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Work-associated learning - Guidelines for practical application

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Ao. Univ.-Prof. Dipl.-Ing. Dr. techn. Peter Kuhlang
CEO MTM ASSOCIATION e. V.
Managing Director of Deutsche MTM-Gesellschaft Industrie und Wirtschaftsberatung mbH
Head of MTM-Institute
President International MTM Directorate

MTM ASSOCIATION e. V., MTM-Institute
Eichenallee 11
15738 Zeuthen, Germany
phone: +49 33762 20 66-31
fax: +49 33762 20 66-40
institut@dmtm.com
www.mtm.org/forschung

Autors:
Christina Winter, Manuela Ostermeier, Dr. Helga Unger, Prof. Dr. Thomas Mühlbradt

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For better readability, the language forms male, female and diverse (m/f/d) are not used simultaneously. All personal designations apply equally to all genders and do not imply any valuation.

Preface

The PALM4.Q project (the name is the German acronym for "process & work-related learning in assembly for future-oriented operator qualification") was launched in 2016 by KOSTAL GmbH & Co. KG in Lüdenscheid, Germany in cooperation with MTM ASSOCIATION e. V. with the encouragement of the European Social Fund (ESF) and the German Federal Ministry for Work and Social Affairs (BMAS) within the framework of the initiative covered by the title "Ensuring human technical resources: promoting further training and parity of treatment".

"We encourage people to achieve what we expect" is one of the KOSTAL principles. From this there arises as a consequence the duty to create appropriate baseline conditions at shop floor level. Operators should be given the means to develop further so that they are able to face new challenges.

"First time right" is the MTM guideline. With MTM's know-how in the field of gauges and gauge concepts for qualification and the company's experience in carrying out public authority-supported projects the task was to support KOSTAL effectively and in a targeted manner until the end of the project in autumn 2019.

The objectives of the PALM4.Q project were the guiding star throughout the entire development process:

- To make operators more flexible for existing core processes (job enlargement)
- To qualify operators for the technologies of the future (job enrichment)
- To provide a deeper understanding of assembly processes and sequences

In these times of digitisation and automation for all organisations a flexible operator, conscious of his/her responsibilities, will become a key element for the long-term success of KOSTAL in Germany; of that we are fully convinced.

In this series of papers you will learn of background conditions and procedures. You will gain an insight into the implementation of a training centre and you will get to know methods and instruments which have been used to cover the individual stages.

We hope you will enjoy reading these papers and learn a lot from them.

Dipl.-Ing. Andreas Stoß
Business Manager - Operations
Leopold KOSTAL GmbH & Co. KG, Lüdenscheid

Prof. Dr. Peter Kuhlang
Head of MTM-Institute and CEO
MTM ASSOCIATION e. V., Hamburg

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1 Qualification on the shop floor

1.1 Companies in the course of change

Companies based in Germany see themselves faced with considerable challenges.

Severe and increasing cost pressures and a greater range of products, with a simultaneous shortening of product life-cycles are being noted by many companies. If this were not enough there are also increasing demands covering transparency and documentation obligations. The amount of information to be processed in the operating systems of industrial manufacturing is increasing significantly. Finally, the activities of companies in the international sphere is having effects on current production locations.

On the personnel side demographic changes are a clear challenge. Increases in the average age, bottlenecks in the search for suitable junior personnel to grow into the jobs and increasing variety in terms of languages and cultural backgrounds are clear signs. And not least the "baby-boomer" generation“ sees a wave of retirements which there has never been before, with the resulting loss of knowledge and experience.

Development taking place under the title of digitalisation and "Industrie 4.0" will themselves have a considerable influence on manufacturing companies. In addition to increasing automation there will be changes in work demands and activities for operators on the shop floor. While repetitive activities will be reduced the number and complexity of work operations will increase overall.

These fundamental challenges also confront Leopold KOSTAL GmbH & Co. KG as supplier to the automobile industry with a large number of employees, especially in manual assembly. The objective is to make the people employed fit for a future which places higher demands on flexibility and quality, makes the use of digital media inevitable and requires greater individual responsibility.

1.2 Manual skills

In assembly as in other production sectors there are always routine manual operations which are generally carried out by untrained and trained personnel.

High pressure on quality, particularly in the automobile industry results in these activities having a crucial influence on the cost structure and image of the company. Manual skills are not confined to the assembly of components or the operation of a machine; they also include sensory capabilities such as recognizing differences in colour or the "feel" of surface finishes. The question of ergonomics also applies, covering the form and sequence in which certain hand holds and movements are to be carried out. These abilities are not in-born; they must be made suitable for the specific field of operation and training must be given.

In practice it is often direct colleagues, setters, shift foremen or team leaders who undertake the task of training. However, it is seen that training processes such as these often have very different results in terms of quality and in many ways do not meet production requirements. Timing bottlenecks and a lack of didactic skills are the main reasons for this. Systematic, quality-assured training processes for manual activities on the shop floor are rather the exception than the rule. However, they are becoming more important because the employment of flexible personnel with well-developed operators is a fundamental pre-requirement for competitive production. It is therefore right to create the appropriate framework conditions with work-related and work-integrated training situations.

In this connection, training in manual skills means that work-processes are understood in terms of their importance, that movements and sequences can be practised and this is aligned with the requirements and capabilities of the trainee, so that standards can be maintained.

1.3 Digital skills

In addition to manual skills familiarity in the use of digital working equipment plays an increasingly important role.

Working with fully and semi-automated production systems demands that employees are able to adjust, set and monitor them, as well as eliminating problems with them. This in turn brings new requirements for the operator in the processing of information in digital assistance systems. This is also linked to the demand for (extensive) paperless manufacturing.

There are only too many examples of the use of these technologies: digital assembly instructions, man-machine cooperation, dashboards, mobile insertion and extraction tools and "pick-by" systems. This requires operators to have a basic understanding of the technologies. They must know how they can inter-act with these systems and how information can be translated into their own handling activities. This requires openness in dealing with the new technologies. A production environment must be established which encourages this openness. At this stage it is not necessary for companies to start from zero because the target group of employees - trained and untrained - will already be using digital technologies in their private life [1]. Dealing with so-called smart technologies already an everyday business for many.

Even so, the challenge for companies is to take this prior knowledge and expand it in the direction of today's and future technologies to be employed.

1.4 Launch-pad solution: a training centre for manual assembly

These challenges describe what is causing companies to develop and implement new learning solutions for operators on the shop floor. There is clear pressure on handling.

KOSTAL have therefore decided to set up a training centre for assembly, following certain principles:

> "An environment where learning is to be encouraged and which reflects conditions in the real world but where, nevertheless, mistakes are allowed to be made so that people can learn from them. In the time available people will be allowed to gain experience and it is possible to develop further, technically and personally, in a real working environment"[2]

[1] Stahl-Rolf, S., Malanowski, N., Dobischat, R., Düsseldorff, K.; Unger, H., Rothenberger, R. (2016). Digitalisierung: Bedarfsgerechte Vermittlung neuer Qualifikationen an KMU-Mitarbeiter in ausgewählten Branchen. Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie. Berlin 2016.

[2] Quote: C. Hesse: Zukunftsorientierte Mitarbeiterqualifizierung – Der Mensch auf dem Weg in die Arbeitswelt 4.0. MTM-Bundestagung 2016

The aim should be to create a field of learning for manual assembly operators, in which training becomes possible, systematic, targeted and attuned to the learner. Core requirements here were:

- Qualification close to the work-place
- Individual control of the speed of learning
- Reach all operators without a great deal of organisational effort
- Activity-related training contents and direct possibility of transfer
- Extension of the previous activity spectrum
- Development of individual capabilities by solving concrete problems

The achievement of this learning environment consists of a training centre very close to the working systems in which individual assembly operations (including tactile feedback, finger dexterity, colour recognition), the KOSTAL-in-house "5S" system, the KOSTAL production system standards, dealing with digital technologies and also analysis capability and ergonomic work practices can be explained and trained.

This guideline explains how a training centre of this kind can be developed and implemented. By explaining procedures, methods, tools and examples it should inspire production personnel to conceive their own qualification and training solutions and implement them successfully.

2 Recognizing potential

Within the framework of a PALM4.Q transfer event the following question was put to ca. 30 participants, generally from outside the company: "What skills do we need in the future on the shop floor?"

Fig. 1: VOXR question at the PALM4.Q transfer event, September 2019

The auditorium - occupied by several representatives of neighbouring industrial companies - had a relatively common opinion (see Fig. 1).

Similarly, after visiting the training centre, the representatives were asked to what extent a transfer of a training solution of this kind to other companies or departments appeared reasonable.

The result (100% agreement) showed clearly that a quality launch-pad of this kind appears very appropriate and reasonable for other industrial organisations.

2.1 Quick-check training centre

The quick check (see Fig. 2) should help you in answering the question: "Is a training centre sensible or not for our company?".

Of course, the need for training does not necessarily mean that a training centre is the reasonable solution. It is often simpler to carry out practice-oriented training at the work-station itself. However, if there is a need to train several employees with similar contents or subjects, this method becomes more difficulty and hinders the smooth running of production.

Even so, this does not always mean a training centre. Training "islands" in the production area can be used effectively for certain training contents. Training islands are locations which are installed in the production area for training purposes. The advantage is that these locations are always there and can be used very flexibly and at short notice.

The drawback is that employees being trained are always under the eye of other colleagues. This usually leads to reserve and an uncomfortable feeling tor the trainees.

A separate area close to the production area, on the other hand, is a "protected" area; not only because trainees are less directly under the observation of others but also because, without time pressure and noise, concentration on the learning process is made easier.

2.2 Questions regarding need

Before starting the establishment of a training centre in your company you should ask whether there are reasons for and against such a centre. The questions in the "quick check" should help you to define the starting point and then discuss and explain the need for actions with personnel in other areas and departments involved.

No.	Question	Yes	No
1	Are there many operators with the same role?	○	○
2	Are there already qualification actions for operators on the shop floor?	○	○
3	Are there enough trainers?	○	○
4	Are your processes, productivity and quality satisfactory?	○	○
5	Are part timers or new employees to be trained?	○	○
6	Are your operators flexible in terms of their tasks?	○	○
7	Is your work highly standardized?	○	○
8	Do you use qualification monitoring?	○	○
9	Are there seldom changes in processes?	○	○
10	Do you achieve great effectiveness with your training?	○	○

Fig. 2: Quick-check training centre

It is useful to carry out the quick check in the form of a workshop, in which personnel from different areas come together and work systematically through the individual questions. The result should show whether and where the need for qualifications exists. Decisions can then be derived from this - e.g., if a project for developing qualifications should or should not be set up on the shop floor. Explanations regarding the quick check questions are set out below.

Are there many operators in the same role?

A role defines the work-content and the responsibilities of the employee. A role might be, for example, an assembler or a setter and, depending on the job, it may be necessary to specify a role in more detail. If there only a few employees with the same role the need for training will be very individual and cannot easily be conceived as a standard. Many operators in the same role, on the other hand, have the same or similar training needs and the training can then be designed and executed in a generalized form (i.e., suitable for several situations).

If the answer to this question is "No" different types of training are required. Generalization of clustering of training contents is then difficult and possible only for certain aspects (e.g., safety training). Designing a training centre with standardised work-stations and general activity sequences is not efficient or effective in such circumstances. Much more different and individually aligned training is required, based on the activities of the employees and their needs.

Are there already qualification actions for operators on the shop floor?

