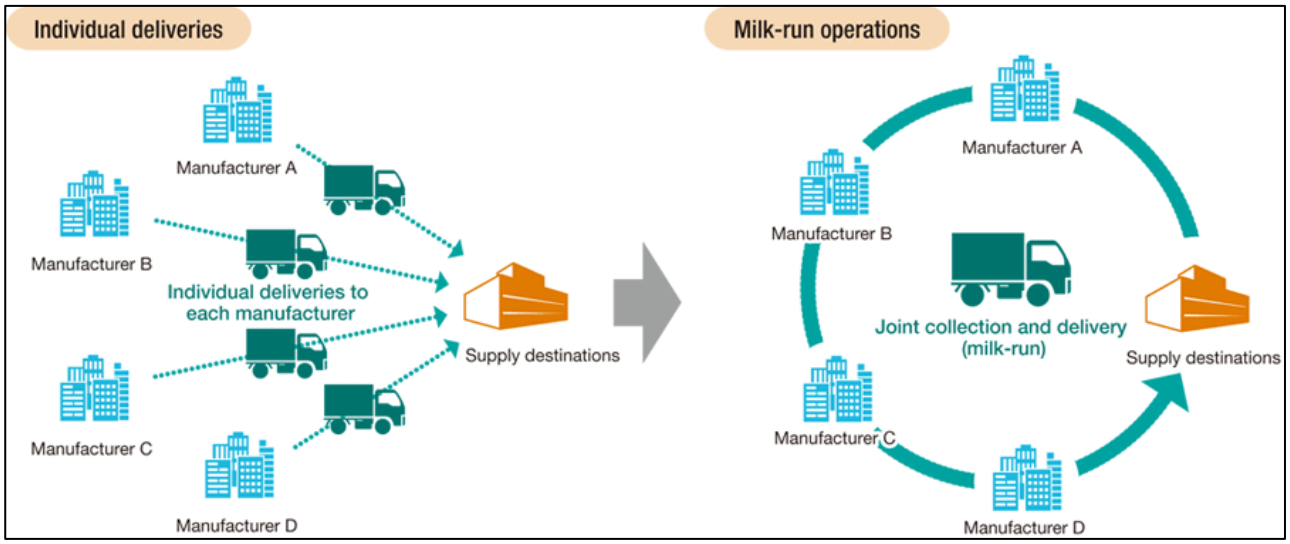


Figure 21 - Milk run[193]

A supplier milk run is a scheduled pickup of parts from multiple suppliers in matching quantities, and is a more sophisticated approach than a hub, reducing inventories of incoming materials, making lead times predictable even for items with variable consumption, smoothing the receiving workload, and providing an infrastructure for the transmission of pull signals.[194]

7.2.5.4 Cross Docking

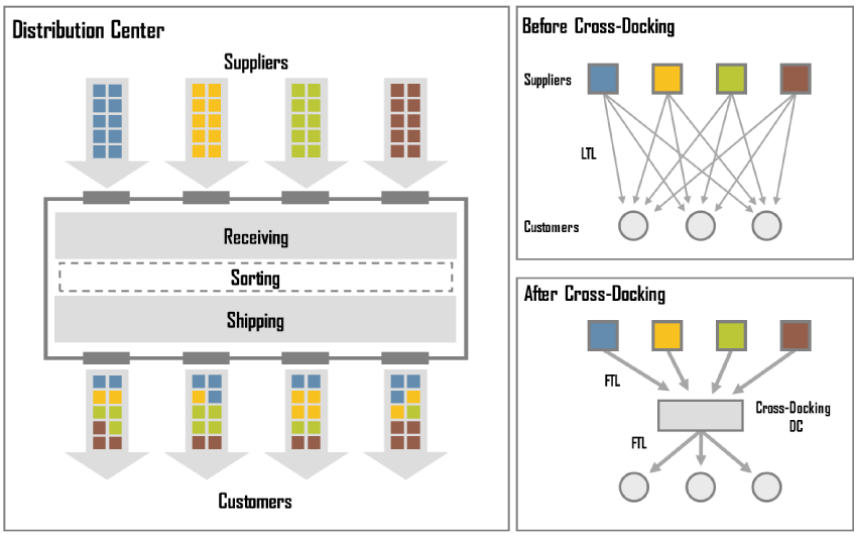


Figure 22 - Cross docking[195]

[192] Baudin, 2004, p.333
[193] Nippon Express, 2013, www.nipponexpress.com
[194] Baudin, 2004, p.131
[195] Rodrigue, 2013, http://people.hofstra.edu

Cross docking is a logistics activity that attempts to reduce costs and total lead time and better synchronize with actual demand. It is therefore a great tool to enable a JIT process. It does this by breaking down received items on the loading dock and immediately matching them with outgoing shipment requirements, as opposed to stocking the items in warehouse locations and returning to pick them for orders at a later time.[196]

7.2.6 Kanban

7.2.6.1 Scheduling Kanban

The Kanban schedule replaces the traditional weekly or daily production schedule that is common in manufacturing operations. This schedule is replaced with visual signals and predetermined decision rules that allow the production operators to schedule the line. Kanban scheduling is more of an execution tool rather than a planning tool. It does not replace material planning, but rather takes the material planning information and uses it to create the Kanban.[197]

7.2.6.2 Implementing Kanban

The typical steps to implement Kanban usually include forming a team to design the complete Kanban system, then constructing a detailed implementation milestone chart, selecting Kanban candidates and determining safety stock settings.[198]

7.2.7 Analytical tools

7.2.7.1 Value Stream Mapping

VSM is a team-based approach to mapping a value stream or process from beginning to end. It visually (and numerically) breaks the process down into value-added and non-value-added steps from the viewpoint of the customer. VSM is seen as the perfect road map to lean.[199]

7.2.7.2 5-Why

The 5-Why method is a simple technique used to determine the root cause of a problem. It involves repeatedly asking why until the root cause is identified. On average this only requires five iterations.[200]

7.2.7.3 Check Sheets

Check sheets are used as a Toll Gate, a way of checking that things are complete at the end of a task or a process. Check sheets allow data to be collected in an easy, systematic and organized manner.[201]

[196] cf. Myerson, 2012, p.84
[197] Gross & McInnis, 2003, p.3
[198] cf. Louis, 2006, p.152
[199] cf. Myerson, 2012, p.117
[200] cf. Zidel, 2006, p.68

7.2.7.4 Histograms

Histograms utilize measurements data and display the spread and shape of the distribution. Histograms are simple bar charts representing the range, amount and pattern of variation for data. The bars are placed together to make it easier to compare data.[202]

7.2.7.5 Scatter Diagrams

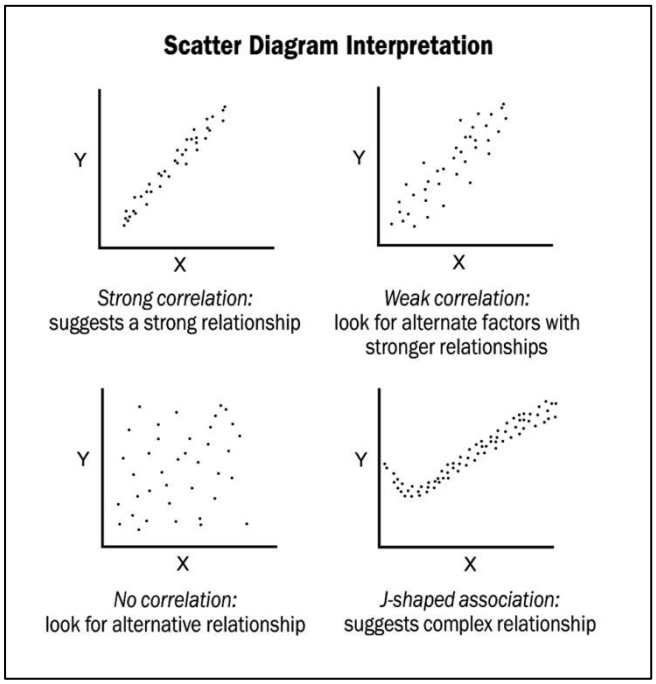


Figure 23 - Examples of some scatter diagrams[203]

A scatter plot, also called a scatter diagram or a scattergram, is a basic graphic tool that illustrates the relationship between two variables. The dots on the scatter plot represent data points.

