
Work-Process Based Development of Curricula: A Framework

Abstract

Education and vocational education have to be finally presented in an operational form i.e. in a curriculum. In any case, when it comes to Technical Education and Vocational Training (TVET), five components are highly relevant as the pillars for a vocational system:

- Relationship with the private sector,
- Curricula and occupational standards
- Teacher training and further (in-service) training of teaching staff,
- Conducting research and networking with other institutions,
- Positive values and esteem for work and for training.

These five pillars render the structure when it comes to quality-based training and education.

Keys words: *Work process knowledge, Curriculum Design, Occupational Standards*

1 Establishing a Platform for State-of-the-Art Development of Detailed Occupational Curricula

1.1 Ensuring the Relevance of Curricula in TVET

We can no longer pursue the idea of acquiring skills which will last for a lifetime. Steadily increasing complexity and rapid technological change at the workplace require competences which respond to changing requirements which we do not yet know. Consequently we can no longer rely on an analysis of only the present competences needed at the workplace and then use this analysis as the basis for designing the curriculum and training programme. Today we need a change of paradigm (cf. Boreham & Fischer 2009). We need to understand the dynamics which occur at the workplace.

The common platform for skill training which has been established by competence-based standards such as the NVQs (National Vocational Qualifications) has to be upgraded to meet increasing complexity at the work place and rapid technological change. These challenges urge us to reach beyond this platform into the work-process and to create a curriculum which can cope with today's uncertainty at the work place.

Therefore, beyond duties and tasks at the work place – as it is the center of DACUM (cf. Norton 1997) – we need to go into the work-process and conduct a work-process analysis to identify all competences which are required in the overall work-process. In order to capture

these dynamics we have to unfold the details of any specific work-process through a work-process analysis.

The required paradigm change towards a work-process orientation leads to the question of how educational content and vocational knowledge could be related to the students' needs and the process of the development of competence.

Curriculum development faces the great challenge to identify educational content, vocational knowledge, and vocational capability (i.e. students' needs) such as intellectual understanding, values, verbalized concepts, motor skills, physical issues. This is due to the fact that vocational knowledge and capabilities are content-related and holistic. Traditional methods of curriculum development such as e. g. "didactical reduction", "functional analyses" etc. cannot meet these requirements. They ignore the holistic, situational and work-process related quality of work (cf. Lave & Wenger 1991, Spöttl & Loose 2014, Hiim 2017). The paradigm change in the world of work calls for new approaches of curriculum development to ensure the relevance of the curricula.

Today curricula are needed in which the authentic practical work, the requirements of the work-process and the work-process itself serve as the guiding structure. For successful learning we first need to progress beyond "narrow" skills to acquire "broad" competences which enable the learner to cope with uncertainty and change at the workplace and second we need to identify and to convey the domain-specific skills which are basic to what we call a "core work-process" in a particular occupation and finally third we need to identify the work-process knowledge behind the work-processes under study. The work-process knowledge encompasses the theory which is needed for performance in a work-process encompassing all aesthetic, moral, societal and technological aspects.

An outline of the necessary steps from planning a work process analysis to the development of Advanced Detailed Curricula (ADCs) and the performance of advanced skill tests will be presented in Figure 1. An approach will be outlined which can face these challenges (cf. Spöttl & Tutlys 2017). It will also be demonstrated how "core work-processes" can be identified with the help of work-process analyses and can then be used as a basis for curriculum development (cf. Spöttl, Loose, & Becker 2018). It also will be demonstrated the development of how the core work-process structure could be shaped in order to guarantee work-process based curricula on the one hand and how to succeed in shaping outcome and competence-based curricula on the other hand. The guidelines are based on empirical surveys conducted in different sectors of the industry in a number of European countries (recycling sector; automotive sector), in Malaysia (manufacturing sector), and Oman (12 sectors) (cf. Spöttl 2008, 169).