The term "qualification actions" covers all actions which help the employee to reach a higher level of qualification and thus achieve better results on the shop floor (e.g., further training, instructions, courses). A first step in the qualification of shop floor employees may be training which is regularly repeated (such as " 5 S" or ESD training courses) and which serve to ensure quality. Training which present employees with new manufacturing contents or manufacturing methods are also important as they enable a more flexible use of the employee and develop him further.

If the answer to this question is "No" there is an urgent need for action. The minimum requirement in law is safety instructions, which must be repeated at regular intervals and certificated. Each additional qualification action will have a positive effect on the performance and motivation of employees. If you have answered "No" because you believe the actions are not yet effective or efficient enough you have equally defined your need for action. What actions are to be taken, to what extent and how they are carried out should be discussed at a separate date with the responsible personnel and people involved.

Are there enough trainers?

Trainers are needed in order to carry out training regularly and continuously. This does not necessarily mean full-time trainers; it is sufficient for all the necessary qualification actions to be carried out in accordance with the plane. Naturally training / courses can be carried out by external trainers. The use of trainers and whether they should be in-house or external trainers will depend largely on the subject of the training. In the case of practical matters or activities close to the challenges of manufacturing it is certainly an advantage if the trainers come from the production sector. Theoretical or general subjects (e.g., "5 S", lean management methods, etc.) can also be handled very well by external trainers. An advantage of this would be that new views and perspectives are brought into the company.

If you have answered "No" there is a need for action when recruiting and the targeted use of trainers. "Train-the-trainer" offensives or the short-term or regular use of external trainers can be effective in eliminating possible qualification deficits which may have arisen. For long-term planning a committee or a working group should be established, where the first step will be to define the needs and then determine further action and responsibilities.

Are your processes, productivity and quality satisfactory??

The assessment of whether your processes, productivity and quality are satisfactory is for you to decide. These factors should be evaluated depending on production and products, together with the requirements of running a company. If you are not satisfied with any one or more of these factors your answer must be "No". Apart from many other factors a lack of qualification can have a significant influence here.

Are part-timers or new employees to be trained??

High levels of fluctuation of employees, or fluctuations in orders or seasonal businesses will always indicate an increased need for personnel and, with it, the need for qualification actions. On the one hand this involves general courses (e.g., safety instructions) and, on the other hand, training to provide skills for production and introduction to new activities to be carried out. New skills can be learned by training on the job or training near the job.

If your answer here is "No" you are faced with the challenge of enabling a constantly changing work-force to carry out activities correctly and efficiently in order to remain competitive and keep production stable. Qualification actions for the different areas of activity must be designed to make it easier for new employees to move into production. Here, training rooms, training centres, training "islands" or similar separate areas should be used to make new employees familiar with the new work contents before they are allocated to the line.

Are your operators flexible in terms of their tasks??

Being able to employ operators flexibly is a significant competitive advantage. It is important, therefore, to increase the flexibility of your employees by qualification actions. Ways of increasing flexibility include, for example, teaching at other work-stations in order to gain new and extended skills. Training in activities in other production areas is another way of encouraging the flexibility of your operators. Increasing their flexibility means that they can be employed at as many different work-stations as possible. This enables much more agile planning of how to use the work-force.

If you have answered "No" to this question you may have potential which you are not yet using fully in production. The flexibility of the operators does not merely encourage communication in the departments and beyond; it also enables easier and more efficient handling of peaks in orders or transfers within production.

Is your work highly standardized?

Highly standardized work is made up of fixed work contents with defined processes and sequences. If your work is highly standardized the amount of training is less in comparison with work-contents which vary greatly within them. Standardized work simplifies the learning process and can therefore be applied more easily to greater numbers of people.

If you have answered "No" to this question an overview of the different activities would be helpful, to permit clustering of contents or skills. This clustering and overview will enable training contents meeting individual requirements to be developed.

Do you use qualification monitoring?

To gain an overview of the current situation and determine what is needed the existing qualifications must be documented and certificated. If you do not have a qualifications matrix or similar as a tool in your company you should answer "No" to this question and work with the personnel department to develop and implement a suitable tool in the company.

Are there seldom changes in processes?

Changes in processes or work-sequences lead to a greater demand for training. If your production processes remain stable over long periods of time the additional training and instruction requirement will be low and you should answer "Yes" here. However, if you are forced to change processes repeatedly or set them up afresh because of short-term control of contracts, for example, or volatile markets or new production technologies your answer should be "No".

Processes and procedures which are changed constantly or frequently also mean a greater need for flexible operators. As already mentioned the flexibility of operators can be developed by qualification actions and placing them in different areas or at different work-stations.

Do you achieve great effectiveness with your training?

This question is directed at discovering how effective your qualification actions are. Metrics for this are difficult to generate but this does not mean that success cannot be recognized. It is merely necessary to use other measurements and assessment criteria. Documentation of the training which has been carried out, together with the development of the individual employees, is the deciding factor. Feedback from the people taking part (the operators), the shift foreman/ line leader/ manager as well as feedback from the quality department must be brought together to form an overall picture and this must be done at regular intervals. Admittedly these are not "hard" facts and figures; however, they are good indicators of the effectiveness of your training. If you have not yet checked the effectiveness of your training you should answer "No" to this question and take action to enable your success to be displayed.

2.3 Assessment logic

Each question answered with a "No" represents a need for handling. The extent of the need for handling increases with the number of "no" answers and depends on the influencing factors mentioned above and the current data situation. If there is a need in the field of qualification the procedure should be driven in a structured manner. The launch-pad as used in KOSTAL for developing training concepts is described in the next chapter.

3 Developing training concepts

The development of training concepts is launched in the company if a "quick check" has revealed that there is a need for training. The process sequence described in this chapter splits the process for developing training units into eight separate steps. This structure can be adopted by any company; however, the contents of each step will vary widely and must always be adapted to suit the needs of the individual company.

The construction is based on a classic project structure so familiar elements such as a kick-off meeting, an analysis of the current situation or a roll-out appear again. This procedure has been developed and carried out in the course of the PALM4.Q research project. The individual steps build one upon the other so that the results from previous steps are taken into account in the subsequent step. It is also possible to go back in the process sequence in order to build in any experience gained in the conception phase.

Concrete statements on the time horizon for the process sequences are not possible because there are so many influencing variables in an individual company. These will include, for example, the size of the comp and also the target group which is selected for developing the training concept and the capacity available.

3.1 An overview of the process sequence

In all the process covers eight steps. The diagram (see Fig. 3) shows a rough overview of the milestones and core tasks in each step of the process.

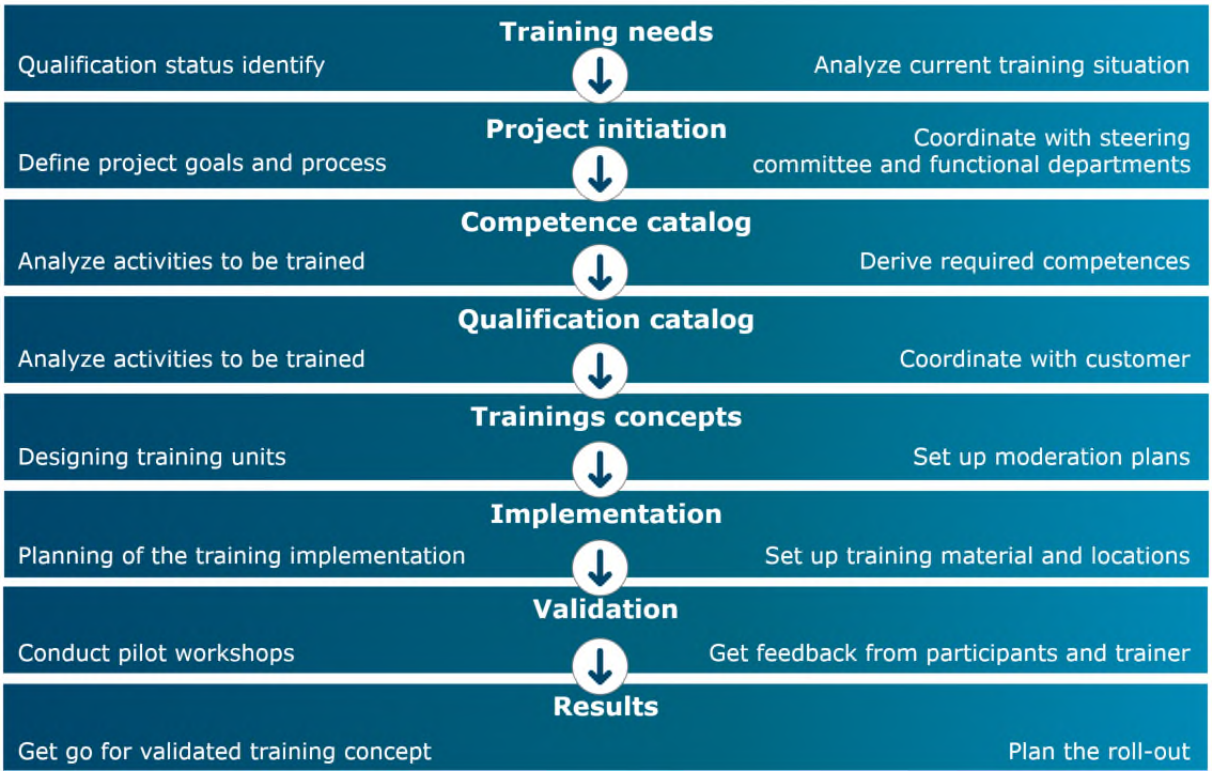


Fig. 3: Process steps and core tasks

After carrying out the quick check and making a decision based on it that a training concept should be generated, the first step is to determine the concrete training requirement at the detail level which will go much further than the information from the quick check [Step 1]. Based on this information the rough project sequence can be mapped out and then presented in the course of project initiation at a kick-off meeting [Step 2].

In the phase during which the list of skills required is drawn up the project team will discuss intensively the role of the operator which was determined in the course of establishing the need for training. In addition to analysing the activities and defining the skills required a clear requirements profile must be drawn up for the role [Step 3].

In generating the list of qualifications the project team discusses the forms of qualification and decisions must be made as to which of the qualifications appear appropriate for the company and the training needs. Forms such as the training centre or classic training on the job must be discussed at this point [Step 4].

When developing training concepts which are illustrated in the list of qualifications and which define concrete training actions the question of technical didactic matters also arises [Step 5]. Taken from the training concepts the training units with all the necessary components (hardware, software, training documents, etc.) must be implemented [Step 6] before a validation of the resulting training units can be carried out with pilot workshops or trial training operations.

The single jump back in the entire process sequence takes place at this point, because it is absolutely essential to feed the experience and knowledge gained in the pilot workshops back into the concept phase. It must be possible to revise and adapt the training concept so that the training units are validated and initial findings can be presented before the results are published [Step 7].

With the publication of the results all those involved must be informed of the concept which has been generated, before the roll-out into day-to-day production can take place [Step 8]. The step which sees integration into day-to-day production is the most important because the foundation stone for the reliability of the project is set here. Only if qualification is achieved and maintained regularly can a company finally gain advantages from it. The actions required to achieve integration following publication of the results are described in chapter 4.

3.2 Descriptions of the individual steps

In the following pages the processes are described, including all the information required, such as setting the objective of each step in the process, the input required, possible influencing factors, tools used and the result of each process step. In addition a practical example from the PALM4.Q project is given in order to clarify the result.