Scatter plots are used with variable data to study possible relationships between two different variables. Even though a scatter plot depicts a relationship between variables, it does not indicate a cause and effect relationship. Use Scatter plots to determine what happens to one variable when another variable changes value. It is a tool used to visually determine whether a potential relationship exists between an input and an outcome.[204]

[201] cf. VanZan-Stern, 2011, p.58
[202] cf. Ptacek, 2011, p.229
[203] HCI Project, 2013, http://www.hciproject.org
[204] cf. Basu, 2008, p.71

7.2.7.6 Fishbone Diagrams

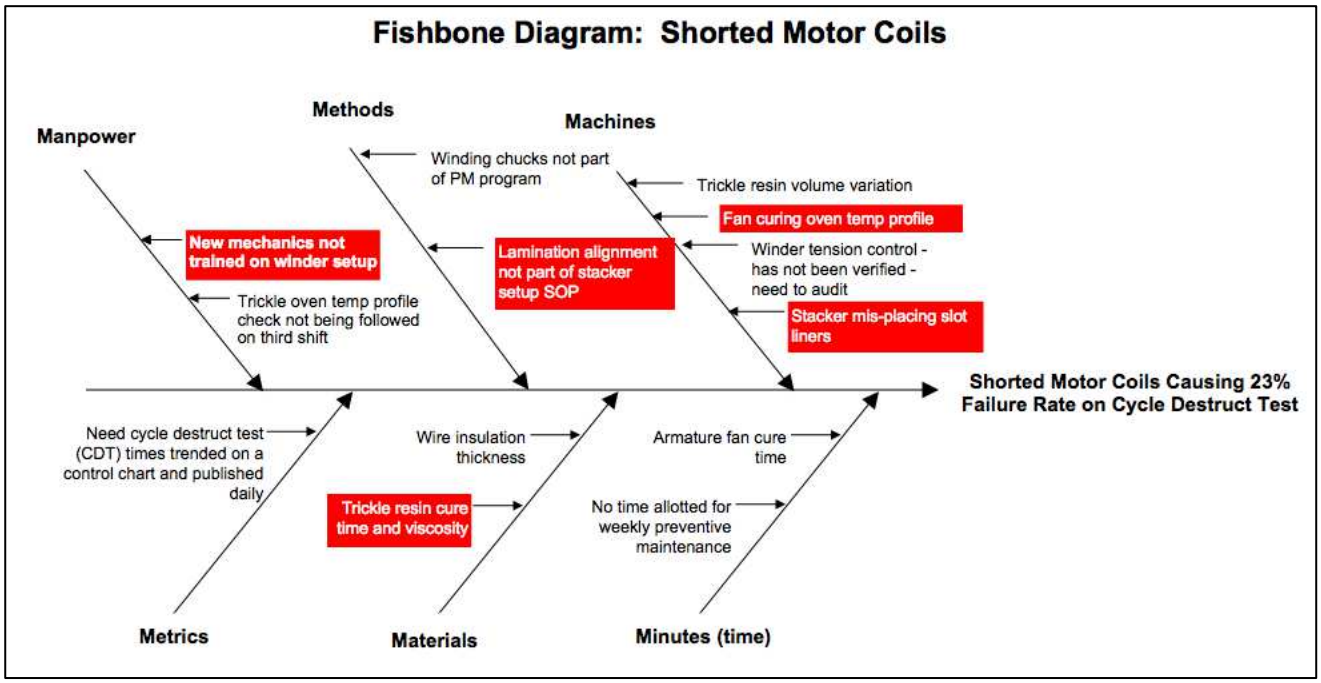


Figure 24 - Example of a fishbone diagram[205]

Also known as Ishikawa or cause and effect diagram, it is a graphical analysis tool that allows the user to display the factors involved in a given situation. Fishbone diagrams are drawn to clearly illustrate the various causes affecting process quality by sorting out and relating causes. Therefore a good Fishbone diagram is one that fits the purpose and has no definite form.[206]

7.2.7.7 Pareto Charts

The Pareto chart is a bar chart that represents the Pareto principle. The Pareto principle states that 20% of the source causes 80% of the problem. By analyzing data with a Pareto chart, teams can understand what the 80% problems are.[207]

7.2.8 Kaizen

Kaizen is Japanese and roughly translated it means “constant change for the better“. Related to business it means that all individuals in an organization constantly seek to improve themselves and the processes in which they are involved. In principle Kaizen is a permanent journey in PDCA-Cycles.[208]

In this module employees should get an overview of the elements and tools of Kaizen and should learn how to apply them to their work setting.

[205] Fishbonediagram, 2013, http://fishbonediagram.org/
[206] cf. Roderick, 2009, p.79
[207] cf. Ptaceck et al, 2011, p.232
[208] cf. Brunner, 2011, p.11

7.2.8.1 3 Mu

In this way of thinking about waste the goal is to achieve a condition where capacity and load are about equal. The three Mus are types of waste that prevent this equilibrium from occurring. They are:

- Muda (waste) – capacity exceeds load
- Muri (Overburden) – load exceeds capacity
- Mura (inconsistency) – sometimes capacity exceeds load and sometimes load exceeds capacity[209]

7.2.8.2 Kaizen Events

Kaizen teams come together during a Kaizen event and disband after the event is over. They tend to be multi skilled, cross-trained and cross functional. Each member receives training in lean, Kaizen and teamwork.[210] They use simple analytical tools to analyze a process. They implement improvements, rather than just recommend them.[211] Kaizen events typically last for less than a week.

7.2.9 Warehousing

7.2.9.1 Slotting

Efficient space usage is commonly referred to as slotting, but it goes beyond the concept of where items are placed within the warehouse; it also takes into consideration how much inventory is put into location and attempts to create a handful of standard location sizes.[212] Items can be arranged by different criteria. Examples would be frequency of use, volume, destination or source of the item.[213]

7.2.9.2 Short-Interval Scheduling

Also known as man loading, this is a way to control labor in the warehouse. By looking at the basic time it takes to do a task, like picking orders, and multiplying this time by the number of orders to be picked is the way to find a staffing plan.[214]

7.2.9.3 Packaging and Returnable Containers

The importance of packaging should not be easily dismissed. It protects the product against damage, the environment against hazardous materials and handlers against injuries. It makes goods easy to handle and provides information through labeling.

[209] cf. Productivity Development Team, 2003, p.7
[210] cf. Alukal & Manos, 2006, p.15
[211] cf. McCarty et al, 2004, p.255
[212] cf. Kerber & Dreckshage, 2011, p.150
[213] cf. Baudin, 2004, p.97
[214] cf. Kerber, 2011, p.156

Returnable containers protect parts rather than disposables, are cheaper if used enough times and often enough, are friendlier to the environment. When used exclusively for an item, they also cap the inventory. Containers designed for transportation are not always fit for part presentation on the line side. Finally, disposable containers remain the norm for shipping finished goods to consumers, and can therefore never be completely eliminated.[215]

7.2.9.4 Warehouse Visibility

Good warehouse visibility makes it easy to navigate through and find goods in a warehouse. It includes labels on the grid of columns, dock numbers that remain visible when docks are open, three-sided overhead zone identification signs, level labels on each slot in a pallet rack, and separators between slots as needed. Rack aisles are oriented to avoid blocking the view.[216]

7.2.9.5 Storage Devices

Warehouses should use multiple types of storage devices and strategies in different zones, based on item volume, frequency of use, destination, or origin. Block stacking, single-deep pallet racks, and gravity flow racks are by far the most common devices, even in lean manufacturing plants.[217]

7.2.9.6 Tracking Inventory

The only way to know what is inside a warehouse is to record what goes in and what comes out. Good tracking promotes inventory accuracy and aids the generation of a realistic production schedule.[218]

7.2.9.7 Security and Access Control

The challenge is to provide the appropriate level of security without interfering with the flow of work, while treating employees with the trust and respect, which is an integral part of managing in a lean environment.[219]

7.2.9.8 Supermarkets

Supermarket is a more descriptive term for the line materials replenishment cycle. Much like a grocery store a supermarket provides a wide range of items close to its point of usage with ample inventories to handle unforeseen demand.[220] Basically, they are small satellite warehouses spread throughout the plant. As the study by Frazelle et al shows[221] small warehouses perform better in areas like productivity, storage density, warehouse order lead time and safety.

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[215] cf. Baudin, 2004, p.171
[216] cf. Baudin, 2004, p.93
[217] Baudin, 2004, p.73
[218] cf. Baudin, 2004, p.104
[219] Baudin, 2004, p.106
[220] cf.Hobbs, 2004, p.141
[221] Frazelle et al, 2002, p.61

7.2.9.9 Water Spiders

A water spider is an employee that distributes materials from the supermarkets directly to the production line.

The term „water spider“ is a mistranslation of „mizusumashi“ the water strider commonly seen darting about the surface of ponds. Toyota called these employees “mizusumashi” based on the similarity of their motions between supermarkets and production lines with those of the insect.[222] Unlike common material handlers, water spiders need to have production knowledge. Therefore they are only recruited among the most senior, most skilled production operators.[223]

7.2.10 Technology

7.2.10.1 WMS

A warehouse management system is a software system that controls the activities within the distribution center. The system knows which goods are to be received and shipped. It determines which tasks need to be performed to process the goods and sends commands to human operators and automated material handling systems to execute these tasks. Furthermore, the system captures the relevant data on orders, shipments and inventory, warehouse layout, warehouse staff, vehicles, customers, suppliers and activities in the distribution center. This ensures the tracking, tracing and quality of warehouse activities.[224]

7.2.10.2 RFID

RFID stands for Radio Frequency Identification and is used in lean manufacturing environments to track materials in real time. RFID tags are attached to each part, which can then be used to record inventory levels as each part moves from one workstation to the next. The tags hold data that uniquely identify each part. An RFID reader can also add data, such as engineering specifications, to the tag as it passes through the assembly process.[225]

7.2.10.3 DRP

Distribution Requirements Planning (DRP) is a time-phased finished-goods inventory replenishment plan in a distribution network. Distribution Requirements Planning is a logical extension of the MRP system, and its logic is analogous to MRP.[226]

[222] Baudin, 2004, p.113
[223] cf. Baudin, 2004, p.112
[224] van den Berg, 2007, p.83
[225] Wisner & Stanley, 2008, p.382
[226] Wisner et al, 2011, p.187

7.2.10.4 ERP

Enterprise Resource Planning (ERP) refers to large commercial software packages that promise a seamless integration of information flow through an organization by combining various sources of information into a single software application.[227]

7.2.10.5 TMS

Transportation Management System (TMS) is a software program that automates a company's shipping process from carrier selection to routing and scheduling.[228]

7.2.10.6 EDI

Auto parts manufacturers today typically receive most of their orders through electronic data interchange (EDI), most of the remainder by email, and a small fraction by fax.