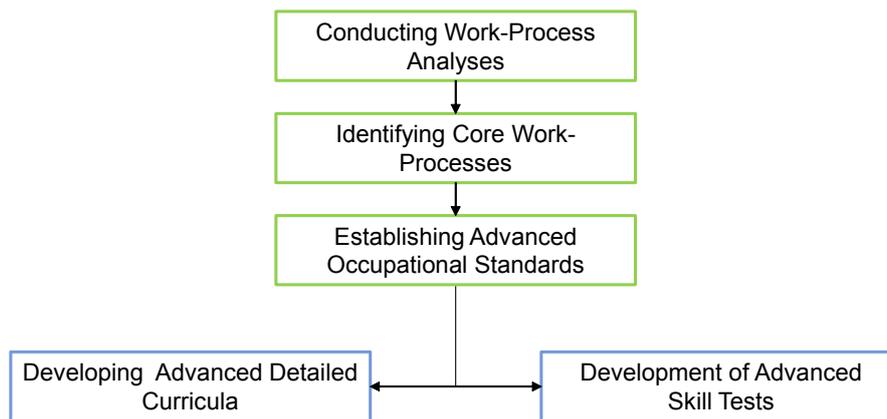


Figure 1: From Work-Process Analysis to Advanced Detailed Curricula and Advanced Skill Testing – An Overview

1.2 Work-Process Based Qualification Research as a Foundation for Curriculum Development

1.2.1 Discussion of Qualification Research

Traditional occupational profiles and standards for most economic sectors are structured by following the technological background involved. This approach does not take into account the increasing importance of the change of work-processes within the framework of the 4th Industrial Revolution and the requirements of work as such.

In order to ensure the identification of requirements for today’s work and its complexity it is necessary to involve research approaches which grant access to work, work-processes, change of work and the related implications. The results provide the essence for conclusions with regard to the need for, qualifications and occupational profiles, the shaping of curricula and consequences for learning processes.

In this process it is of special relevance in vocational education and training to get access to social structures of work and competence development in order to guarantee a co-shaping by the society regarding the objectives of education. This has to be closely interlinked with the development of competence for the performance of occupational tasks and work-processes.

One of the main tasks in this context is the selection of a research approach which is sophisticated enough to be used for the identification of the implications of work relevant for the development of curricula. The choice of an adequate approach depends on the objective and the understanding of curricula, influenced by the contents and the objectives of vocational education. In the present case the “term of curricular structure in a curriculum theoretical sense is understood as construction alignment and interior interrelationship of curriculum elements according to certain shaping principles” (Reetz & Seyd 1995, 204) for curricula. Curricula have to be translated into practice – and have to be open for critical scrutiny (cf. Stenhous 1975) and have also to support the shaping competence. In our case the objectives of the curriculum are oriented towards the concept of core work-processes and

towards the procedures of evaluation and assessment (cf. Scott 2008). This understanding of curriculum development can be combined with different procedures which are described as follows, e. g. (cf. Spöttl 2009b, 1630):

- Central curriculum development by authorities or universities,
- Decentralised curriculum development e.g. by teachers (called “open curriculum development”),
- Regional curriculum development by regional pedagogical centres,
- Teacher-initiated curriculum development,
- Expert initiated curriculum development.

These procedures for curriculum development are to be distinguished by the participation of different actors. Finally “the concept of participative curriculum development shows a way to solve the dilemma between self-determination and heteronomy: The participation, the co-shaping and the involvement of all actors on the basis of the profile, the tasks and the learning contents of the intended voluntary commitment and the learning process itself become the principle [...]” (Kircheldorff 2006). This perception of a participative curriculum development aims at the shaping of curricula as a dynamic process in which all persons involved negotiate and agree upon learning objectives, learning steps and learning results.

In the present case, curriculum development is based on participation on the one hand and on the analysis of work-processes on the other hand. Participation is part of it because the skilled workers of the companies should participate in the identification of work processes.