3.2.1 Determining the need for training

In this step the aim is to set out in concrete terms the need for action which was identified by the quick check. On this basis it must be decided which roles in the company are covered by a need for training and then to take this into account in designing the training concept.

The procedure

Firstly the results from the quick check are included in the examination and important questions are attached to them with detailed information in order to describe the need for action in more concrete terms. With the aid of interviews with personnel at different levels of hierarchy on the shop floor checks are made to determine the current qualification situation. Possible problems associated with planning the use of personnel, quality or productivity can be further indicators of the need for qualification in any specific role.

In addition a concrete analysis of the current situation is carried out, taking account of the following aspects:

- The organisation of previous trainings
- Target groups
- Training success
- Training contents
- The trainer

The results are now checked for strengths and weaknesses and summarized. Above all, the weaknesses must be taken into account in setting out the objective of the project.

Input required	**Influencing factors**	**Facilities used**
Quick check results	Current training activities; Problems on the shop floor	Interviews

The result

The result of this step in the process is a detailed training need which states the role for which the training concept is to be developed. Here specific statements must be arrived at regarding what additional value will be achieved by designing a training concept compared with current problems and the qualification status of the role. It is important to describe objectives in very clear terms in order to make clear the significance of the project in the next step towards initiating the project.

A practical example

The training concept at KOSTAL before PALM4.Q already included many important subjects and played several roles in its entirety on the shop floor. However, its contents were withdrawn in the face of acute problems and requirements from various audits and only a training method remained. This was based on a sort of lecture without direct input or concrete feedback from those taking part in the training. Because of this it was not possible to determine the success of the training throughout. The quality of the training was very dependent on the enthusiasm of the trainer.

This weakness needed to be eliminated. From the start, therefore, the requirements was stated that those being trained must themselves take an active part in the training. The presentation of individual training elements, the clarification of questions and uncertainty should therefore take place essentially in discussion with the trainer (see Fig. 4).

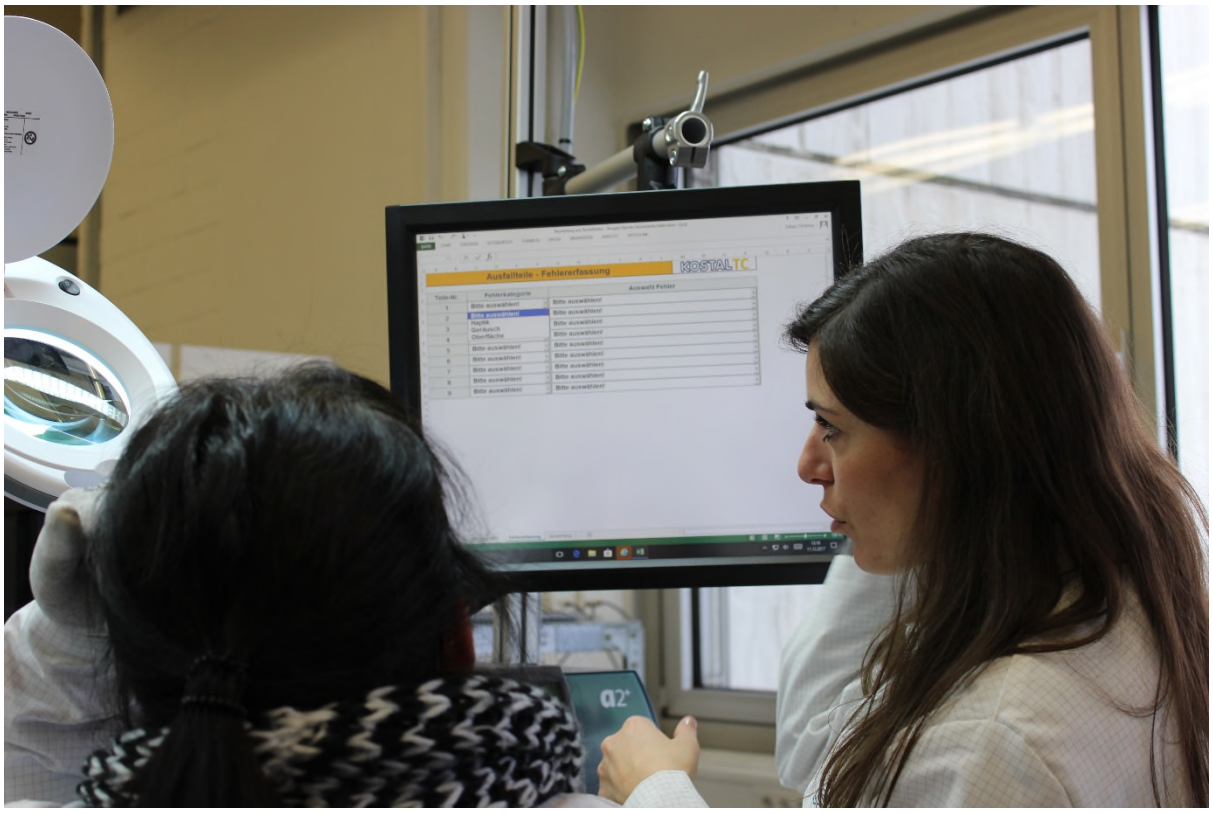


Fig. 4: Discussing a working task

3.2.2 Initiating the project

The objective of this step in the process is to hold a kick-off meeting, in which all the information relevant to the project is presented. For this it is necessary to sketch out the whole of the project sequence - i.e., a rough time frame is specified, project targets are defined and the necessary personnel are called into the project team.

The procedure

Based on the results of the first step in the project: "Determining the need for training" and the weaknesses identified there, targets are specified for the project in order to eliminate these weaknesses and to achieve improvements.

In setting up the project team all the associated parts of the company affected should be integrated into the team in order to increase acceptance of the project. In addition to production this should include the personnel department, quality management, production planning, the industrial engineering department and external associates. The company council with its trade union representatives must be informed as a minimum - or best of all, included in the team.

A rough time frame can be sketched out, depending on the scope of the project; it will be dependent above all on the complexity of the role to be considered and the training resulting from this, with very different levels of organisation required for implementation.

Input required	**Influencing factors**	**Facilities used**
Analysis of the training situation; project objectives; potential roles in designing the training concept	Company departments and areas affected by the project and its results	Project structure plan; Work packages; milestones

The result

In addition to formulating and setting the objectives the results of the second step in the project include a project structure plan with work-packages and milestones, as well as a fixed project team responsible for processing the contents of the project. The entire structure of the project is now known to the departments and areas involved and their agreement must be obtained for the project to be carried out.

A practical example

The project team represents a crucial factor for success in establishing a training centre and it is therefore important to bring together a team which has been carefully considered and which will give its full support. In the PALM4.Q project the project team was made up of 10 people (see Fig. 5). They included colleagues from the functional areas of quality, production planning, the company council, human resources, production, industrial engineering and external support by MTM. The actively involved members of the project were selected on the basis of their interface to the role of the assembler. Their managers were asked about their readiness to take part and approval was given because the employees were sometimes required for several hours on project work. It was seen that all the people questioned had a high level of interest in working with us on this innovative project. Because the running time of the project (the project encouraged by public authorities) was three years there were also personnel changes within the team. However, at all times there was at least one person from each of the departments stated above.

Fig. 5: Members of the PALM4.Q project team

This project team drew up the project plan and planned and carried out the launch in the form of a 2-hour launch event with managers and decision-makers (control group).

3.2.3 Generating a list of skills requirements

This step in the process begins with an analysis of the activities and levels of skills in the role(s) under consideration, in order to create a basis for generating the training concept. The data collected are then summarized in a list of skills requirements for the role under examination. If several roles are directly involved at the beginning of the training concept a list of skills requirements must be generated for each role. Thereafter the roles can be handled in parallel in generating the training concept.

The procedure

When drawing up a list of skills requirements the first step is to describe the activities in the roles and summarize them in an overview (e.g. a "Mind-Map"). Depending on the role in question it is useful to bring in operators who carry out this role in the company in order to achieve a picture which is as complete as possible.

In this way the activity profile of a role is recorded. From this a list of the skills required for the activity in question can then be derived.

Determining the skills required is necessary so that the complexity of the activity can be assessed and is an aid in deciding whether or not training is required for the activity. At this point areas of skills are differentiated into technical, methods and social skills (see glossary). This differentiation is used later to allocate appropriate didactically suitable qualification actions.

The activity profile and the associated skills requirements are brought together in a matrix.

Input required	**Influencing factors**	**Facilities used**
Estimates by the operator; Work-place related technical knowledge in the project team	Job descriptions	Questioning / interviews; Mind-Mapping Matrix display (xls)

The result

The matrix is the central result of this step in the process. The activities which have been examined are listed on the vertical axis and the skills requirements on the horizontal axis so that areas of skills can be allocated to the individual activity in the separate fields of the matrix. In this way each activity can be linked to several skills requirements and so activities can be identified, for which several skills are needed. These are classified as more complex than others and must be given special consideration when generating the training concept.

Practical examples

The extract from a Mind-Map in Fig. 6 shows how the project team has displayed the activities for the role of assembler. The advantage of this means of display is that it gives a structured overview of the core activities and detailed activities of the employee. Without an analysis of this kind the subsequent steps cannot be carried out sensibly and in a targeted manner.