EDI is the exchange of commercial documents such as orders, invoices and shipping notices in electronic form between customer and supplier, directly from a computer application in one organization to an application in another over a communication network.[229]

7.2.11 Leadership

7.2.11.1 Glass Wall Management

Running mini companies in an isolated setting is not good enough. The company needs to find ways to tie people's creative potential closer together. One approach to do so is "glass wall management."

Here "glass wall" indicates open communication throughout the company. If pertinent information is shared with everybody, all people in a company can participate in collectively managing the company.[230]

[227] Hossain et al, 2002, p.108
[228] Blanchard, 2010, p.89
[229] Baudin, 2004, p.251
[230] cf. Sukazi, 1993, p.78

8 Correlation Matrix

The initial matrix got reviewed by LOPEC Members. After some discussion it was altered to the following final form. Just like the author of this thesis LOPEC Members came to the conclusion that it would be beneficial to add a module on quality tools. Other notable additions are the module on project management and change management.

Table 4 - Final correlation matrix after LOPEC review

LEAN LOGISTICS content framework								EFQM excellence apporach				
								Committed	Recognised for Excellence			Excellence
								to Excellence	3	4	5	Award
LEAN LOGISTICS content framework												
	Scope, potential & objectives							■				
	Types of waste							■				
	Material and Information flow							■				
Basics of Lean Logistics												
	Lean warehousing											
		Objectives and scope						■				
		Inbound & outbound logistics						■				
		Logistics & storage planning							■			
		Inventory management & control							■			
		Procurement management							■			
		Logistics outsourcing								■		
	Lean supply chain management											
		Objectives and scope						■				
		Differences with in-plant logistics						■				
		Planning level & tasks							■			
		Bullwhip effect							■			
		SCM process management							■			
		Transparency of information							■			
		Supplier relationship management								■		
		Supplier integration								■		
		Supply chain controlling									■	

Analysis tools							
	Analysis tools for in-plant logistics						
		Procedure chart		■			
		Material flow analysis			■		
		Lead time analysis			■		
		Stock location analysis				■	
		Shop floor analysis				■	
		Bottlenecks analysis				■	
		Value stram mapping					■
	Analysis tools for supply chains						
		Activity profiling for supply chains			■		
		Supplier performance monitoring				■	
		Distributor performance monitoring				■	
Process design & optimization methods							
	Optimization methods for in-plant logistics						
		5S / 5A	■				
		Kaizen & PDCA-Cycle	■				
		Pull vs. push & Kanban		■			
		FIFO, LIFO		■			
		Poka Yoke		■			
		LCIA (Low Cost Intelligent Automation)			■		
		Jidoka			■		
		Heijunka			■		
		One-Piece-Flow			■		
		Container strategies			■		
		Supermarkets			■		
		Sequencing, JIT & JIS			■		
		Synchronized tugger trains				■	
		C-Part management				■	
		Packaging improvements				■	
		APS (Advanced Planning Systems)					■
		Category management					■

	Optimization methods for SCM						
		Milk runs			■		
		Cross-docks				■	
		Consignment stock				■	
		SMI (Supplier Managed Inventory)					■
		VMI (Vendor Managed Inventory)					■
		ECR (Efficient Consumer Response)					■
Additional tools							
	Tools for project mgmt. & decision making						
		Network planning	■				
		Critical to quality analysis	■				
		Decision tree diagram		■			
		Cost-benefit analysis			■		
		Affinity diagram			■		
		Entity relationship diagram			■		
	Quality management tools						
		Parameter design method		■			
		Control card		■			
		Fault tree analysis		■			
		Pugh concept selection method			■		
		Process capability study			■		
		Failure Mode and Effect Analysis				■	
		Tolerance analysis				■	
	Statistical tools						
		Design of Experiment			■		
		Statistical tests			■		
		Regression analysis			■		
		Multivariate analysis			■		
		Probability grid				■	
		Measurement system analysis				■	
	Graphical tools / visual management						
		Ishikawa chart	■				
		Bar chart		■			
		Paretro chart		■			
		Assessment form			■		
		Relational diagram				■	

	Tools for customer management											
		Customer interview / questionary										
		Kano model										
		Customer needs allocation										
		Taguchi method										
		Voice of the customer / QFD										
		Conjoint analysis										
Technology support for Lean Logistics												
		Warehouse mgmt. Systems										
		EDI-Systems										
		RFID										
		DRP & ERP										
Organisational Behavior & Sustainability												
	Change management											
	Innovation management											
	Employee Lean & KVP Training											
	Total Productive Management											
	Monitoring & reporting											
								Total	**14**	**18**	**25**	**24**	**9**

9 Evaluation of Training Methods

Now the training methods will be rated. Noe[231] did an extensive evaluation of different training methods. His results shall serve as scientific basis for this chapter. Noe used the following 14 criteria to rate training:

- Verbal information
- Use of intellectual skills
- Use of cognitive strategies
- Attitudes
- Use of motor skills
- Clear objectives
- Opportunity for practice
- Meaningfulness
- Opportunity for feedback
- Ratio between observation / interaction
- Transfer
- Development cost
- Administrative cost
- Effectiveness

Winston and Arthur[232] conducted a similar study. They tried to find the best training delivery methods while considering task characteristics. The task categories they used were: cognitive, interpersonal and psychomotor skills. The evaluation criteria were Kirkpatrick's four levels. Looking at the correlation matrix it can be seen that most of the tasks are either interpersonal, cognitive or a combination of both. The data Winston and Arthur found on teaching those types of tasks are the most relevant for this evaluation.

[231] cf. Noe & Peacock, 2002, p.184ff
[232] Bennett & Winford, 2001, p.10ff

Skill/Task Category	Training Method: Rank-Ordered Effectiveness for Each Skill/Task Characteristic	δ	*SD*δ
Cognitive	Lecture	.917	.471
	Audio Visual	.749	.724
	Programmed Instruction	.633	.467
	Equipment Simulator	.568	.000
	Discussion	.561	.647
	Self-Taught	.437	.438
	CAI	.435	.411
	Orientation	.398	.265
Psychomotor	Job Aid	.795	.448
	Audio Visual	.634	.545
	CAI	.626	.398
	Discussion	.579	.421
	Lecture	.479	.281
	Equipment Simulator	.335	.195
Interpersonal	Programmed Instruction	.991	.253
	Lecture	.649	.622
	Audio Visual	.617	.581
	Self -Taught	.585	.000
	Discussion	.429	.560

Figure 25 - Final ranking of Winston & Arthurs study[233]

For the sake of clarity and simplicity some rating criteria will be consolidated and some others will be left out. This results in the following list:

- Use of cognitive strategies
- Use of interpersonal skills
- Proximity to real working atmosphere (high proximity results in high transfer and is therefore important)
- Development cost
- Administrative cost
- Scalability (aptitude to teach a large number of people)

The methods that shall be evaluated are:

- Classroom training (lectures)
- On the job training
- Simulations, e.g. learning factory
- Web based training
- Self-study (programmed instruction)

[233] Winston & Arthur, 2001, p.71

9.1 Lectures

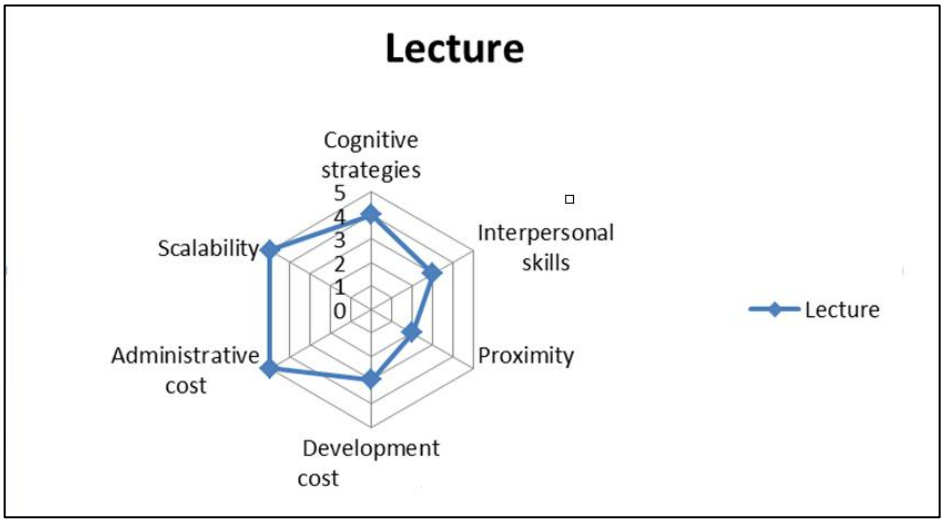

Figure 26 - Rating for the lecture method (compiled by the author)

As expected. Winston and Arthur found that the lecture is the most effective method for cognitive skills and tasks (σ = 0.917, SDσ = 0.471). The lecture was also found to be effective for training interpersonal skills and tasks (σ = 0.850, SDσ = 0.504). This result is not surprising given that many types of focus groups and sensitivity training activities use the lecture as the primary training method.[234]

Noe rates the developmental cost for the lecture as medium because one hour of classroom training requires eight hours of preparation. The administrative cost is rated as low. Proximity to real workspace is rated low as well.