A direct involvement of the target group for curricular decisions – i.e. the skilled workers and key persons of the companies – is mandatory. These persons have to be actively involved in the support of the analyses of skilled work and of the incorporated practical know-how and skills during the identification of work processes. Beyond being part of the development process they thereby legitimise the results of the analyses. At the same time, the ranking and the relevance of the findings are evaluated in expert-skilled-worker-workshops by creating an expert pool of skilled workers, representatives of companies, curriculum developers and teachers.

The procedure outlined above requires the selection of corresponding research approaches. Priority should be given to a scientific approach of qualification research. Research following this approach is based on the fact that the perspective of insight into curriculum research and curriculum development and/or curriculum design must aim at the safeguarding of subject development and evolution. This can, however, not be guaranteed and societally accounted for without the foundation of an empirically secured need assessment of concrete capacities. Socially necessary work capacities are the result of complex configurations, based on technological, economic, legal, and social developments (cf. Spöttl 2009b, 1629).

1.2.2 *Work-Process Based Curriculum Development*

Traditional occupational profiles for almost all of the sectors and trades are structured in a way that they include basic scientific and technological knowledge and basic work related skills at the beginning of the training (e. g. metalwork) and then step by step deal with the important components, systems or service requirements. The requirements of an occupation as a whole (for example with the maintenance of a car as an entity) are hardly ever subject of vocational training. This is not only due to the fact that the skilled trades are specialized either regarding the mechanic or the electronic systems of a car or even regarding other components such as the engine, the brakes, or bodywork. This subject systematic, technology-centered curriculum design, which focuses on the systematic of the particular subject is burdened with the following shortcomings:

- The content deviates largely from the work process.
- Since the basic training is separated from the work-process it leads to motivational problems among the trainees.
- The curricula are overloaded with topics and subjects which have no practical orientation (cf. Spöttl 2009a, 76).

As an alternative, a work-process-related curriculum is proposed here, with the intention to abolish the horizontal and vertical division of work: Vocational education and training with a focus on industry is today confronted with implications of the 4th Industrial Revolution which is drastically changing the nature of work (cf. Spöttl & Loose 2015, 31, Schwab 2016).

The objectives at all levels of differentiation should be designed in a work-process-oriented way. With the aid of work-process analyses work-processes have to be identified and structured with the help of expert interviews. Finally core work-processes have to be structured according to a concept which enables a beginner to develop into an expert. Based on the actual competences for work involving high-technology and society the model for the development of competence described here aims at a qualitative re-organization of a philosophy of “regulation-guided know-that” towards “experience-based know-how” (Dreyfus & Dreyfus 1986, 41, Ryle 1949).

With regard to dealing with work oriented issues, this approach is successful if based on a differentiation between three dimensions:

- the objects of skilled work (issues based on their relevance for the work process and the functioning of technology),
- the methods, tools and organization of skilled work,
- the company-related, social and subjective demands regarding skilled work and technology (demands resulting from standards, legal issues and the wishes of employees, company and customers). (cf. Spöttl 2009b, 77)

Following this approach the core questions is which contents should find their way into vocational education and training and how they should be structured.

Contents with a special relevance for curricula are path-breaking work interrelationships which have to be identified with the help of qualification research. Such contents are the basis for conceiving complex learn and work arrangements for the qualification of employees for the actual requirements at the place of work. Numerous curriculum approaches ... reveal a work orientation. This is, however, not the only performance index for a good curriculum (cf. Spöttl 2009b, 1634).

“A curriculum must not only perform better than to simply answer to the needs of the labour market and to ensure that the imparted qualifications can be made use of. It must also react to the changes on the labour market and take into consideration the multi-dimensional requirements of employees/ apprentices and the learning process. These are all normative determinations for the quality of a curriculum”. (Spöttl & Becker 2008, 105).

In order to ensure the proper work orientation of the curricula, work-process analyses have to follow scientific structures which concentrate on the identification of work interrelationships and the dimensions of skilled workers. They thereby pursue the following three aims:

1. to identify the competences for the coping and shaping of occupational work tasks;
2. to access the most important coherences for competency development;
3. to determine the work-process knowledge for the shaping of business and work-processes.