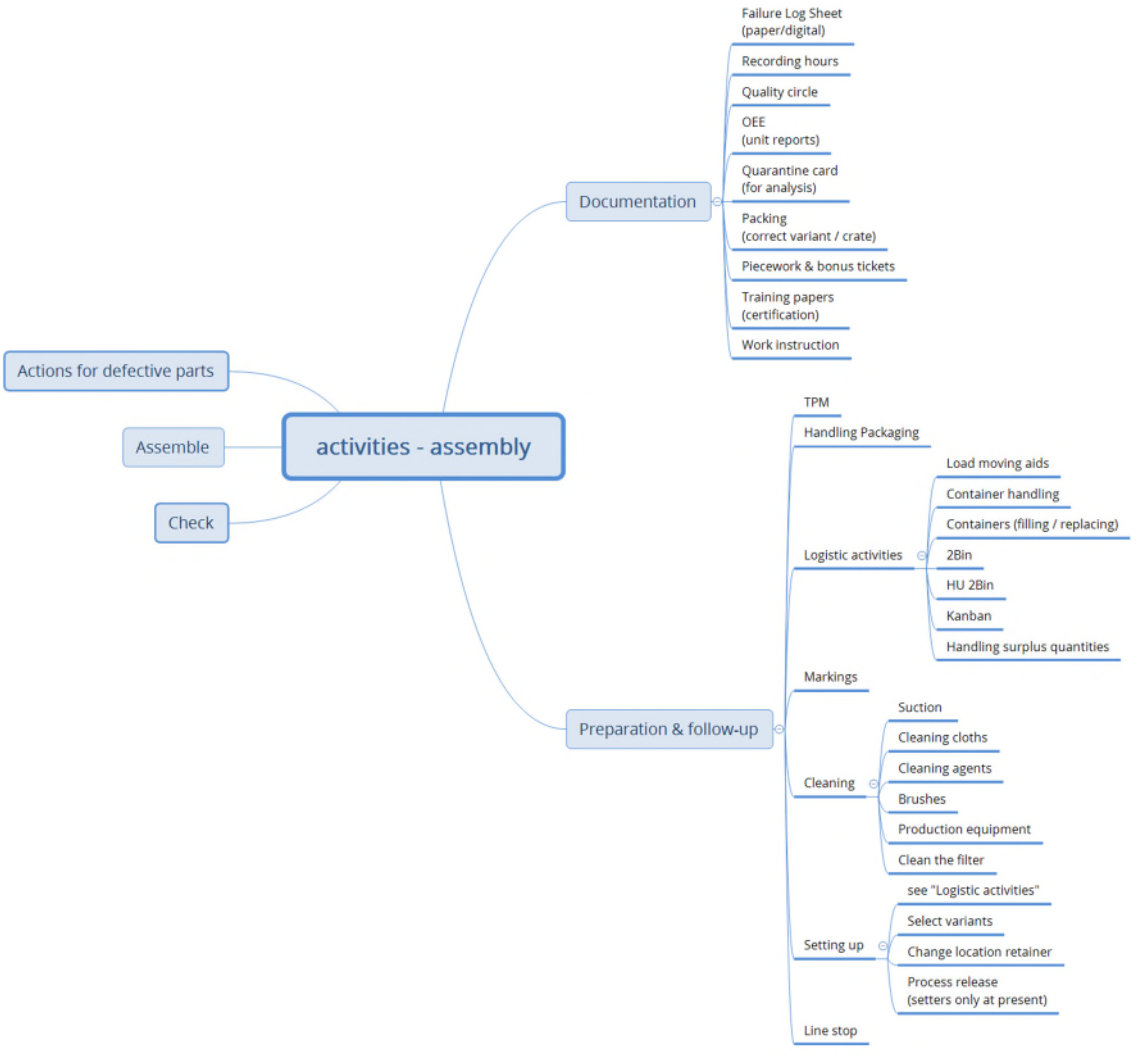


Fig. 6: Extract from a Mind-Map for assembly activities

The matrix shown in Fig. 7 is based on the logging of activities which are entered as superior categories on the vertical axis. The skills requirements are shown on the horizontal axis. The sum totals of skills for each activity are shown in the last column of the matrix in the form of a "Heat-Map". The same evaluation is carried out for the activities for each skill in the lower line. The more often a skill is required for the activities the more this must be considered when generating the training concept. This is shown in the last line of the matrix as sum totals.

Skills matrix	Technical skills			Methods skills		Social skills	Total skills per activity
	Failure detection	Use of auxiliary tool	Documentation	FiFo	5S	Communication activities	
Clipping	1	1		1	1		4
Manual screw-driving	1			1	1		3
Gluing	1				1		2
Soldering	1		1		1	1	4
Laying wiring	1	1		1	1		4
Staking	1	1			1		3
Separating	1	1			1		3
Total activities per skill	7	4	1	3	7	1	23

Fig. 7: Skills matrix completed as an example

The "Heat-Map" in this example shows that some activities are linked to several skills requirements (red) and should therefore be given special consideration in the training concept (with supporting videos, for example). Similarly the skills listed as "detecting defects" and “5S” appear as relevant for several activities. In designing the training concept these skills should be taught as a priority because they act as the most powerful lever.

3.2.4 Drawing up a list of qualification requirements

The objective of this step in the process is to decide which activities and skills require training. The basis for this is the skills matrix which was created in the previous step, with further information from different members of the project team covering their departments. In addition it must be decided what kind of training should be provided.

The results must be assembled in a list of qualification requirements which must then be agreed with the client.

The procedure

As a first step the activities and skills from the list of skills required must be clustered together. In this, activities which often occur in combination and which require the same skills are brought together so that they can be used to draw up combined training courses.

Further information is relevant in addition to the purely summarised results. Here the knowledge in the inter-disciplinary project team is questioned as information from the different areas can be brought together.

Examples of this further information are:

- In the field of quality: data which show which activities frequently lead to product failures and must therefore be categorized as specially critical (critical measurement data are failures and rework).
- In production: information on which activities are frequently associated with plant and equipment failures and thus result in lower productivity (critical measurement data is the OEE for example).
- In the production planning department: information on which activities and skills will continue in the future to be of great importance in production; and which may be replaced or modified by new technologies.

The list of qualification requirements represents a prioritized listing of activities and skills and is drawn up with the following individual stages:

1. Prioritizing activities and skills via the Heat-Map.
2. Clustering activities into reasonable training combinations.
3. Expansion with additional information from the different technical areas represented by the project team.
4. A final examination and definitive prioritisation of activities and skills.
5. Draw up the qualification list
6. Presentation of the results and their approval by the client.

The list of qualifications required does not merely show the prioritized activities and skills. It also includes the reasoning behind the priorities which have been set. This provides useful information when shaping the training and, in particular, the form of instruction (training on the job, training near the job, training centre, external training, tandem training).

Input required	Influencing factors	Facilities used
List of skills; Information from technical departments; Information on types of qualification	Classic production metrics (e.g., OEE, ppm)	Clustering; Data collection; Production metrics

The result

The result of this step in the process is the list of skills required, agreed with the clients. It goes as input into the next step in the process.

A practical example

Fig. 8 shows an extract from a list of skills required, generated by the project team. The columns contain the prioritized activities and skills clusters, a justification for the prioritization and the decision regarding the type of training. An example is provided as an appendix to this document.

No.	Prioritized activities	Skills required	Reason for priority	Decision on type of skills required
1	Location wiring (PCB)	Agile fingers; defect recognition; understanding of process & quality	Most expensive and sensitive items in many products; many failures	Training near the job; training centre
2	Attaching labels	Agile fingers; ability to concentrate; product knowledge; language ability; PC experience	Most frequent failure at EOL	Training near the job; training centre
3	Documentation (quarantine cards)	Product knowledge; understanding of process & quality	Handling of NOK products frequently causes logistics problems	KPS training
4	...	...	...	...
5	...	...	...	...

Fig. 8: Extract from a list of skills required for the role of assembler

3.2.5 Developing training concepts

The objective of this fifth step in the process is to draft concrete training concepts based on the role-related list of qualification requirements. Here, therefore, the individual training units are planned specifically in terms of their construction and sequences.

The procedure

After publishing and agreeing the list of qualification requirements concepts are generated for the training for the prioritized items.

At the beginning it must be specified whether the entire project team will start in handling the individual subjects or if smaller, subject-specific groups should be formed. In a group the individual subjects are analysed in depth and comprehensively, using the information provided with the list of qualification requirements. In this, one of the most important items of information is the form of training which was specified in the previous step in the process. The form of training provides the framework for generating a training concept in regard to location, timing and the equipment required. In addition the following questions must be answered:

- Where are the greatest problems and what is their effect on production?
- What information must be disseminated without fail in the training for the training to be a success?
- Is practical training necessary?
- How can a training assessment be carried out?

Following this the creative work of the project team begins and training methods are developed. It is an advantage if the project team has a technical teaching background or can obtain information in this regard at the beginning of the project. The training methods used specifically in the PALM4.Q project are described in more detail in chapter 3.3. They include, for example, methods such as the use of planned games, blended learning or the use of training films.

Generating the concept also involves the planning of the materials required. Depending on the type of qualification selected and the training method these can vary from simple written documentation and hand-outs to complex hardware components to carry out practical training in a training centre.

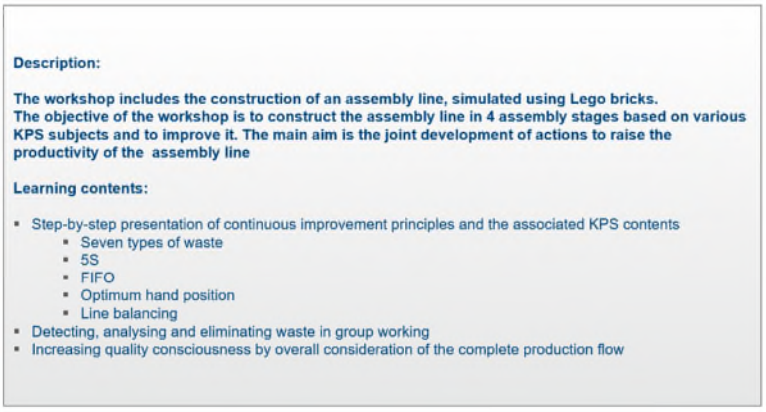
Input required	Influencing factors	Facilities used
List of qualification requirements; basic technical teaching background; training methods	Resources approved by the client; existing training materials; in-house standards (e.g., CI guidelines)	Creative workshop with chairman; brainstorming

The result

The training concepts drawn up in this step of the process contain above all the sequence of the training (see the presentation plan attached as an appendix), parts lists for materials and documents required, as well as drawings of hardware which may be needed, statements of software required and the number of delegates per unit, as well as the estimated duration of the training.

A practical example

The example in Fig. 9 shows how such a training concept might appear. In a sequence of ca. 3 hours and using Lego bricks, a multiple-stage assembly task is simulated. Here the planned game integrates certain requirements from the KOSTAL production system. In the course of several rounds the participants learn the various aspects of the production system more or less by themselves and work together to discover the practical importance for their day-to-day work.



Description:

The workshop includes the construction of an assembly line, simulated using Lego bricks. The objective of the workshop is to construct the assembly line in 4 assembly stages based on various KPS subjects and to improve it. The main aim is the joint development of actions to raise the productivity of the assembly line

Learning contents:

- Step-by-step presentation of continuous improvement principles and the associated KPS contents
  - Seven types of waste
  - 5S
  - FIFO
  - Optimum hand position
  - Line balancing
- Detecting, analysing and eliminating waste in group working
- Increasing quality consciousness by overall consideration of the complete production flow

No. of delegates	Workshop duration	Location
5 people	3 hours	Kostal: Trainings centre

Fig. 9: Description of the Lego game plan

3.2.6 Planning the implementation of training units

Once the training concept has been established preparations must be made for their practical implementation. At the end of this step in the process there will be complete training units with all the necessary materials, premises, participants and trainers and the first pilot training exercises can begin.

The procedure

The individual training concepts must be divided into concrete work-packages and the responsibilities for their implementation must be decided.

The documentation required for the training must be drawn up and departments must be brought in to implement hardware and software solutions if these are included in the concepts.

In addition the individual training concepts must be assembled into theme-based workshops with appropriate timings.

Input required	Influencing factors	Facilities used
Training concepts	Budget and personnel planning for implementation	None

The result

From the individual training concepts training units are formed to carry out pilot training exercises and the operational plan for carrying out the training is available. The training materials required are available and the location where the training will take place has been arranged.

A practical example

The following pictures show examples of the layout of the training centre (Fig. 10) and a training station (Fig. 11). These learning places replicate actual work-stations to a great extent but also include additional elements such as a screen with a training video, which will also be used later in the work process. There are also tables, chairs, a flip chart, etc. for group working. An area for man-machine collaboration has also been set up.

Fig. 10: Training centre from above

Fig. 11: Training station in the training centre

3.2.7 Validating the training units

This, the last but one step in the process, describes the execution of the first training units in the form of pilot workshops. These pilot workshops enable the training units to be testes and checked for feasibility and effectiveness.

The procedure

The training units are tested for the first time in pilot workshops. At this stage the trainers are initially individual members of the project team with appropriate training experience and who have also themselves developed and planned the concepts.

Personnel in the target group for the individual pilot workshop must be selected and spoken to; they must be open to a test run and also ready to give extensive feedback on the training unit in question.

The training must be carried out to the agreed plan. Within the training it may be possible to measure progress in learning regarding manual activities insofar as timings and failure quotas are maintained and thus the associated level of training can be determined.