9.2 On the Job Training

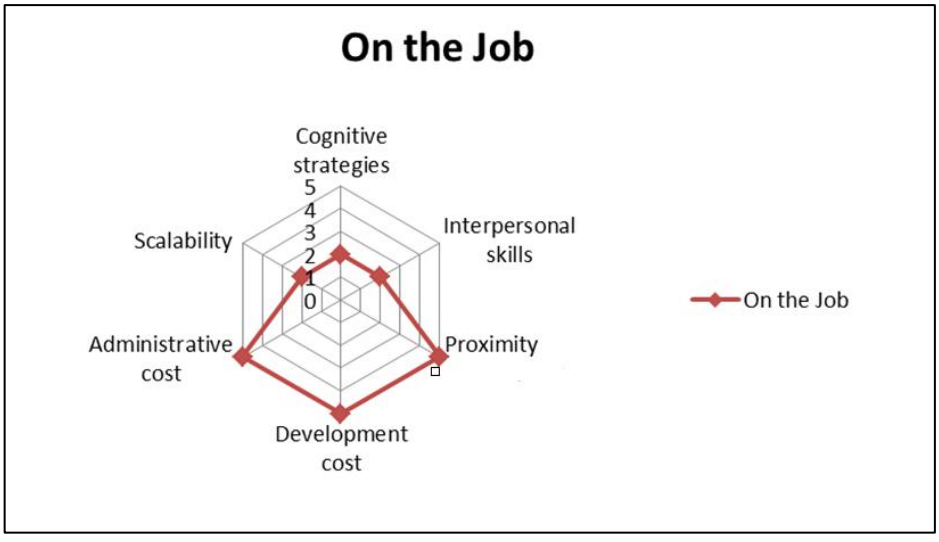

Figure 27 - Rating for the on the job method (compiled by the author)

[234] Winston & Arthur, 2001, p.58

The obvious strength of on the job training is its proximity to the real work environment, because it actually takes place there, and its low cost. In Winston and Arthur's study, on the job training rates low for teaching cognitive tasks. Unfortunately they do not provide any data for OTJ and interpersonal tasks, but it can be hypothesized that a busy factory environment is probably not the right place to teach interpersonal skills.

9.3 Simulations (Learning Factory)

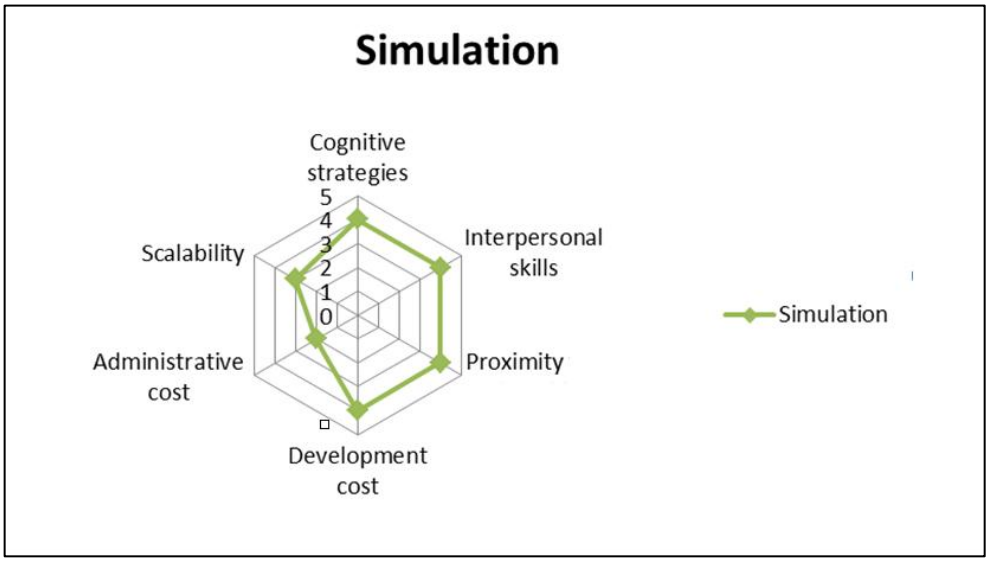

Figure 28 - Rating for the simulation method (compiled by the author)

While Noe and Winston & Arthur provide some data on equipment simulation, neither mentions simulated systems, such as in a learning factory. Their data therefore does not seem to be entirely appropriate for the analysis. A learning factory will be viewed as a type of on the job training where instructors can stop time to explain or demonstrate details. This does two things: on the one hand it should improve the ability to teach cognitive and interpersonal skills. A finding by Winston and Noe confirms this: Equipment Simulation rated (σ = 0.581) at teaching cognitive skills which is about twice the value of on the job training.

On the other hand the proximity to the real life work environment is not as high as on the job training, because there is no pressure to work quickly or error free.

The development cost for a learning factory is obviously very high, but since LOPEC partners already have learning factories, development is not necessary anymore and the cost can be rated as low. Administrative costs are, however, quite high, due to the costs of energy and demonstration material.

9.4 Programmed Instruction

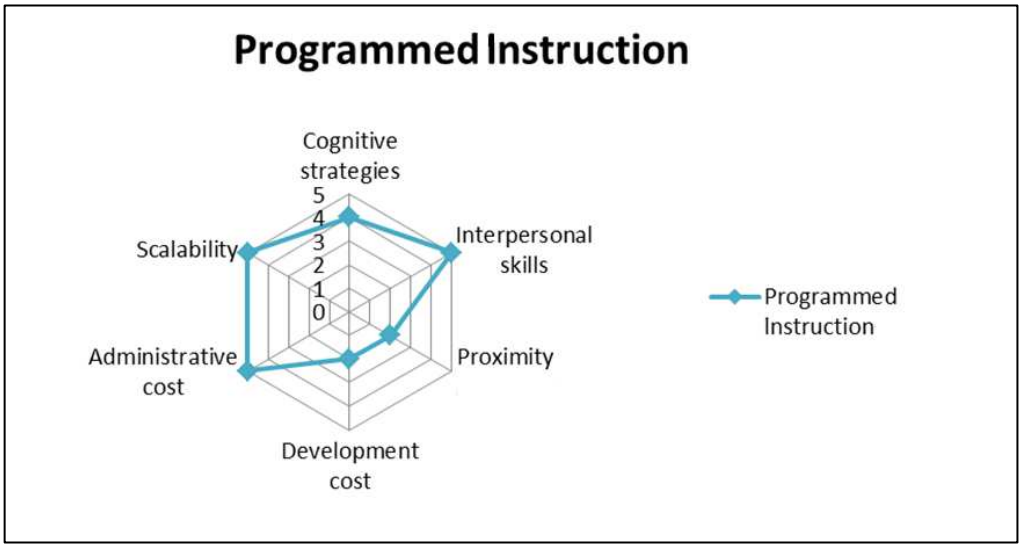

Figure 29 - Rating for the programmed instruction method (compiled by the author)

Surprisingly (at least for the author) programmed instruction has shown to be highly effective in teaching interpersonal skills and also as an effective method to teach cognitive skills and tasks.[235] Furthermore, administrative costs are very low, while developmental costs for a text book or an online platform can be rather high. Scalability is also very high.

9.5 Web Based Training

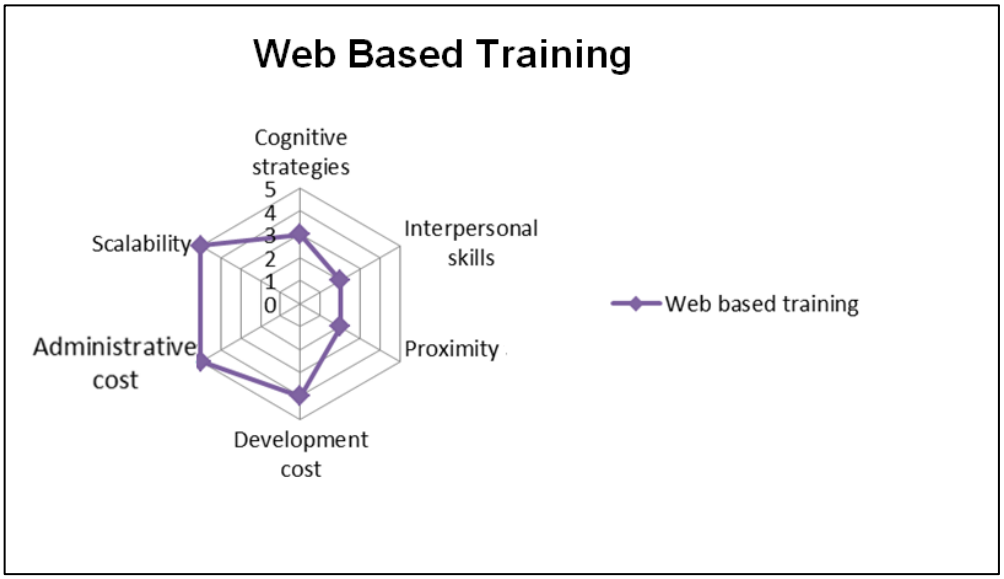

Figure 30 - Rating for the web based training method (compiled by the author)

[235] cf. Winston & Arthur, 2001, p.59

There are several studies comparing web based or computer aided training with various other training methods. E.g. Sitzman et al[236] found web based training to be less effective than lectures. However they noted that, „Overall these results support the argument that instructional methods rather than delivery media determine learning outcomes. In addition, designing long training courses and providing trainees with control, practice, and feedback during web based instruction will maximize learning declarative knowledge from web based instruction relative to class room instruction." Ergo, web based training is viewed as more of a delivery method than a training method. Thus the ratings on effectiveness (cognitive and interpersonal) have to be taken with care, as they depend on how the online course is actually designed. It would be possible to incorporate a type of classroom learning or programmed instruction into an online course.