With their three categories of objectives, i.e. competence, competence development and work process knowledge, these objectives reflect competing principles for the determination of the contents of curricula. Reetz and Seyd concluded that this leads to three different curriculum structures and approaches (science principle, personality principle and situation principle; cf. Reetz & Seyd 1983, 1995) and they predicted well in advance of the introduction of learning fields an increasing importance of the principle of personality in practical issues of vocational education and a continuous dominance of the principle of science on the macro-level with its specialized scientific structures. “Work-process analyses have to take into consideration all three principles”. (Spöttl 2009b, 1634) The target is to offer a bottom up approach for curriculum development.

These research domains reveal a high affinity to the „levels of occupational profiles“ (cf. Lisop 2003, 317) which are employed for an empiric adaptation of the contents for curricula (cf. Huisinga & Lisop 2002). Actually a more comprehensive analysis has to be applied whenever a drifting apart of qualification and curriculum research are detected.

Each of the three skilled work-related dimensions of work and learning correlate with one another. In this way the demands for skilled work and for technology are reflected in the object of the skilled work and also in the methods, tools and organization of the skilled work.

The consequence for the shaping of a curriculum is that the three dimensions of work and learning of an instructional area will indeed be formally divided but at the same time the content will be interdependent.

Three predominant methods are used within the framework of work-process analyses: the observation of work (cf. Becker 2005b), the expert interview and the action-oriented specialized interview (cf. Becker 2005a) as well as the situation-related interview, i.e. the direct interview during real and challenging work situations. The work observations aim at the decoding of those situative work practices which lead to successful occupational action. This technique – closely linked to recent trends of the studies of work allows a detailed analysis of the practice community of skilled work. This is no distant observation with the aid of pre-cast observation criteria but an observation relying on the closest possible witnessing of occupational practice. The action-oriented specialised interview is also closely linked with work observation. The researcher tries to clarify open questions and discusses applied knowledge. If explicable, this approach allows a high degree of objectification of implicit knowledge by trying to understand all moments within the context of action (context oriented objectification, cf. Becker 2003, 65).

2 Work-Process Knowledge as the Basis of a Curriculum Design which follows Logical Development

Work-process knowledge is the pivotal point for logically designed vocational education and the respective curricula. All knowledge incorporated in this approach excels by a much higher stability than “technological knowledge” which can be assigned to the surface of the technological development. In his essay “From work experience to work process knowledge” Fischer has comprehensively and systematically developed the term work-process knowledge as a scientific and vocational educational category and has thus considerably contributed to an identification of logical structures of development in vocational education (cf. Fischer 2000). The term “work-process knowledge” describes the knowledge of skilled workers which is to a great extent acquired by individual work experience (see Figure 2). In this complex the following characteristics have been specified with respect to the “range of the term experience”:

- Work-process knowledge combines theoretical knowledge and practical experience in a systematical rather than in an accidental way.
- Work-process knowledge is oriented towards the entire work and business processes of a company and is not just confined to work experience at the workplace.
- Work-process knowledge is accumulated in situations calling for tasks such as targeting, planning, execution and assessment of one’s own work.
- Work and business process knowledge unfolds in problem situations, above all at crystallisation points of corporate decision making, e.g. with the introduction of a new technology or with the decisive change of existing work processes within the framework of operational innovation processes.

The concept of work process knowledge in this form goes beyond the concept of a stepwise development towards an expert described by Dreyfus & Dreyfus as it more strongly underlines the interaction between experience and systematical knowledge. Furthermore

work-process knowledge is not confined to the organisational dimension of operational processes and the respective overall knowledge; it also encompasses the practical, implicit, and theoretical knowledge incorporated in the concrete vocational work.

Work-process knowledge can therefore be characterized as a holistic concept of knowledge because practical, rational, aesthetical, and social moments form a unity within work experience.