Experience shows that the following points must receive particular attention in the pilot workshops. After the experience from the first training it may be necessary to make adjustments:

- Handling the materials
- Duration of the training
- Number of participants in the training
- Ease of understanding of the training paperwork
- Comprehensiveness of the training paperwork
- Functionality of hardware and software if used
- Logical sequence of the training to the teaching plan

In addition to the assessments by those carrying out the training the feedback from the participants is of great importance. To obtain this an open feedback discussion is held at the end of each pilot workshop and evaluation questionnaires are used. In this way a comprehensive picture is gained of the relevance and effectiveness of the training contents.

The results of the evaluation form the basis for revising the training concepts.

Following revision and possible modifications covering the above points further pilot workshops may be held to check the effectiveness of the actions before the entire concept is rolled out.

Input required	Influencing factors	Facilities used
Presentation plan Training materials Training documentation	Selection of trainers Selection of participants	Pilot workshops Evaluation questionnaire Open feedback rounds

The result

Following this phase of holding pilot workshops all the training units have been tested, evaluated and prepared for a comprehensive roll-out.

A practical example

In total the pilot workshops were carried out and tested by KOSTAL with ca. 100 participants. The address inviting participation was carried out directly and verbally via the project team and the managers in the various areas. Great interest was shown by those assembly operators addressed in a "test run" but also a certain scepticism as to what the level of the requirements implied.

Fig. 12 shows the white-board used in the feedback round with the participants. In addition to verbal assessments regarding individual stations in the training centre the delegates were asked to give a general evaluation of the individual learning station (in the form of "smileys").

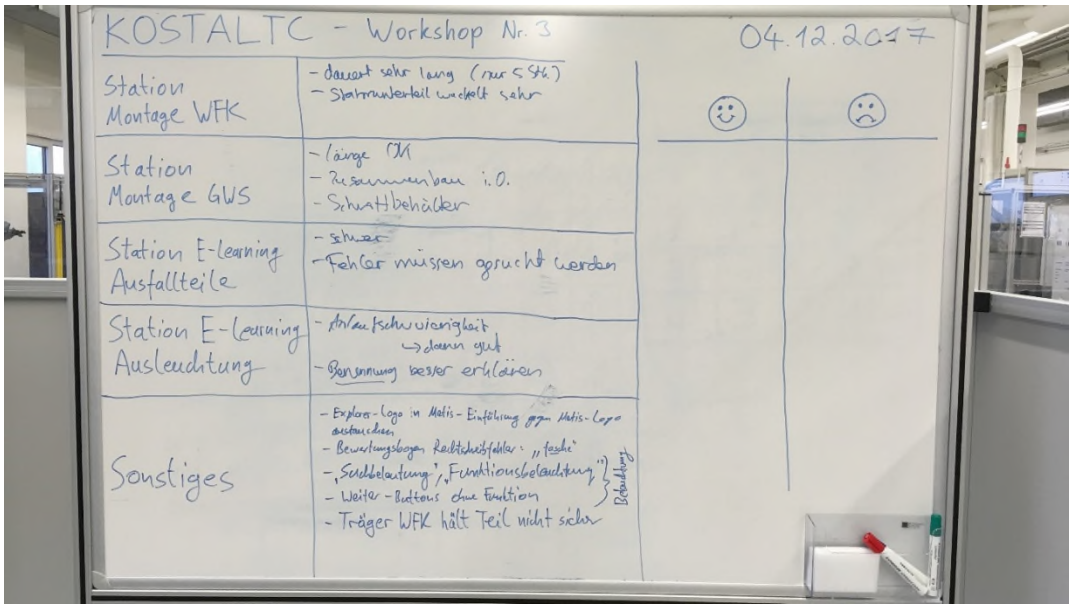


Fig. 12: Evaluation grid from the feedback discussion in the pilot workshop

3.2.8 Publishing the results

The objective of the final step in the process is to present the validated training concept to the client and an extended circle of personnel in the company. Provided the overall concept meets with approval the comprehensive roll-out must be planned and with this to integrate the project into day-to-day production (see chapter 4).

The procedure

The validated training concept is presented to the personnel involved and above all to the clients in a final event. The following results should be presented in order to give a comprehensive overall impression:

- The procedure for show clearly the established data base, on which the training contents have been defined.
- The forms of education and training methods with the preceding arrival at decisions. It may be possible to visit the training centre or individual training stations.
- The validation process with a presentation of the pilot workshops and the knowledge gained and implemented as a result of them.

The experience from the pilot workshops, including the evaluation, is important in order to give greater weight to the subject of qualification and greater attention to this in production, since qualification actions are very difficult to evaluate in monetary terms. It is therefore important to point out successes in training.

Following the presentation a joint commitment to the roll-out must be achieved. This is essential in order to obtain the support needed to transfer the results into the productive system, as this will affect many areas and employees.

Input required	**Influencing factors**	**Facilities used**
Documentation of the project sequence and results	None	Presentation techniques

The results

Clients and other personnel are informed of the results of the pilot phase. Support for permanent implementation is gained. The training concept is released to those responsible for the roll-out.

3.3 Facilities

In the process steps described in chapter 3.2 various facilities are used to generate the training concepts, in the course of which contents can be decided on in the project team. The following chapters explain a number of these facilities in more detail.

3.3.1 Brainstorming and chaired creative workshops

Brainstorming is a well-known and easily implemented creative technique which can be carried out without much preparation and materials. It is useful particularly at the beginning of a workshops or for introduction in a subject if the participants have not yet been burdened with a lot of information. This enables a free and unrestricted approach to the subject.

Brainstorming a precisely defined question makes it possible to find a wide range of different ideas, in which these ideas are not immediately evaluated or assessed. Each participant must allow free rein to his or her thoughts because each idea may provoke another. There are 4 basic rules which must be followed when brainstorming:

1. Combine and take up ideas which have already been expressed
2. Comments, corrections and criticisms are forbidden
3. As many ideas as possible in the shortest possible time (max. 5-30 minutes)
4. Free association and dreaming are allowed

Brainstorming has often been used in the course of generating training concepts in the PALM4.Q project. Above all the layout of training stations with the necessary documents or materials to be used have always been part of chaired creative workshops. The central questions in this connection are:

- What learning method is suitable?
- What materials can be used?
- What documents are helpful and how are these provided?
- How can a training assessment be carried out?

3.3.2 Mind-Mapping

Basically "Mind-Mapping" is used as an illustration of a themed area. The theme is divided into its component parts, influencing factors or processes. The Mind-Map shows at a glance the relationships between the individual concepts by illustrating associations between mutual links.

The results of rounds of brainstorming and creative workshops have been contained in "Mind Maps" in order to show the ideas in a regular structure. Even ideas which are not followed up can be stored in this way in an understandable form and possibly called on again in a different context.

3.3.3 Analysing qualification requirements

The following steps must generally be carried out to determine the factual qualification requirements:

1. Define the tasks for which a qualification action should be developed.
2. Decide on the skills relevant to carrying out these tasks and the skill levels required (TO BE ACHIEVED).
3. Determine the gap between existing skill levels (CURRENT) and the future skill levels required (TO BE ACHIEVED).

Within the framework of the PALM4.Q project the first step was to develop and cluster activity profiles for each role. From this basis the necessary technical, social and methods skills relevant against the background of digitalisation which are becoming relevant to the shop floor were derived. An illustration followed in a matrix which showed both aspects in the relationship and offered the possibility of identifying the main points for the qualification actions (loop-holes).

3.3.4 The inter-disciplinary project team

As part of classic project management work structures were created at the start of the project. As a rule these form a control group (the client), the appointment of a project manager and, as an operational committee, a project team is established. Depending on the contract covering the project this project team is made up in such a way that:

- it has the necessary skills to develop training concepts
- it represents the areas and departments involved.

In this way the project team is not made up of one single technical area (personnel development, for example); instead it is formed on an inter-disciplinary basis (see Fig. 13). This has the advantage of involving various existing experience and perspectives and thus increases the probability of a generally acceptable, practicable solution.

Including external personnel has the advantage that a company often lacks teaching skills and experience and these can be brought in from similarly placed qualification projects. Similarly, given the background of increasing digitalisation, innovation impulses will arise and previous thought-structures can be interrogated.

In the PALM4.Q project this project team was made up of personnel from production, human resources, industrial engineering, the company council, quality and production planning.

Fig. 13: Composition of the inter-disciplinary project team

3.3.5 Project planning control

Project management involves detailed sequence planning and monitoring of the progress of the project. Therefore the project management will work with the project team members to establish a milestone plan for the work in the project, defining the intermediate results to be achieved and the associated work-packages. A time-frame is specified. At each project team meeting these plans must be used to reflect the actual status of the project and to introduce any adjustment actions required. If there are significant delays or if work-packages are redefined the control group must be informed or called in to make decisions on future progress.

3.3.6 Interviews

Qualitative methods are used to gain more precise information on an area of interest. An interview is generally the first choice for doing so. However, before people are asked, a clearly defined concept must be established in order to obtain information directly related to the objective. For this concept the following questions must be clarified in advance:

1. What information is needed?
2. Who has this information?
3. How should the data be collected?
4. How are these data evaluated?

A guide to the interview is provided from the first question, so that all interviewers proceed in a structured manner and collect comparable data. Questions 2 and 3 define the extent and format - e.g., where and at what time should the interview take place. The last question is central for qualitative analyses as this often takes the most time and effort.

3.3.7 Training progress evaluation questionnaire

One of the most important elements in checking the effectiveness of training concepts is to monitor the success of the teaching. This assessment also encourages the acceptance of qualification projects by management; however, it must also be agreed with the company council and the personnel department.

The individual success of the teaching in purely manual activities (in assembly itself, for example) can be judged by the speed of execution and the quality achieved. Here an evaluation questionnaire is used which logs time and the numbers of errors in each training operation (see Fig. 14) and on this basis calculates the individual training level. This questionnaire is used jointly the trainees and trainer as the basis for further training operations and also acts as a feedback loop for the continuous improvement of training places. The progress of a person in the course of training can be clearly determined in this way. It is important that these individual data are used exclusively for the training and are never used as a basis for any further person-related assessments are documentation.

An example in Excel covering the documentation of training progress is attached as an appendix.

Training station 1
GWS - Clipping, connecting laying wiring

KOSTAL TC

Training passage	Date	Time needed	No. of errors	Trainings grade
D1	31.08.2020	02:19	3	60,9
D2	31.08.2020	02:49	1	100,2
D3	31.08.2020	02:24	0	147,0
D4		00:00		

Fig. 14: Example of a completed evaluation questionnaire

3.3.8 Feedback on the success of training

In an open feedback round with those taking part in the training an assessment is made of the training following the completion of each training unit. Here, feedback is collected from the participants regarding the relevance of the training to everyday work and, therefore, the performance of the trainer (see also chapter 3.2.7). It is important for the results of this open feedback to be recorded so that it is visible to all those taking part (on a white-board or flip chart, for example). For those taking part this underlines the value and the importance of the training.

To complete this qualitative feedback from participants the trainer also reflects on the training which has been carried out and evaluates the training results from his viewpoint. Based on his systematic observations he classifies the success of the training and checks whether further action must be taken. These assessments are collected together with the participants' feedback in a document and forwarded to the personnel responsible for the training concept, so that any necessary adjustments may be made. Because these are subjective assessments a regular exchange of trainer is necessary in order to achieve a uniform level of assessments.