Arguments for online training would be its capability to train a large number of people at a low cost.

9.6 Conclusion

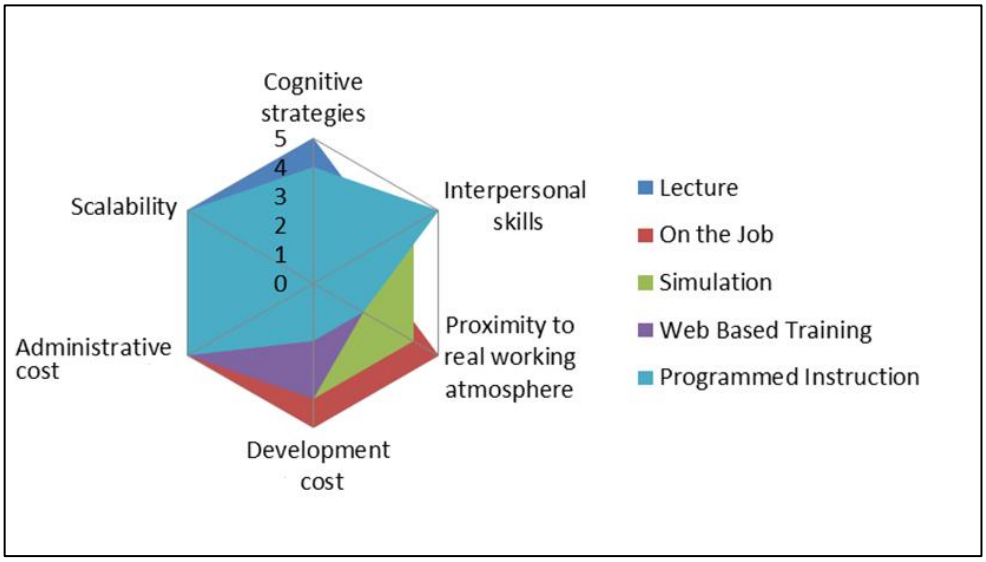

Figure 31 - Summary of rated methods (compiled by the author)

As noted earlier, a good training program has to use several different methods to accommodate all perceptual modes. (See Chapter 3.5).

From a practical perspective it has to be noted that LOPEC partners already have several learning factories in place and a large number of experienced instructors available. It would be recommendable to use that potential. Furthermore the market analysis showed that a learning factory would be an (almost) unique selling point in Europe and it provides good stimulus for interactive and kinesthetic learners.

[236] cf. Sitzmann, 2006, p.623

The lecture method was found to be the best way to teach cognitive skills and the programmed instruction method rated best at teaching interpersonal skills. The two are also easily combined, relatively cheap and are good ways to transport visual, aural and printed information.

The conclusion therefore should be that a combination of lectures, programmed learning and simulations within a learning factory is the most effective way to teach lean logistics. The learning factory, however, might turn out to be a bottleneck because it cannot accommodate as many trainees at the same time as the two other methods.

9.7 LOPEC Results

LOPEC Members investigated the issue of training methods and confirmed the author's conclusion. Figure 32 shows how LOPEC intends to combine classroom lectures with self-studies and learning factory simulations.

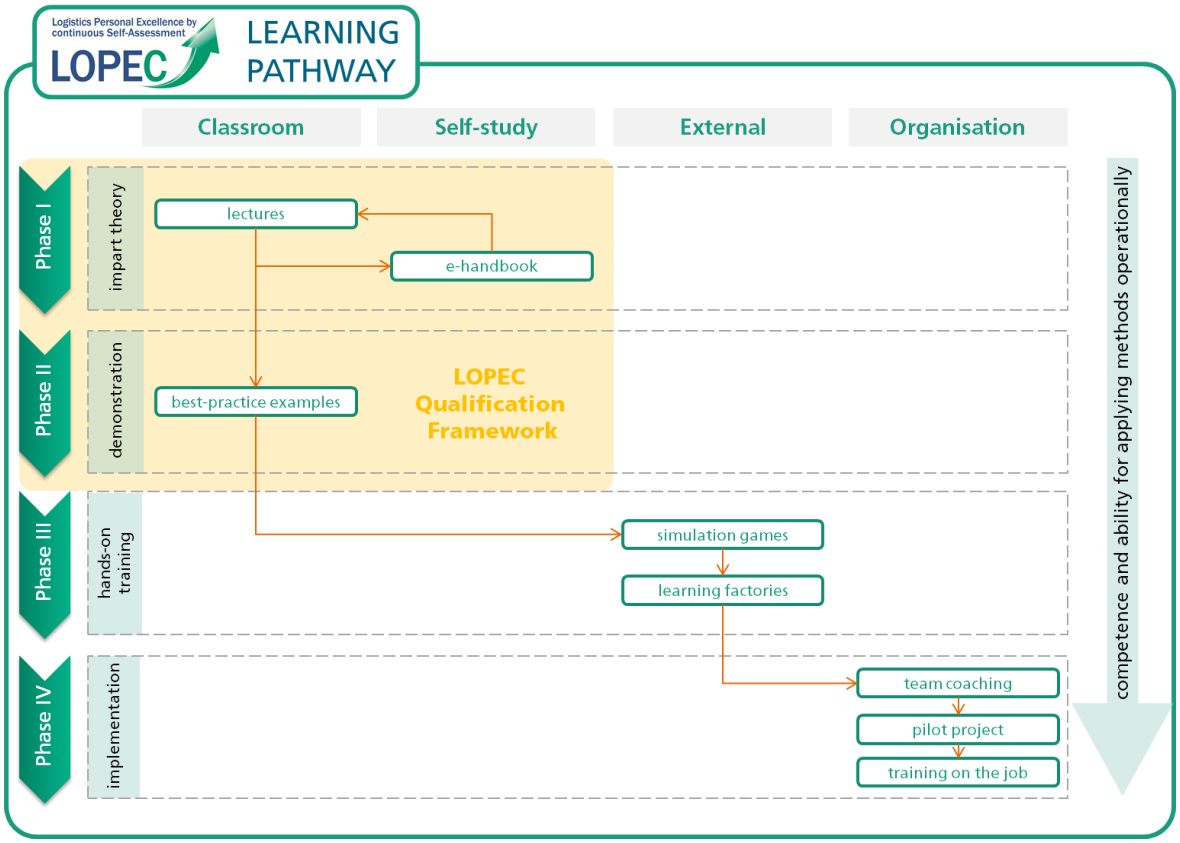

Figure 32 - LOPEC training methods[237]

[237] LOPEC, 2013, www.esb-lopec.eu (site was still under construction at time of creation of this thesis)

10 Conclusion

Figure 33 - Thesis word cloud (compiled by the author)

As the word cloud illustrates, the main themes of this work are training and lean logistics, just as originally intended. Additionally, competence and manufacturing proved to be important.

To conclude the research question mentioned in the introduction will now be revisited and answered.

1. What is lean logistics?

After some literature research it was concluded that the following definition is most appropriate in relation to this work:

"Lean logistics refers to the use and constant improvement of a lean flow method in the supply chain. The purpose is the reduction and the elimination of all activities which do not add value to the value stream from a customer's perspective."

1.1. Where are the differences and commonalities between lean logistics, lean manufacturing and lean administration?

In Chapters 2.4 to 2.6 it was found out that all three disciplines share commonalities and dependencies. It was discussed those relations and some graphics were created for illustration. Generally lean administration was defined as the administrative structure that supports lean manufacturing and lean logistics. Lean manufacturing

was implied to be the part of an organization where goods are physically changed, under the application of lean principles.

2. What is a competency? What types of competencies are there and how do they relate to problem solving and learning?

While doing the initial research on the target group the term competency turned out to be more complex than originally expected. It emerged that there was a requirement for exact definitions about what a competency actually is and what type of competencies there are. Therefore current literature on the topic was analyzed and proper definitions were deducted and a competency model was created. It was found that the term competence refers to the ability to successfully apply ones traits, skills and knowledge in combination with experiences, values and norms in a self-organized fashion to novel situations. The competency model included three main categories of competency: technical competence, social competence and leadership competence.

3. How much lean logistics knowledge does the shop floor employee need and what are the concrete topics he/she needs to know about?

In order to identify lean logistics knowledge, extensive literature research was undertaken and the current situation on the market was analyzed. Then a matrix of relevant lean knowledge was created by the author of this work, which can be found in chapter 7. The initial matrix then was discussed and edited by LOPEC members. The result can be found in chapter 8.