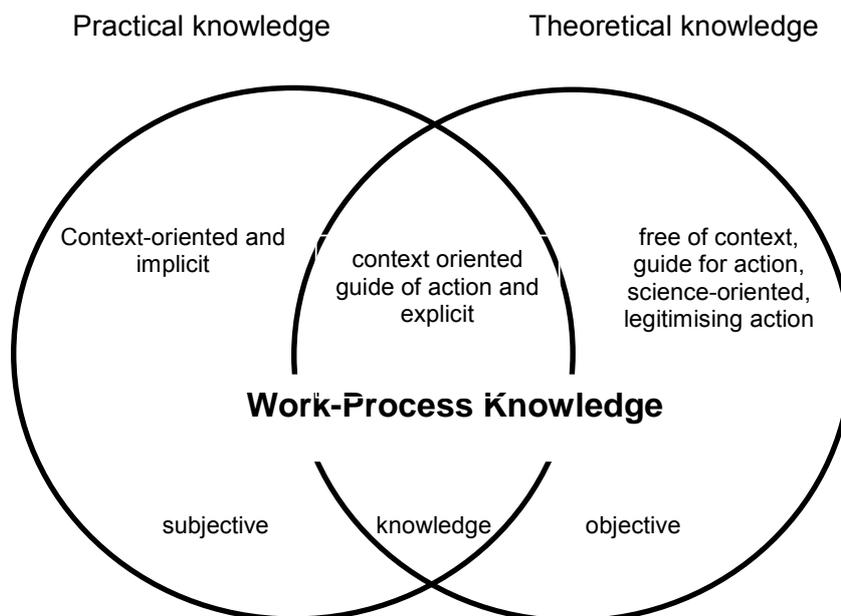


Figure 2: Dimensions of Work-Process Knowledge

The work-process oriented concept of the development of competence is highly suitable for curriculum development as it supports the formulation of contents from the perspective of work tasks. The model does not start from the prevailing differentiation of formalized knowledge but aims at a qualitative reorganisation of thinking “from standard-guided ‘know-that’ to experience based ‘know-how’” (Dreyfus & Dreyfus 1987, 41). Competences and expert knowledge should be developed which are both organised in a way which is qualitatively different than explicit standard knowledge. The most way important links are the real challenges of work, technology, and society. This is what makes the difference of this concept compared to models which rely on a defined “spectre” of entry competences and then try to develop “final competences” – defined as “reflected mastership” - with the aid of differently shaped teaching and learning processes. These models range within a defined framework and imply that the determined entry and final competences are both “correctly” assessed and that the applied teaching-learning processes initiate data processing procedures which produce the expected “knowledge” and develop the defined competences. However, what is often overlooked is the fact that the entire learning process is confined to a given framework which can firstly only be tied in with the known subject structures (due to definitions) and which secondly completely ignore the complexity of the “real world” of skilled workers and engineers. The link to the complex working world which is promoted

here and the development of a highly complex, dynamic expertise across the four levels of development increases the chances for the acquisition of effective knowledge structures.

The Process of the Development of Curricula

The factual differentiation of learning contents oriented at work-processes for an integrated vocational educational plan is based on three central questions:

1. What is handled by the occupational work?
2. How is this occupational work carried through?
3. What are the requirements – and who sets them? – concerning form and subject of occupational work?

These central questions suggest a work-process oriented differentiation of working and learning contents according to three dimensions:

- Object of (skilled) work,
- Tools, methods and organisation of (skilled) work,
- Requirements for the skilled work and its objects (Figure 3)

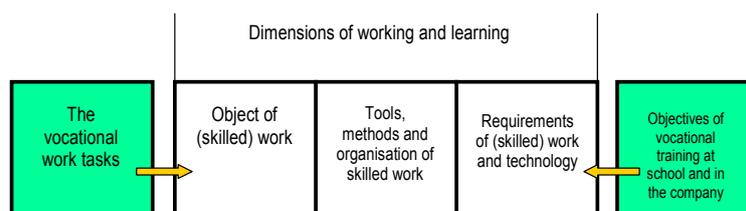


Figure 3: Dimensions of Working and Learning

What is distinctive for such a vocational education plan is the fact that it complies with three central requirements for a modern occupational curriculum.