3.3.9 Pilot workshops

Where there are many changes in a company pilot applications are tested initially. In this way possible defective planning can be detected at an early stage and changes in concept can be made before any comprehensive introduction is carried out. It is therefore sensible to select a defined area, in which the initial introduction will take place. Where training is concerned this means that a group of operators must be selected who will take part in a trial run in a real training environment with an experienced trainer (see Fig. 15). The danger with pilot applications is that often "model areas" or "model participants" are chosen, who are not representative of the entire target group. On the other hand, in many innovative cases it is a case of producing positive examples in order to prepare the ground for an innovation in the company. It is crucial here to decide which strategy those responsible for the project wish to follow.

In the PALM4.Q project the strategy of encouraging acceptance was chosen by the selection of participants who were openly against a pilot action. In particular this was blamed on the fact that, especially with those to be trained and those untrained there was a great deal of resentment against further training measures. A positive "mouth to mouth propaganda" can work against this

Fig. 15: Participants in a pilot workshop

4 Integration into everyday production

Following completion and checking of the concept phase, integration of the concept into everyday production and thus making the proven concept permanent is essential. Only when the integration is successful and the training concept plays a part in the day-to-day work of each operator in production can the job finally be assessed as successful. However, since a training concept is always a mirror image of the operator's activities there will always be the need for adjustments and further development, even after implementation. In this connection an organisational structure should be established. The following points must be considered with regard to integration:

Fig. 16: Organizational structure for integration in to the daily production routine

Points 1-5 describe the training process in production and each point builds on the others. Points 6 and 7 must be considered independently and run in parallel with the actual training process. The following chapters describe the individual stages in more detail.

4.1 Determining the need for training

A training organisation requires certain trigger points which cause training to be launched. In KOSTAL's production there are 4 different trigger points.

If there is training which needs to be repeated at regular intervals, training which must be observed is applicable to each and every operator. This can be supported by SAP-VM software, for example. This reminds personnel responsible for arranging training which operator requires refreshment training. A typical example of this kind of interval-related training is safety instruction in the working environment.

A second trigger point is the speedy reaction to current quality problems where these can be influenced by the operators and can be traced back to a lack of suitable qualification. Here, close agreement between the production and quality departments and the personnel responsible for training is essential so that existing training can be carried out or, if there are new contents, the training can be adapted or developed afresh. These requirements must be forwarded to the training centre committee which is described in detail below.

In many companies there is a wage-related annual performance assessment by the manager. This is the third trigger point for the training organisation. In these meetings development possibilities can be discussed and planned from the training on offer. Action arising from these discussions must be organized with the people responsible for training.

The fourth trigger point must be derived from the company's planned activities for production. As soon as it is seen that framework conditions in production are changing (e.g., by innovations, new products, new technologies or new organisational structures) the training concept must be adapted to cover these changes. This requires many production-related areas and departments to have knowledge of the training concept. The initiative for the training to be adapted must be passed by these departments to the training centre committee as early as possible so that qualification actions can begin at an early stage, before the innovation has been fully integrated into the production operations.

4.2 Operational training organisation

By determining the need for training the subjects for training and also the employees to undergo the training to be carried out have been identified. The trainer must now organise dates for carrying out the training and an announcement to the relevant employees can be made. In KOSTAL the training announcement is organized via a "SharePoint" platform. It is important for other departments to see what trainings are to take place and when, so that further employees may be added if appropriate. Particularly in large companies there are synergy effects to be gained between departments. Employees registered for the training will receive an automatic advice of the training if they have an e-mail account. If this is not possible the manager will advise the employee. In the case of personnel closely associated with production it is also important for training dates to be taken into consideration in personnel employment planning and that those responsible are also informed.

4.3 Carrying out training and documentation

This point is the trainer's responsibility. Trainers are required to prepare and carry out the training in accordance with the presentation plan. This plan describes the individual stages in each training course in terms of its contents, the results to be achieved and any necessary preparatory action (see an example in the appendix). In addition the plan provides information on the time planning for the training and gives useful tips at certain points for carrying out the plan. This type of training documentation has been proven to be effective, on the one hand in maintaining the training at a common level even with different trainers; on the other hand, in the case of training courses carried out only at irregular intervals, it acts as an aide-memoire for the trainer.

After the training has been carried out the results achieved by the operators must be stored in a protected form. Here, agreement must be reached with the company council regarding the use and accessibility of the training data. As a general rule, after each training course the training contents are summarized and open feedback is obtained from the operators. The feedback basically covers the training, the trainer and also those who have been trained. The results of the feedback are also stored carefully so that improvements can be derived from them in cooperation between the trainers and the training centre committee. Here again a protected section of the "Sharepoint" Platform can be used.

4.4 Evaluating training

One of the questions difficult to answer is regarding the actual success of the completed training. In order to achieve at least an estimate a step-by-step evaluation of the training by individual participants is necessary, which goes beyond the open feedback on how the training was carried out.

For this employees are selected at random and, about 2 weeks after the training they are sent an evaluation questionnaire. This must be completed with the aid of a trainer and, if appropriate, in discussion with the manager. The questions in the evaluation questionnaire deal with the applicability of what has been learned in the work environment and whether possibly, activities already expanded have been carried out after the training was completed. The results of the evaluation questionnaire are also collected together, stored and evaluated. In the same way as the feedback the results are discussed in the training centre committee jointly with the trainers and further action is defined if necessary.

Metrics are another way of evaluating the success of a training operation. If production metrics are used it must be remembered that these are influenced by many other factors and changes need not necessarily have been caused by a training concept. In the PALM4.Q project metrics regarding the use of the training centre are used in order to determine how intensive the use is and which target group can be reached above all others. In order to generate metrics it is first necessary to collect data. In the KOSTAL training centre the

following metrics can be generated via the training announcements which are made via a "Sharepoint" platform:

1. The number of training courses carried out in the last 3 months
2. The number of participants each month
3. The number of training themes

Based on these metrics specified qualification targets in the organisation can be evaluated; with the third metric the relevance of the individual training themes can also be determined.

4.5 New and further development of training

This point is launched if there have been changes to framework conditions covering processes and technologies on the shop floor, or because of quality problems and/or performance assessments a qualification requirement has been identified. On this basis requirements for future training must be defined and forwarded to the training centre committee. In this regard the committee plays an important role.

In this instance the training centre committee is the central launch-pad for adjustments and further developments. Accordingly the choice of members of the committee is of particular importance because requirements from a wide range of areas and departments arrive and must be processed. The committee should be made up of personnel from the following areas and departments:

- Industrial engineering (if this exists)
- Personnel department
- Quality
- Production planning
- Production
- The trainer staff
- The company council (if this exists)

In addition to the new and further development of training there are other tasks which must be coordinated by the committee. These include the training of trainers, monitoring and implementation of actions following an evaluation of training and feedback, the tracking of annual target achievements for the use of the training centre and maintaining the training centre dashboards.

As soon as requirements covering new or further development of training courses are reported to the committee the committee must decide whether further development should take place or whether external training already exists which are coordinated with this theme via the personnel department. If the committee initiates a training development, financial and personnel resources for this are planned and implemented. Speedy implementation is necessary so that the desired training effects are gained as early as possible. Whether a training course should be permanently included in the training programme offered is a decision to be taken in each individual case. If so, the contents and documents must be integrated into the existing training organisation and the trainers must be instructed in them. A revision of existing training courses must also be carried out by the committee at regular intervals.

4.6 Maintenance

Because the training centre is representative of production and should be as close as possible to the production area it is sensible to integrate overhaul and maintenance work required with regular use into the production organisation. This will include, for example, drawing up and maintaining maintenance plans similar to these for production equipment. This applies to the general equipment in the training centre.

The regular users of special training materials and maintenance of the dashboard are responsible for their overhaul and maintenance, as well as the committee.

4.7 Trainer development

The education of trainers is an important development point in the train of integration into everyday production because training is always only as good as the trainer who has carried it out. If there are no trainers in the company instruction is the initial step. If there are already trainers these should be integrated from the beginning into designing the training concept and into the training centre committee. Suitable and interested candidates should be selected for the initial instruction. In KOSTAL the decision has been taken to instruct personnel close to production as trainers as they represent the contextual and organisational link between operators and the structures in production. The trainers in KOSTAL do not work 100% in the trainer's role; they remain actively attached to the production process. This has particular advantages with regard to determining the need for training and the training evaluation. Because of their proximity to production the trainers understand much better the need for training and can link this directly to the contents of existing training. The success of training can also be judged by trainers directly in the production environment. Actions covering further or new training can therefore be controlled in a targeted manner from the first source of information with an understanding of all the training units used.

The motivation to work as a trainer is of particular importance for the quality of future training. Before instruction begins the candidate should be given an observer's role in a typical training exercise and also carry out a trial training operation. After this the person instructing the candidate and the candidate him or herself can decide better if the candidate is suitable as a trainer. Only then is the actual instruction carried out. In KOSTAL this begins with a general "train the trainer" seminar, the purpose of which is to enable the future trainer to form a view of instruction unit in a targeted manner suitable for the target groups and how to use proven teaching tools and forms. In addition learning how to interact with participants and addressing large groups of people are in the foreground. The second stage in train the trainer is an intensive round of practical training, in which knowledge of the training unit in the training centre is imparted. This covers not only the contents of the training but also the processes in the overall training organisation such as, for example, the systems and documents used. The living training centre philosophy (working with participants; creating a training atmosphere, etc.) is also imparted at this point.

5 Learning methods on the shop floor

Once it has become clear how a training centre can be developed and implemented on a permanent basis there still remains the question: how do the delegates learn what they are supposed to learn? The methods selected and carried out by KOSTAL are presented in detail in this chapter. However, this is only a small extract from a rich methods landscape which is not suitable only for a training centre. Furthermore, other learning arrangements can be imagined, in which these methods can be used, such as at the work-station itself or in "learning stations" close to the working area.

5.1 Shaping the learning – basic thoughts on methodology

How are things taught up to now in many companies (and in KOSTAL it was not so very different)? Frequently a person responsible for the task in question will explain to the newcomer what he or she needs to know. Sometimes this is in the form of a presentation supported with pictures; it may also be at the work-station itself by showing and explaining So far, so good. Naturally something is learned in this way but the many possibilities offered by learning processes to build up knowledge and capabilities remain insufficiently used.

Anyone acting as a trainer, manager or a colleague and wishing to "contribute" to anyone else must be aware of what he or she understands by learning. In fact learning is more than a process and should be understood rather as a one-off event. I have learned when, in future, I have other ways of behaving than before. And for a company the main point is that which has been taught can also be "brought to the party". Only when the knowledge has been implemented in daily work can the learning process be described as successful.

To make things clear at the outset: this cannot be achieved by innovative and polished digital technologies alone. Augmented reality/virtual reality technology or Web-based training (WBT) can support the learning process in terms of technology but it can never be the sole solution, in particular for the shop floor. Learning for the shop floor, directed at handling capabilities, must always take place by dealing with the real objects, the work task and the working environment. Technologies such as those used in the training centre (videos, for example) will accompany and support the learning process but can never replace the trainer in the concept presented here.

That was the main reason why KOSTAL have installed a training centre, in which people learn by handling and with a strong probability that what is learned will be implemented. The training centre itself is therefore a method which is used for so-called routine work - that is, activities which are generally carried out by trainees and unskilled personnel and which will not disappear and be replaced by automation and digitalisation.