4. What is the target group? What competencies and characteristics does it need to have?

The target group was discussed in chapter 5. It was named the grey collar worker. It was found to be necessary for the grey collar worker to have some initial social and leadership competencies that will help him spread lean change within his organization and some initial professional competencies in order to understand the concepts of lean logistics and then he will need additional characteristics such as high general mental ability.

5. What are some factors that influence transfer of training and how can the effect of training be maximized by manipulating work environment?

This question was answered in chapter 6. Some factors affecting training transfer where identified in the pre- and post-training environment and a list of recommendations was created. The most important factors that influence transfer of training were identified as trainee characteristics, supervisory support and the ability to apply new skills. The recommendations included that participation in the program

should be voluntary, each trainee should have a mentor that helps him to establish and evaluate goals, that trainees should be provided with sufficient information about the program, its benefits and the post training activities and evaluations before it starts, have trainees teach their peers after the completed that program and allow them to apply the learned skills as soon as possible.

6. What are the best training methods to deliver the lean curriculum?

In chapter 9 some general characteristics of the topics in the curriculum (mostly being of cognitive and interpersonal nature) were found and a rating system to find the best training methods was developed. There are probably more conscientious ways to categorize the training material, but finding them would go beyond the scope of this work. However, it might be an interesting task for a future thesis. The evaluation showed that a combination of classroom lectures, programmed instruction and simulations in a learning factory should be the preferred choice of training methods.

Additional questions emerged during creation of the thesis:

7. What are the differences between the Toyota Production System and lean System and why does the TPS appear to be more effective?

The definition of lean manufacturing was derived from the characteristics of the TPS in chapters 2.2 to 2.4. While doing so it showed that some authors view lean as inferior to the TPS and it also appears that numerous lean implementations fail to or do not produce the desired outcome. Further investigation was undertaken to determine the causes. There turned out to be two common reasons. The first one is the misinterpretation of lean as a quality tool. The second is the absence of Toyota's unique company culture and consequently the treatment of lean as a mere set of tools. In order to make LOPEC customers avoid these common traps some recommendations were made. These included the encouragement of learning by teaching, the adding of a quality module to the curriculum and the establishment of a learning organization.

8. Does a lean organization provide an excellent framework for organizational learning?

In chapter 6 actions an organization has to undertake to create a good learning environment were investigated and traits of learning organizations were identified. In order to make proper recommendations it was found to be important to see what principles of organizational learning are already incorporated in lean principles. The conclusion was that lean thinking had some traits of a learning organization but was lacking others and even had some traits that hindered learning (e.g. standardization).

11 Bibliography

11.1 Works Cited

11.1.1 Lean

11.1.1.1 Books

Alukal, G., Manos A: Lean Kaizen: A Simplified Approach to Process Improvements, ASQ Quality Press, 2006

Babson, Steve: Lean Work: Empowerment and Exploitation in the Global Auto Industry, Wayne State UP, 1995

Basu, Ron: Implementing Six Sigma and Lean, Routledge, 2012

Baudin, Michael: Lean Logistics – The nuts and bolts of delivering materials and goods, Productivity Press, 2004

Blanchard, David: Supply Chain Management: Best Practices, John Wiley & Sons, 2010

Brunner, Franz J: Japanische Erfolgskonzepte, Hanser Verlag, 2011

Farmer, Neil: The Invisible Organization: How Informal Networks Can Lead Organizational Change, Gower, 2008

Frazelle, E.: World Class Warehousing & Material Handling, McGraw Hill, 2002

Hobbs, Dennis P.: Lean Manufacturing Implementation Guide: Proven Step-By-Step Techniques for Achieving Success, J.Ross Publishing, 2004

Imaoka. Zenjiro: Understand Supply Chain Management through 100 words", KOUGYOUCHOUSAKAI, 2004

Goldsby, Thomas J. Martichenko, Robert: Lean Six Sigma Logistics: Strategic Development to Operational Success, J. Ross Publishing, 2005

Gudehus, Timm, Kotzab, Herbert: Comprehensive Logistics, Springer, 2012

Goetschalckx, Marc: International Series In Operations Research and Management Science: Supply Chain Engineering, Springer, 2011

Gross, John M., and Kenneth R. McInnis: Kanban Made Simple: Demystifying and Applying Toyota's Legendary manufacturing Process, AMACOM, 2003

Hobbs, Dennis P.: Lean Manufacturing Implementation: A Complete Execution Manual for Any Size Manufacturer, J. Ross Pub., 2004

Hossain, Liaquat, Jon David. Patrick, and Mohammad A. Rashid: Enterprise Resource Planning: Global Opportunities and Challenges, Idea Group Pub., 2002

Kannt, Andreas: Supply Chain Management and Design at Global Companies, A. Kannt, 2002

Kerber, Bill, and Brian J. Dreckshage: Lean Supply Chain Management Essentials: A Framework for Materials Managers, Boca Raton, 2011

Liker, Jeffrey K.: The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, McGraw-Hill, 2004

Louis, Raymond S.: Custom Kanban: Designing the System to Meet the Needs of Your Environment, Productivity, 2006

Matyas Kurt: Taschenbuch Instandhaltungslogistik, Hanser Verlag, 2008

McCarty, Thomas Daniels, Lorraine Bremer, Michael Gupta, Praveen Heisey, John Mills, Kathleen: The Six Sigma Black Belt Handbook, McGraw Hill Professional, 2004

Myerson, Paul: Lean Supply Chain and Logistics Management, McGraw-Hill, 2012

Monden, Yasuhiro: Toyota Production System: An Integrated Approach to Just-In-Time, CRC Press, 2011

Ōno, Taiichi: Toyota Production System: Beyond Large-scale Production, Productivity, 1988

Ortiz,C Park M, Murry R. Par: Visual Controls: Applying Visual Management to the Factory, CRC Press, 2010

Plenert, Gerhard Johannes: Reinventing Lean: Introducing Lean Management into the Supply Chain, Butterworth-Heinemann, 2007

Productivity Development Team (Productivity Press): Identifying Waste on the Shopfloor, Productivity Press, 2003

Ptacek, Rob, Motwani, Jaideep: Lean Six Sigma for Service, MCS Media, 2011

Roderick A. Munro, Ph.D: Lean Six Sigma for the Healthcare Practice: A Pocket Guide, ASQ Quality Press, 2009

Sailer, Gernot: Lean Administration - Instrumente des Lean Production für das schlanke Office, Grin Verlag, 2012

Shingō, Shigeo: Zero Quality Control: Source Inspection and the Poka-Yoke System, Productivity, 1986

Sukazi Kiyoshi: New Shop Floor Management: Empowering People for Continuous Improvement, Simon and Schuster, 1993

Swamidass, Paul M.: Encyclopedia of Production and Manufacturing Management, Springer US, 2006

Tsigkas, Alexander C.: The Lean Enterprise: From the Mass Economy to the Economy of One, Springer, 2012

Vanzant-Stern, Terra, Lean Six Sigma: Practical Bodies of Knowledge, Fultus, 2011

Wilson, Lonnie: How to Implement Lean Manufacturing, McGraw-Hill, 2010

Wisner, Joel D., and Linda L. Stanley: Process Management: Creating Value along the Supply Chain: Text & Cases, Thomson South-Western, 2008

Wisner, Joel D., G. Keong. Leong, and Keah-Choon Tan: Principles of Supply Chain Management: A Balanced Approach, South-Western, 2011

Womack, James P., and Daniel T., Jones: Lean Thinking, Simon & Schuster, 2003

Zidel, Thomas G.: A Lean Guide to transforming health care, Milwaukee, 2006

11.1.1.2 Thesis and white papers

Jaeger, A., Mayrhofer, W., Kuhlang, P., Matyas, K., & Sihn, W.: The “Learning Factory”: An immersive learning environment for comprehensive and lasting education in industrial engineering, World Multi-Conference on Systemics, Cybernetics, and Informatics, 2012, n.p.

Jones, D. T., Hines, P., & Rich, N.: Lean Logistics, International Journal of physical distribution & logistics management, 27(3/4), 1997, p.154ff

Lockamy III, A., & McCormack, K.: The development of a supply chain management process maturity model using the concepts of business process orientation. Supply Chain Management: An International Journal, 9(4), 2004, p.272-278

Van den Berg, Joren P: Integral Warehouse Management: The next Generation in Transparency, Collaboration and Warehouse Management Systems, Management Outlook, 2007, n.p.

Wu, Yen-Chun Jim: Effective lean logistics strategy for the auto industry, International Journal of logistics Management, The 13.2, 2002, p.19-38

11.1.1.3 Web pages

Adam Europe: n.d., http://tinyurl.com/njenmsr , retrieved: January 4th 2013

Bundesverband für Materialwirtschaft und Einkauf: n.d. http://tinyurl.com/p3yq2le retrieved: March 4th 2013

CSCMP Supply Chain Management: n.d., http://tinyurl.com/op8bntk , retrieved: January 4th 2013

D-Cap: 2013, http://www.d-cap.de/140.0.html, retrieved: March 4th 2013

Fishbonediagram: 2013, http://fishbonediagram.org/ , retrieved: March 9th 2013

HCI Project: 2012, http://tinyurl.com/p2sjrg7 , retrieved: March 9th 2013

Impuls Trainingscenter: n.d., http://tinyurl.com/pep5v2m , retrieved: March 14th 2013

Inspirative: 2013, http://inspirative.edu.au/lean-training-courses/ , retrieved: January 07th 2013

Lean Enterprise Institute: Principles of lean, What Is lean, n.d., http://www.lean.org/whatslean/principles.cfm , retrieved: January 6th 2013.