Vocational Education as a Link between Working and Learning

Learning and working within vocational education are closely linked-up. Therefore the identification of work tasks with a high degree of learning potential are in the centre of interest. The dimensions of working are at the same time dimensions of learning. Vocational education is context-related education and identifies work processes as the challenge and trigger of continuous development of competence. The task of the curriculum planners therefore is to formulate the contents of working and learning in a work-process oriented way.

A Shaping Oriented Curriculum

Vocational education should qualify for a co-shaping of the working world. Only contents with a clear orientation to and a representation of the concrete working world are likely to trigger shaping competence. The documentation of different comparable requirements for skilled work and their objects of work directly points at a wide scope of shaping of work and technology. Teachers and trainers are therefore facing the challenge to understand a process encompassing a variety of very different interests – economical, ecological, work related interests etc. as well as a variety of customer interests with regard to competition as a compromise for technical solutions.

A Curriculum for Cooperative vocational Education with two Profiled Learning Environments

The vocational education system must shape vocational education as a cooperation of learning environments (postulate of cooperation). As for the learning environment “company” this means the identification of learning during work processes. The competences indicate under which point of view, with which emphasis and in which form the common competence targets of working and learning contents may become the objects of vocational training in enterprises. The complementarily formulated competences for the learning environment “school” indicate the perspective of the educational process at school with regard to the contents of the curricula.

Thus both learning environments concentrate on the same world of work. On the other hand this will result in vocational work tasks and their differentiation through work process oriented contents. Learning environment specific competences eventually result in a discussion of these contents at school and in the company.

The description of the objects of skilled work considers both the work context and the work process as documented in case studies. The object of skilled work within an occupational work context is the centre of interest (see Figure 4).

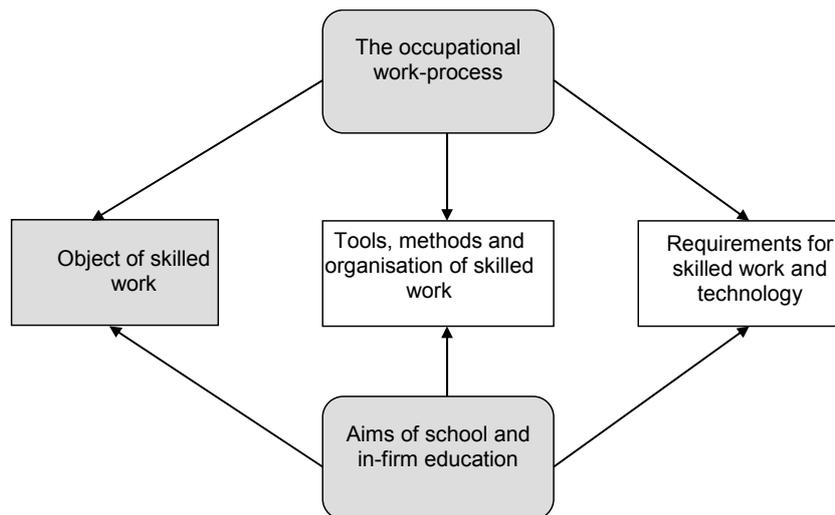


Figure 4: Development of Fields of Learning. Identification of Objects of Working and Learning

The work-process and the work context of an industrial mechanic (industry) who is participating in the construction and operation of an engine test station differs greatly from the engine check with the aid of a diagnostic device carried through by a car mechanic in the automotive workshop of a car dealer. As for the first case, the object of skilled work is the engine test station which has to be constructed and put into operation. The second case features the diagnostic device as a tool and method which helps to check engines – in this case the object of work – regarding their functioning. While the industrial mechanic has to deal with the functioning and structure of the motor test station prior to its putting into operation, the car mechanic must concentrate on the mastering of the diagnostic device as a checking and measuring unit.