When selecting the learning methods within the training centre it is important to align them precisely with the target group, which will often have not had the best learning experiences in the past but will also gladly be characterized as "used to learning". That they are used to real learning is certainly open to doubt because, although learning of an informal nature happens almost every day in a job-related context, we use the term "used to learning" more to describe formal learning with seminars and instruction courses, etc. And this is a sign that explicit learning processes must be less in "school arrangements" and more very close to the work-place, so that it is part of the world of experience of the target group. The individuality of the target group (who) and the defined learning targets (what; why) therefore represent the fundamentals when selecting the method (how).

The "what" is the work tasks. What are the activities and tasks in which the participants should extend their manual and intellectual capabilities, knowledge and skills? To analyse this a simple example from everyday life is useful: learning to drive a car. Fig. 16 shows the contents of the learning process and how they can be rendered systematic in regard to the tasks and requirements.

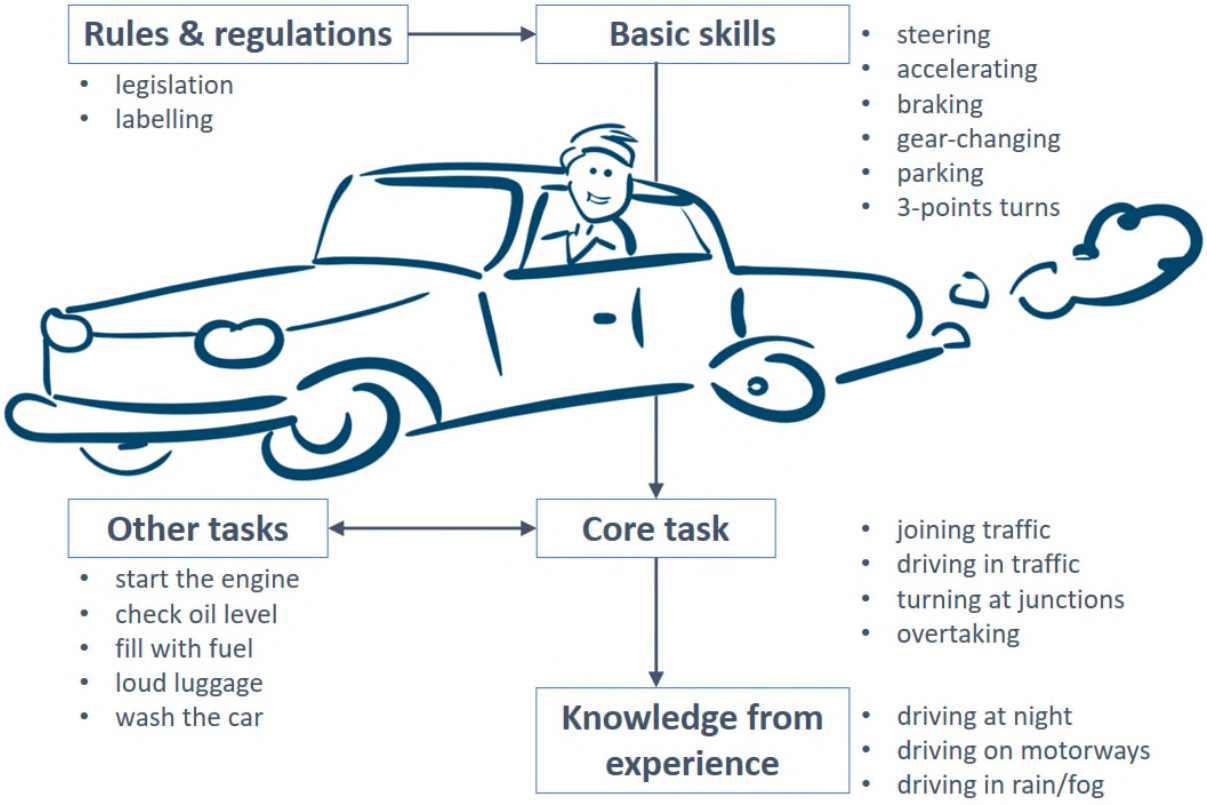


Fig. 17: Analysis of tasks and requirements with driving a car as an example

This principle can be transferred to an assembly activity. The core task is to fit a defined part in a specific sequence. However, basic skills are important for many tasks using a screwdriver, for example. Other tasks refer to additional activities, such as setting equipment, documenting activities or topping up. Under rules and regulations we have

the aspects of quality, safety at work or environmental protection to consider and experience shows these are important when assembling more complex product variants

With the "what" structured in this way the demands on the person being taught become clear. The learning method derived from this should be selected to ensure that the learning objective is achieved in the best possible way. If we take the core task of "fitting a component", after training the person under instruction should know the individual steps in the assembly process and carry them out without mistakes. The classic 4-steps method (see below) is suitable for this, in which the person does not merely see how the part is assembled and then copies the actions. Instead, by stating the key operations and the reasons for them the person can process the operations in more depth and what is learned becomes permanent.

The field of rules and regulations must be handled in a completely different way because this involves purely language-based teaching contents. The person under instruction should know the relevant rules and observe them in everyday work. Naturally this can be handled in the form of schooling for safety instructions but here again it must be ensured methodically that "explanation" and "presentation" alone are not appropriate for the target group. A link must be made to the world of work and experience in which the assembly operators operate - i.e., a tight restriction between theory and practice. This can take the form of a game, for example, using concrete work scenarios in which a "failure" in work practices is sought, so that the "correct behaviour" is highlighted.

Learning in the form of games have become very popular in recent time under the heading of "gamification" – and rightly so. For a target group of those being taught and the unskilled this also eases the pain of learning experiences which can sometimes be difficult and throws a more positive light on learning processes, creating greater motivation. If, finally, the knowledge gained by experience is examined, it is striking that, this can be gained by "gaining experience" alone - that is, by carrying out the work itself (training on the job) and, in the optimum case this can be expanded and corrected with another person (a trainer, manager, colleague) reflected in the form of a mentor.

The band-width of learning methods is also broad enough for the shop floor (see Fig. 17), so the purely "presentation-based method" should really have had its day. The wide range of ideas (always considering the background of the activity, the requirements it contains and the skills required, as well as the learning objectives derived from it) ensure that there are practically no limits.

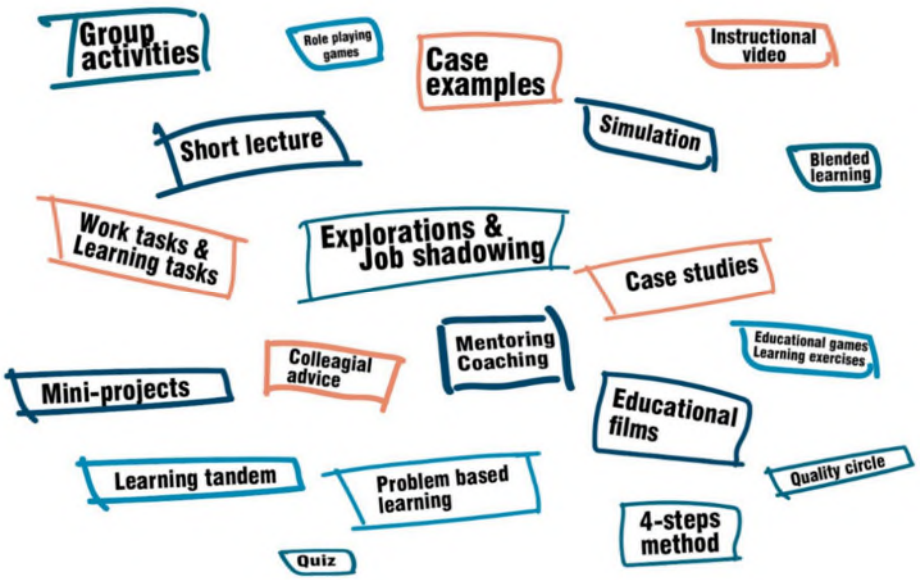


Fig. 18: The rich band-width of learning methods

5.2 Examples of learning methods

In the PALM4.Q project the training centre was selected as the form of further training as it is close to the shop floor. Because there is such a rich range of possibilities in a complete training centre many potential learning methods were chosen for use. Some of the learning methods used can also be employed for training on the job.

Given the various roles with their different contents and requirements the methods used in the training centre are also varied and multi-faceted. The following chapters describe in detail some of the learning methods used in KOSTAL.

5.2.1 The 4 steps method

The 4 steps method is a tool for most applications which is used above all for learning in practical activities. Essentially the method is based on the principle of "demonstrate and copy". In detail this method has the following 4 steps:

1. Prepare the instruction
2. The instructor demonstrates
3. The person being instructed carries out the action
4. Close the instruction

In step 1 the instructor prepares all the materials required. The work task must be explained in detail to the person being instructed, to make the objective clear and to arouse interest in the activity. The person being instructed must also be positioned correctly so that he / she obtains the correct perspective for step 2.

One of the most important points for step 2, in addition to demonstrating the activity at a reasonable speed, is to explain the activity in parallel. It must be clear to the person being instructed how an activity is to be carried out and, above all why it must be carried out in the way it is demonstrated. It is important that learning the wrong way to hold items is prevented at this stage.

Copying the activity by the person under instruction is crucial for step 3. Here there is a swapping of roles as the person under instruction must also explain the ways of gripping items as he / she carries out the activity. This gives the instructor the opportunity, by assessing the execution and explanation of the activity, whether the person has developed a true understanding of the task. At this point it is important that the task is carried out and reported correctly but that corrective action is taken if any mistakes are made. This step can be carried out several times. The individual decision by the trainer determines when they can move to step 4.

Step 4 serves to fix the work task firmly. The person under instruction carries out the task independently and the instructor is there only if there are any questions or to check individual sections of the activity.

This method is suitable for use on the shop floor (training on the job) and also in the training centre to provide schooling in core tasks and subsidiary activities. It is useful to prepare in advance a job breakdown sheet (see appendix), in which the individual stages of the task are listed in their correct sequence (what), key points in carrying out the task are identified (how) and reasons are stated (why). This is why this way of carrying out a task is important.

At KOSTAL the 4-steps method is used in both areas for teaching assembly tasks. It is necessary to train the instructor beforehand and thereby achieve a permanently high level of training.

5.2.2 Training film

As an extended form of video instruction the training film is used in KOSTAL in combination with the 4-steps method. The films are effective in covering mainly manual activities.

In a training film the activity is divided into sensible instruction sections which can be viewed in small video clips at a chosen speed and then copied at the identical work-station. The film is also referred to as a step-by-step guide. One of the greatest advantages in using the films is that the method provided by the film always remains the same. There are no fluctuations in the way the task is carried out, as would inevitably occur if several instructors were responsible. The training film runs with no words and is suitable for the shop floor and also international use.

In the training centre the people taking part should approach this digital form of work instruction. The trainer supports the relevant learning process as a teacher using the 4-steps method, as well as giving additional explanations and feedback to those learning in the execution process.

5.2.3 Transferring theory into practice

This basic learning principle must also be implemented both in a training centre and (with the necessary equipment) at a work-station. In the KOSTAL training centre in particular experience has shown that disseminating theoretical background knowledge in combination with practical execution leads to a better knowledge of methods and a greater sense of responsibility for purely practical activities, such as classic assembly tasks. The time available and focussing on an activity are therefore an advantage in a training centre.

The procedure is basically simple. There is a strong emphasis on the inter-action between trainer and the person under instruction, above all in the provision of theoretical background knowledge. The theory relates essentially to the execution of the actual practical activity. Here, above all, the following questions are raised in an open discussion with the people under instruction – and not in a presentation made from the front.