Lean Institute, n.d., http://tinyurl.com/nbq9anm , retrieved: March 17th 2013

Lean Enterprise Institute. "Principles of lean." What Is lean, n.d.. http://www.lean.org/whatslean/principles.cfm , retrieved: January 6th 2013

McBride D., 2004, ems-consulting group, “Heijunka, Level the load”, http://www.emsstrategies.com/dm090804article.html, retrieved: November 11th 2012

Michigan College of Engineering, n.d., http://tinyurl.com/lreu7af , retrieved: March 14th 2013

Nippon Express, n.d., http://www.nipponexpress.com/about/csr/environment/cooperation.html retrieved: March 8th 2013

Rodrigue, Jean Paul, Dept. of Global Studies & Geography, Hofstra University,n .d., http://people.hofstra.edu/geotrans/eng/ch5en/conc5en/crossdocking.html , retrieved: March 8th 2013

Saskatoon Public Schools, Instructional Strategies online, 2012, http://olc.spsd.sk.ca/DE/PD/instr/strats/simul/index.html , retrieved: December 5th, 2013

Smalley, Art., 2005, TPS vs. Lean and the Law of Unintended Consequences, Superfactory, http://tinyurl.com/o8295cx , retrieved: January 5th 2013

11.1.2 Training

11.1.2.1 Books

Almeida, Rita, Jere Behrman, and David Robalino: The Right Skills for the Job?, 2011

American Society for Training & Development: The Complete Guide to Technical and Skills Training, American Society for Training & Development, 1998

Barbazette, Jean: Training Needs Assessment: Methods, Tools, and Techniques, Pfeiffer, 2006

Bates, R. A.: Managers as transfer agents: Improving learning transfer in organizations, Jossey Bass, 2003

Bennett, Gregory: Cross-training for First Responders, Taylor & Francis, 2010

Cragan, John F., and David W. Wright: Communication in Small Groups: Theory, Process, Skills, Wadsworth Pub., 1999

Gagne, R. M., Briggs, L. J., and Wagner, W. W.: Principles of instructional design, Harcourt Brace Jovanovich, 1992

Ghoshal, S. and Bartlett, C. A.: The Individualized Corporation, Heinman, 1998

Goldstein, I. L.: Training in Organizations: Needs Assessment, Development, and Evaluation, Cole Publishing Company, 1986

Hannum, Wallace H.: Hansen, Carol, Instructional Systems Development in Large Organizations, Educational Technology, 1989

Hayes, David K., and Jack D. Ninemeier: Human Resources Management in the Hospitality Industry, John Wiley & Sons, 2009

Iskander, Magued: Innovative Techniques in Instruction Technology, E-learning, E-assessment and Education, Springer, 2010

James, Waynne B., Galbraith, Michael W.: Perceptual Learning Styles: Implications and Techniques for the Practitioner, Lifelong learning, 1985

Kirkpatrick, Donald L.: Evaluating Training Programs: The Four Levels, Berrett-Koehler, 1998

Köster Abad, M.: A Lean System for Operator Training and Skill Management with Genetic Algorithm Based Allocation for a Complex manufacturing Environment, ProQuest, 2008

Landy, Frank J., and Jeffrey M. Conte: Work in the 21st Century: An Introduction to Industrial and Organizational Psychology, Blackwell, 2007

Lawson, Karen: New Employee Orientation Training, Routledge, 2012

Lewis, Pamela S. Goodman, Stephen H. Fandt, Patricia M. Michlitsch, Joseph F.: Management: Changes for Tomorrow's Leaders, Cengage Learning, 2006

Levine, Charles I: On the Job training, American Society for Training and Development, 1997

McGehee, W., and Thayer, P. W.: Training in Business and Industry, New York: Wiley, 1961

Noe, Raymond A., and Melanie Peacock: Employee training and development. McGraw-Hill/Irwin, 2002

Rasmussen, J.: Information processing and human–machine interaction: An approach to cognitive engineering, Elsevier, 1986

Papert, S.: The Children's Machine: Rethinking school in the age of the computer, Basic Books, 1993

Pedler, M., Burgogyne, J. and Boydell: T. The Learning Company: A strategy for sustainable development. 2nd Ed., McGraw-Hill, 1997

Senge, Peter M.: The Fifth Discipline, Random House Business, 2006

Taylor, F. W.: The Principles of Scientific Management, Harper, 1911

Walsh, J.: Legal aspects of training. In R.L. Craig and L.R. Bittel (Eds) , Training and Development Handbook, McGraw-Hill, 1967

Wexley, K. N., & Latham, G. P.: Developing and training human resources in organizations (3rd ed.), Prentice Hall, 2002

11.1.2.2 Thesis and White papers

Alderfer, Clayton P., et al.: The race relations competence workshop: Theory and results., Human Relations 45.12, 1992, p.1259-1291

Arthur Jr, Winfred, et al.: Effectiveness of training in organizations: a meta-analysis of design and evaluation features, Journal of Applied psychology, 2003, p.234ff

Baldwin, Timothy T., and J. Kevin Ford: Transfer of training: A review and directions for future research, Personnel psychology 41.1,1988, p.63-105

Baldwin, Timothy T., and Richard J. Magjuka: Organizational training and signals of importance: Linking pretraining perceptions to intentions to transfer, Human Resource Development Quarterly 2.1, 2006, p.25-36

Bargh, J. A., & Schul, Y.: On the cognitive benefits of teaching. Journal of Educational Psychology, 72(5), 1980, p.593-604

Bates, R. A.: Managers as transfer agents: Improving learning transfer in organizations, Jossey Bass, 1980, p.264

Bell, Bradford S., and W. J. Kozlowski: Goal orientation and ability: Interactive effects on self-efficacy, performance, and knowledge, Journal of Applied Psychology 87.3, 2002, p.497

Bennett Jr, Winston R., and Winford Arthur Jr.:Factors that influence the effectiveness of training in organizations: A review and meta-analysis. HUMAN EFFECTIVENESS DIRECTORATE MESA AZ WARFIGHTER TRAINING RESEARCH DIV, 2001, n.p.

Biswas, G., Schwartz, D. L., Bransford, J. D., & TAG-V.: Technology support for complex problem solving: From SAD Environments to AI. In K. Forbus & P. Feltovich (Eds.) Smart machines in education, AAAI/MIT Press, 2001, p.71-98

Birdi, K., Allan, C., & Warr, P.: Correlates of perceived outcomes of four types of employee development activity. Journal of Applied Psychology, 82, 1997, p.845–857

Bontis, N.: There's a price on your head; managing intellectual capital strategically, Business Quarterly, Summer, 1996, p.43-58

Burke, Lisa A., and Holly M. Hutchins.: Training transfer: An integrative literature review., Human resource development review 6.3, 2007, p.263-296

Carnevale, A.P., Goldstein, H.: Schooling and training for work in America: an overview, Labor Law Journal, Aug91, Vol. 42 Issue 8, 1991, p.563

Cascio, W.: 1998, Valuing intellectual capital, HR Monthly, February, p.12-16

Chi, M. T. H., De Leeuw, N., Chiu, M.-H., & Lavancher, C.: Eliciting self-explanations. Cognitive Science, 18, 1994, p.439-477

Chi, M. T. H., Siler, S. A., Jeong, H., Yamauchi, T., & Hausmann, R. G.: Learning from Human Tutoring. Cognitive Science, 25(4), 2001, p.471-533

Clarke, N.: Job/work environment factors influencing training effectiveness within a human service agency: Some indicative support for Baldwin and Fords' transfer climate construct. International Journal of Training and Development, 6(3), 2002, p.146–162

Cohen, Debra J.: What Motivates Trainees?, Training and development journal 44.11, 1990, p.91-93

Downs, S.: Industrial training. In A.P.O. Williams Using Personnel Research, 1986, n.p.

Dolezalek, Holly: Training magazine's 23rd annual comprehensive analysis of employer-sponsored training in the United States, Training Magazine, 2004, n.p.

Farrell, Mark A.: Developing a market-oriented learning organization, Australian Journal of Management 25.2, 2000, p.201-222

Feldman, Daniel C.: Socialization, resocialization, and training: Reframing the research agenda, 1989, n.p.