Therefore the object of work must be identified and described as an incident of the work-process. Thus it underlines both the object in its own determination (the engine test station in its entire complexity) and – above all – the function of the respective occupational work-process.

The work tasks and their description allow to decode the dimensions “tools, methods, and organisation of skilled work” with regard to their overall educational and qualificational objectives (Figure 3).

Once again the context of the work-process is crucial. Above all universal tools have to be analysed as tools for a specific work-process. This is less true for the working methods and the work-processes as these are generally already defined in a work-process oriented way. Work-processes and methods are especially characteristic for the development of a logical structure of an integrated curriculum.

Tasks for the organisation of skilled work are a basic prerequisite for curriculum development as only the indications on work organisation clarify the quality of the work-process for the employees. Different organisational variants for occupational work tasks lead to considerable

differences with regard to occupational responsibility and the requirements for cooperation and communication within the work-process. The indications on work organisation point at the shaping options and scopes of shaping during the work-process.

The identification of requirements for the work-process and the skilled workers takes place according to the following challenges from different sides:

- legal stipulations and ordinances,
- technical standards (ISO, manufacturers' standards etc.),
- quality standards resulting from the quality competition process,
- customers, interests,
- subjective employee interests and
- individual operational requirements of the companies.

An example for the "requirements for skilled work and technology" is given below by stating "Amendments and additional installations" (see Table 1).

Table 1: **Requirements for Skilled Work and Technology**

Occupational work-processes	Requirements for Technology and Skilled Work
<ul style="list-style-type: none"> - Standard extension and additional installations (equipment and retrofitting with »modular parts«) - Execution of extension installations for individualisation and/or special use of the vehicle by adhering to traffic and operational safety and by taking into consideration the standards for - type approval 	<p>for technology:</p> <ul style="list-style-type: none"> - manufacturer related stipulations (manufacturer; company; subject) - type approval stipulations/standards (manufacturer, company, legislation, subject) - stipulations with regard to shaping of additional installations (legislation, company, subject) - stipulations for the positioning by ECE; ISO; STVZO (legislation, company, subject) - limits for shaping due to construction - user-friendly and safe shaping (customer; subject; legislation) - regulations on functioning and operational safety (legislation; company; manufacturer) - safety regulations for company (legislation; company) <p>for skilled work:</p>

<ul style="list-style-type: none"> - traffic safety - »constructive safety« - manufacturer's stipulations, standards (ECE, ISO, ...) 	<ul style="list-style-type: none"> - qualification for customer advising (subject; customer) - qualified customer advising on retrofitting (company; subject) - differentiated offer on retrofitting (company; customer; subject) - transparency with regard to legal stipulations and freedom of shaping of extensions (customer; legislation; company) - type approval (legislation; manufacturer; customer) - shaping of retrofitting at the workshop (specialist vs. all-rounder) - qualified retrofitting (customer; company; subject) - TÜV (=Technischer Überwachungsverein = Periodical Vehicle Inspection)-approval after retrofitting (legislation; customer; company) <p>Collision of interests:</p> <ul style="list-style-type: none"> - Individualisation of a vehicle by a customer vs. limitation of freedom of shaping by type approval stipulations.
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Educational and Qualificational Targets

In a last step towards the completion of the curriculum structure specific objectives of education and qualification are formulated. They blend into the objectives determined for every learning area and at the same time concentrate on the learning contents identified for the respective main focal points.

It is important to formulate a manageable number of objectives per occupational work-processes and to open an adequate scope of shaping for the inclusion of specific operational work-processes which eventually determine the quality of the vocational education practice in the form of learning and work tasks.

3 A Final Note

Work-processes and work-process knowledge are at the centre of developing state-of-the-art detailed vocational curricula. This process has been outlined above. While work-process knowledge is typically conveyed at schools as learning environments, learning in the actual work-process takes place at the place of work. In this sense this learning pattern describes the "dual system of training" which is the dominant mode of training in the three central

European countries of Austria, Germany and Switzerland. In fact the training success of this approach seems to be due to its reliance on the work-process orientation of training.

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