- Are there rules for carrying out the activity and why must they be followed?
- Are there examples or practical experience to support these rules?
- What are effects of my activity on preceding or subsequent processes?
- How is the quality of the final product influenced by my activity?

At this stage displays (pictures; graphs; etc.) are very useful in imparting the theoretical contents but should not hinder open exchanges in the group. It is much better to encourage people to make a contribution to the subject in discussion, so as to encourage active involvement. Finally this also encourages an understanding of the subject.

After a detailed discussion of the theoretical contents these must be used in a practical example. A direct feedback covering the execution is important at this stage, so that what has just been learned becomes firmly fixed.

5.2.4 Planned games

The purpose of a planned game is to provide a practical simulation which enables the people under instruction to gain as realistic and practice-related view as possible of problems and associations. In a simulation of this kind methods of handling can be simulated in a targeted manner in order to derive results and consequences. Experience can be gained in a realistic environment and this experience permit not only the generation of "AHA" effects but also an estimate of advantages and disadvantages of specific handling methods. Realistic consequences can be experienced in a planned game without causing any actual damage.

Implementation in the KOSTAL training centre is based on simulated assembly using Lego bricks. At this stage the target group is made up of production personnel who work directly on the assembly line. The simulated assembly line has very low productivity and must be improved using a wide variety of theoretical considerations (handling instructions) in the KOSTAL production system, carried out in 4 rounds of the game. Subjects included in the improvement loops include:

- Seven kinds of waste
- 5S
- Line balancing
- First-In-First-Out (FIFO) principle

In this planned game (see Fig. 18) each round in the game reveals the effects of each completed handling instruction on the productivity of the assembly line.

It is important that the contents of the daily work of those under instruction can be recognized so that what has been learned can be transferred. It must be possible to use what has been learned before much time passes, so that it becomes firmly fixed.

Fig. 19: A planned Lego game

5.2.5 A quiz

A quiz enables questions to be asked regarding knowledge and also to impart knowledge. AS relaxed atmosphere which comes with this method of learning also makes it possible to handle seemingly dry subjects in an interesting way. This learning method can be used in a group and also for individuals.

In a quiz it is assumed that those taking part have a certain degree of knowledge beforehand, which can be interrogated by targeted questions. It is important to have a chairman who runs the quiz.

Questions can be answered using knowledge already gained; depending on the kind of question guesses can also be made. The chairman reinforces correct answers and corrects wrong answers so that a learning effect is achieved at this stage. The advantage is that each person taking part is actively involved in the learning process by answering the questions. In a group quiz additional motivation can be generated by competition.

Holding a quiz need not be tied to a particular location and can therefore be held anywhere, depending on the schooling involved. At KOSTAL we use the training centre to make participants aware of failure costs for parts on the assembly line.

The quiz reveals to participants the monetary effects of a low-cost plastic part which is assembled wrongly. An estimate of costs is made in the production phase, from the component itself, through to failure at the customer's premises. This develops knowledge of quality-relevant inter-actions and increases the responsibility of the individual operator on the line. The role of the chairman is of particular importance at this stage, to ensure that answers are collected and integrated in the explanations.

5.2.6 Blended Learning

The "blended learning" method combines the advantages of a classic personal event (that is, direct training between trainer and student) and the use of digital media for independent study.

In the KOSTAL training centre this learning method is used above all for quality-related subjects and dealing with digital media. The actual learning unit takes place digitally, in part with real, digitally represented instruction items. However, an introduction to the subject is always linked in combination with a trainer.

On the one hand the trainer is responsible for ensuring that the person under instruction is able to use the digital tool - from much experience it cannot be assumed that people in the target group have much familiarity with PCs and tablets. On the other hand, from the person under instruction gains personally from the trainer a brief overview, the necessary background knowledge and the training contents. Support is always there during the digital training

The contents of the training cover the classification of failed products based on the reason for failure and using the correct descriptions from the company's own failures list (see Fig. 19). During private study the people under instruction must familiarize themselves with the digital documents covering failed products and the terms used and then employ these correctly in practical applications. Automatic assessment of the digital tool provides immediate feedback of the results of the training; these results must be discussed with the trainer in order to determine the success of the training.

Fig. 20: Determining failures using a list of defects

6 Concluding notes

The authors and everyone involved in the development, construction and permanent establishment of the KOSTAL training centre hope that the procedures and information set out in these guidelines will provide as many readers as possible with assistance in developing their own training units for operators on the shop floor,

For KOSTAL there now comes the world-wide roll-out, which also represents a great challenge, given the different mentalities and accustomed ways of learning around the world. There will have to be modifications to the training concepts to meet specific framework operating conditions; however, the basic concept set out here will be set as the world-wide standard for work-related and work-integrated personnel development assembly for future-oriented operator qualification.

The PALM4.Q project, which has been supported with the facilities of the BMAS, was the basis for this. In close and trusting cooperation between KOSTAL GmbH & Co. KG and MTM ASSOCIATION e. V. it was possible to bring new ideas to maturity, indicate best practice and proceed with the further development of standards. In the view of all those involved the solid discussions with their many results covering learning processes on the shop floor have led to a very practical and efficient model for qualification.

With the construction of the training centre and the expansion of training activities on the whole of the shop floor KOSTAL have come a great deal closer to the objectives listed at the beginning:

- A more profound presentation of assembly-related knowledge,
- Handling digital technologies
- Creating flexibility by broad qualification for core processes

These objectives remain a guideline for all subsequent activities. It is essential to stay "on the ball" in order to develop a uniform mind-set throughout the company covering qualification requirements especially for the shop floor. Above all this requires driving forces which display good staying power. Particular thanks are due to those who have already shown this as the project has progressed -the project management both at KOSTAL and MTM and all the other actors in this process.

If you have your own launch-pads for shop floor qualification and you would like to use the procedure set out here we would be pleased to exchange view. Contact details are set out in the appendix.

Facilities

Individual facilities developed within the framework of the PALM4.Q project are defined briefly here. As support for your own projects you download documents and examples from the MTM website under the following link.

Quick check: 10 questions to clarify the basic requirements for personnel development on the shop floor as an Excel list which can be completed.

Interview guideline: Interviews were held to determine the current qualification status on the shop floor and to identify possible qualification-related quality or productivity problems. This interview guideline serves as an aid for uniform execution and for comparable results.

Mind map: A pictorial illustration of a range of subjects (creative technique). The core subject is in the centre of the illustration, with more important and subsidiary points aligned to the sides. This can also be used as a group technique. It is used here to provide an overview display of activities in a role.

Skills matrix: A link between activities (tasks) and the skills required to carry them out (capabilities; expertise) in an easy-to-use matrix.

List of qualifications: An overview, derived from the skills matrix, of the activities for which qualification is required. Arranged in clusters (linked tasks) and by priority, with the reasons and the appropriate type of qualification.

4 steps method: A didactic method of instruction for learning practical activities, based on the Principe of "show how and copy" in 4 steps.

Job breakdown sheet: The basis for the 4 steps method. A task is broken down into its sequential parts and key points are noted, with reasons for the handling operation in question.

Moderation plan: The moderation plan describes the individual stages of each training course in terms of the contents, the results and the preparatory operations. The moderation plan also provides information on time planning and useful tips for execution.

Training progress evaluation questionnaire: An evaluation sheet for logging individual progress in training. This records time and the number of errors in each training operation and this information is used to calculate an individual training level.

Glossary

Blended learning: A form of learning in which the advantages of personnel presentations and E-learning are combined (integrated learning).

Digital skills: The skills of people able to understand modern digital media and how to use them. Digital skills are increasingly regarded as a central cultural technique alongside reading, writing and arithmetic.

Evaluation: In the context of qualification this refers to the evaluation of actions regarding their effectiveness. This can be carried out with various methods, including observation, questioning and self-evaluation).

Technical skills: Knowledge, capabilities and expertise and skills with a direct reference to the technical task (e.g., knowledge of machines and how to operate them).

Heat map: A 2-dimensional form of diagram to illustrate data in colour.

Job enlargement: The previous activities of the operator are extended to other work tasks on the same requirement level (horizontal), For example, the assembler takes on work in future at other assembly stations.

Job enrichment: The previous activities of the operator are "enriched" to enable him / her to carry out tasks at a higher requirement level (vertical). For example the operator also undertakes the inputting of data where a new digital technology is used and implements system information in adequate work operations.

Skills / expertise: Skills are made up of knowledge, abilities and operations by a person. The term covers human capabilities and skills with which tasks are carried out and problems are solved in defined work areas

List of skills: An allocation and overview of the skills required for a defined work area.

Method skills: Everything which an operator should be able to know and do with regard to procedures in his / her work area (e.g., systematic elimination of errors).

Qualification requirements analysis: A systematic procedure to determine loop-holes between the current skills level of specific groups (CURRENT) and the skills required (TO BE ACHIEVED) to carry out fault-free, non-detrimental and perhaps also future-oriented execution of tasks.

Role: A role defined the work contents and responsibilities of a group of operators in the same function (e.g., the role of the assembler or the setter).

Social skills: Dealing and working with other people such as colleagues or managers (e.g., targeted information).

Activity: A clearly definable quantity of work tasks for an operator with an equally clearly defined result of the work.

Training near the job: All methods and actions to express and test practical knowledge and capabilities near the work-place - e.g., in the form of a training centre.

Training off the job: Qualification actions taking place away from the work - e.g., the presentation of theoretical principles in a seminar.

Training on the job: All methods and actions to express and test practical knowledge and capabilities directly at the work-place, e.g. in the form of instruction in the work.

Training centre: A clearly separate area close to production, in which several work-stations are set up for learning purposes.

Training islands: Single learning points directly located in production in order to present specific work contents.

Training concept: The whole of the planning required to carry out a training operation. It includes details covering learning objectives, contents, methods, setting, target groups, materials, trainers and many other features.

List of illustrations

The authors

Christina Winter (nee Hesse)

Head of Production Systems at Leopold Kostal GmbH & Co.KG. Studied industrial engineering at the TU Dortmund specializing in production technology with a focus on assembly. In the PALM4.Q project as project manager and internal supporter for training on the shop floor and integration of the TC at Kostal.
(Contact: c.winter@kostal.com)

Manuela Ostermeier

Team leader digitization & internationalization of MTM training at the institute of MTM ASSOCIATION e. V. Studied industrial engineering as a bachelor and technical management and logistics as a master at the TH Wildau. Longstanding MTM instructor, since 2020 with a focus on train-the-trainer in the context of blended learning concepts. External advice and project support at PALM4.Q.
(Contact: manuela.ostermeier@dmtm.com)

Dr. Helga Unger

Scientific colleague at the MTM ASSOCIATION e. V. institute. Studied business management and work psychology. Several years' working as team leader, organisation consultant, trainer and lecturer. Her main current area of activity is personnel development in an increasing digitalized world of work. Over several years she has supported KOSTAL actively in questions covering qualification and, in particular with the PALM4Q project-the training of trainers.
(Contact: helga.unger@dmtm.com)

Prof. Dr. Thomas Mühlbradt

Head of working systems for the future at the MTM ASSOCIATION e. V. institute. Studied work psychology and industrial science. Hold the position of professor for working and engineering psychology at the FOM college. Current areas of research include digitalization of the world of work, learning near the job and industrial cognitive engineering. Scientific association with the PALM4Q project.
(Contact: thomas.muehlbradt@dmtm.com)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