Fleischman, Edwin A., and Michael D. Mumford: Abilities as causes of individual differences in skill acquisition, Human performance 2.3, 1989, p.201-223

Frayne, Colette A., and Gary P. Latham: Application of social learning theory to employee self-management of attendance, Journal of Applied Psychology 72.3, 1987, p.387

Gist, Marilyn E., Cynthia Kay Stevens, Anna G. Bavetta: Effects of self-efficacy and post-training intervention on the acquisition and maintenance of complex interpersonal skills, Personnel Psychology 44.4, 1991, p.837-861

Graesser, A. C., Person, N., & Magliano, J.: Collaborative dialog patterns in naturalistic one on one tutoring. Applied Cognitive Psychologist, 9, 1995, p.495-522

Gregoire, T. K.: Assessing the benefits and increasing the utility of addiction training for public child welfare workers: A pilot study. Child Welfare, 73, 1994, p.69–81

Hawley, J. D., & Barnard, J. K.: Work environment characteristics and implications for training transfer: A case study of the nuclear power industry. Human Resource Development International, 8, 2005, p.65–80

Hicks, William D., and Richard J. Klimoski: RESEARCH NOTES. ENTRY INTO TRAINING PROGRAMS AND ITS EFFECTS ON TRAINING OUTCOMES: A FIELD EXPERIMENT, Academy of Management Journal 30.3, 1987, p.542-552

Hines, Peter, Matthias Holweg, and Nick Rich: Learning to evolve: a review of contemporary Lean thinking, International Journal of Operations & Production Management 24.10, 2004, p.994-1011

Hülsheger, Ute R., Günter W. Maier, and Thorsten Stumpp: Validity of General Mental Ability for the Prediction of Job Performance and Training Success in Germany: A meta-analysis, International Journal of Selection and Assessment 15.1, 2007, p.3-18

Industrial Relations Research Association Series: Industrial Relations Research Association, 1990, n.p.

Kirkpatrick, D.: Another Look at Evaluating Training Programs: Fifty Articles from Training & Development and Technical Training: Magazines Cover the Essentials of Evaluation and Return-on-investment, American Society for Training & Development, 1998. p.77ff

Kochnev, Ivan: WHAT, IF ANY, ARE THE DIFFERENCES BETWEEN THE TOYOTA PRODUCTION SYSTEM AND LEAN?, LEAN6SIGMA, Innovation lighthouse, 2007, n.p.

Latham, Gary P., and Colette A. Frayne: Self-management training for increasing job attendance: A follow-up and a replication, Journal of Applied Psychology 74.3, 1989, p.411ff

Latham, G. P.: Human resource training and development. Annual Review of Psychology 39, 1988, p.545-582

Leelawong, Krittaya, and Gautam Biswas: Designing learning by teaching agents: The Betty's Brain system, International Journal of Artificial Intelligence in Education 18.3, 2008, p.181-208

Lim, D. H., & Johnson, S. D.: Trainee perceptions of factors that influence learning transfer. International Journal of Training and Development, 6(1), 2002, p.36–48

Longnecker, C. O.: Maximizing transfer of learning from management education programs: Best practices for retention and application. Development and Learning in Organizations, 18(4), 2004, p.4–6

Martin, Harry J.: Workplace climate and peer support as determinants of training transfer, Human Resource Development Quarterly 21.1, 2010, p.87-104

Marsick, Victoria J., and Karen E. Watkins: The learning organization: An integrative vision for HRD, Human Resource Development Quarterly 5.4, 1994, p.353-360

Mathieu, J. E., S. I. Tannenbaum, and E. Salas: A causal model of individual and situational influences on training effectiveness measures, M. Teachout (Chair), Understanding and evaluating training effectiveness: Multiple perspectives. Symposium conducted at the Fifth Annual Conference of the Society for Industrial and Organizational Psychology, 1990, n.p.

McHugh, D., Groves, D. and Alker, A.: Managing learning: what do we learn from a learning organization? The Learning Organization. 5 (5), 1998, p.209-220

Mealiea, L. W., and Duffy, J.: Contemporary training and development practices in Canadian firms. Annual Meeting of the Atlantic School of Business, 1985, n.p.

Mital, A., et al.: The need for worker training in advanced manufacturing technology (AMT) environments: a white paper, International Journal of Industrial Ergonomics 24.2, 1999, p.173-184

Noe, Raymond A., and Jason A. Colquitt: Planning for training impact: Principles of training effectiveness, Creating, implementing, and managing effective training and development, 2002, p.53-79

Pennathur, Arunkumar, et al.: A framework for training workers in contemporary manufacturing environments, International Journal of Computer Integrated manufacturing 12.4, 1999, p.291-310

Rasmussen, Jens: Cognitive control and human error mechanisms, New technology and human error, 1987, p.53-61

Richman-Hirsch, Wendy L.: Posttraining interventions to enhance transfer: The moderating effects of work environments, Human Resource Development Quarterly 12.2, 2001, p.105-120

Russ-Eft, D.: A typology of training design and work environment factors affecting workplace learning and transfer. Human Resource Development Review, 1(1), 2002, p.45–65

Schein, Edgar H.: On dialogue, culture, and organizational learning, Reflections 4.4, 2003, p.27-38

Schleiffer A.: Schlüsselqualifikationen zum Unternehmenserfolg, Observer, Februar 2011, n.p.

Schneider, Walter: Training high-performance skills: Fallacies and guidelines, Human Factors: The Journal of the Human Factors and Ergonomics Society 27.3, 1985, p.285-300

Schneider, W., & Shiffrin, R. M.: Controlled and automatic human information processing: I. Detection, search, and attention. Psychological Review, 84, 1977, p.1–66

Schmidt, Frank L., and John E. Hunter: The validity and utility of selection methods in personnel psychology: Practical and theoretical implications of 85 years of research findings, Psychological Bulletin; Psychological Bulletin 124.2, 1998, p.262

Sitzmann, Traci, et al.: The comparative effectiveness of web-based and classroom instruction: A meta-analysis, Personnel Psychology 59.3, 2006, p.623-664

Stata, Ray, and P. Almond: Organizational learning: The key to management innovation, The training and development sourcebook 2, 1989, p.1ff

Strickland, B. R.: Internal–external control expectancies: From contingency to creativity. American Psychologist, 44, 1989, p.1–12

Tannenbaum, Scott I., and Gary Yukl: Training and development in work organizations, Annual review of psychology 43.1, 1992, p.399-441.

Wang, Yaqian, and Tony Huzzard: The impact of Lean thinking on organizational learning.(unpublished), 2011, n.p.

Weissbein, Daniel A., et al.: Influencing learning states to enhance trainee motivation and improve training transfer, Journal of Business and Psychology 26.4, 2011, p.423-435

Wexley, K. N.: Personnel training. Annual Review of Psychology, 35, 1984, p.519 – 551

US Department of Labor: High Performance Work Practices and Firm Performance: Background material for the Conference on the Future of the American Workplace, Washington, DC, 1993, n.p.

11.1.2.3 Web pages

ID Reflections, n.d., http://tinyurl.com/ov4zzq3 , retrieved on February 28th 2013

11.1.3 Competence

Boyatzis, R.: The Competent Manager, John Wiley & Sons, 1982

Cavell, T.A.: Social adjustment, social performance, and social skills, A tri-component model of social competence, Journal of Clinical Child Psychology 19, 1990, p.111–122

Crick, N.R.; Dodge, K.A.: A review and reformulation of social information-processing mechanisms in children's social adjustment, Psychological Bulletin 115, 1994, p.74–101

Edmunds, T. & Teh, M.: Personal competence: where does it fit in?, Competence & Assessment, Issue 13, 1994, p.6-8

Erpenbeck, J. Heyse, V.: Die Kompetenzbiographie: Wege zur Kompetenzentwicklung, Waxman Verlag, 2007

Gerig, Valentin: Kriterien Zur Beurteilung Unternehmerischen Handelns Von Mitarbeitern Und Führungskräften, Hampp, 1998

Goldfried, Marvin R., and Thomas J. D'Zurilla: A behavioral-analytic model for assessing competence. Current topics in clinical and community psychology 1, 1969, p.151-196

Hackman JR, Walton RE: Leading groups in organizations, Goodman PS Designing effective work groups, Jossey-Bass; 1986

Jaeger, Andreas, et al.: The “Learning Factory”: An immersive learning environment for comprehensive and lasting education in industrial engineering, 2012

Kauffeld, Simone; Grote, Sven: Mit viel Gefühl am Problem vorbei, New management : die europäische Zeitschrift für Unternehmenswissenschaften und Führungspraxis, Handels-Zeitung-Fachverl.,. - Vol. 71.2002, 1-2, p.42-48

Katz, Robert Lee: Skills of an effective administrator. Harvard Business Press, 1974

MacDuffie, John Paul: Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry, Industrial and labor relations review, 1995, p.197-221

Mumford, Michael D.: et al., Leadership skills for a changing world: Solving complex social problems., The Leadership Quarterly 11.1, 2000, p.11-35

Rifkin, K., Fineman, M., & Ruhnke, C.: Developing technical managers: first you need a competency model, Research Technology Management, Vol. 42 Iss. 2, 1999, p. 53-57

Rowe, W. Glenn, and Laura Guerrero: Cases in leadership, Sage, 2012

Whiddett, S. & Hollyforde, S.: The Competency Handbook, Institute of Personnel Development, 1999.

Wikimedia: http://commons.wikimedia.org/wiki/File:PDCA-Two-Cycles.svg , retrieved February 08th 2013

12 Figures Listed

13 Tables Listed

14 Abbreviations

DRP	Distribution requirements planning
e.g.	Exempli gratia (for example – for instance)
EDI	Electronic data interchange
EFQM	European foundation for quality management
ERP	Enterprise resource planning
et al.	Et alia (and others)
JIT	Just in Time
LOPEC	logistics personal excellence by continuous self-assessment
OJT	On the job training
PDCA	Plan Do Check Act
R&D	Research and development
RFID	Radio frequency Identification
sic	sic erat scriptum, "thus it has been written"
SOP	Standard operating procedure
SPC	Statistical process control
TPM	Total productive maintenance
TPS	Toyota production system
VSM	Value stream mapping
WIP	Work in process
WMS	Warehouse management systems