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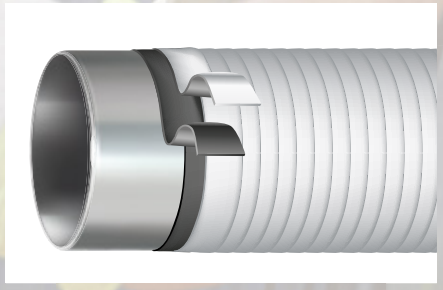

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Qualification in the pipeline industry

Dr. Klaus Ritter
Editor in Chief

Studies indicate that we in the international pipeline industry are heading for a shortage of well-trained engineers and scientists.

On the one hand, this is due to the fact that in recent years there have been fewer and fewer young people starting engineering or scientific studies, and on the other hand to the fact that the scope of tasks has increased.

The reasons for this increase are the growing number of new construction routes in all parts of the world and the fact that many older pipelines have come of age and that a greater effort has to be made to maintain and rehabilitate them.

On the other hand, it cannot be overlooked that incidents in the international pipeline network are increasingly attributable to human error.

The safety technology (Integrity Management/Inspection/Detection) as well as materials and construction techniques have been significantly further developed in the past 2 decades. Simultanously, it can be doubted that the qualification of employees at all levels of the pipeline value-added chain has kept up everywhere with these significant developments - especially considering the background of the personnel shortage that prevails in many companies.

Everyone should know that a suitable level of qualification can not only help to avoid accidents but can also extend the service life of a pipeline and improve public perception.

All these factors have an impact on the profitability of pipelines - it is therefore surprising that there are no coordinated international efforts to increase the industrywide level of qualification.

With its instruments ptc, ptj, and ptj-newsletter, EITEP has begun to shed light on this topic from various angles under the heading "Qualification and Recruitment". The articles of this ptj focus issue belong to it. The upcoming ptc (March 19 to 21, 2019, Berlin) will follow with lectures and a seminar to this topic.

Perhaps it will be possible to bring together the various existing approaches to a coordinated international initiative.

Yours,

> Dr. Klaus Ritter, President EITEP Institut

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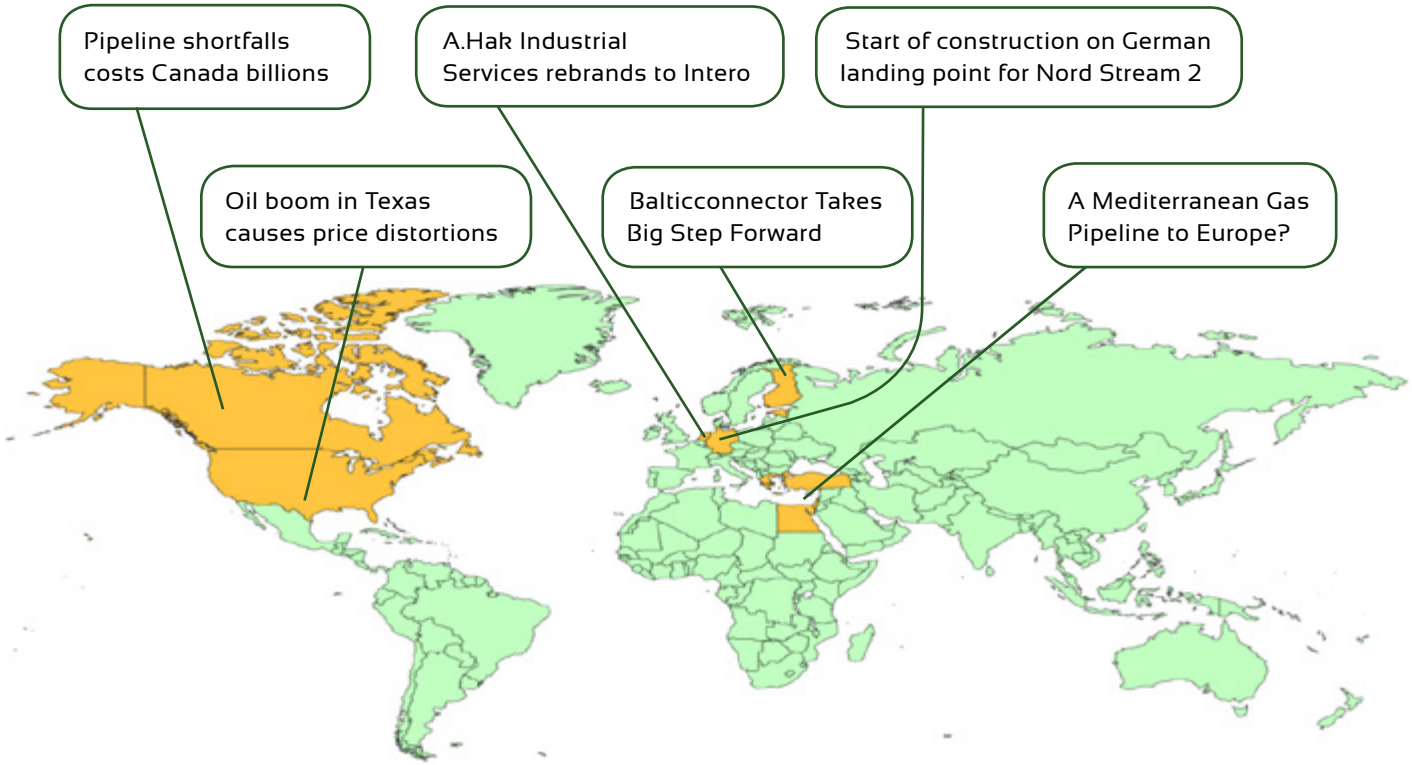

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CHANGING HOW WE EDUCATE ENGINEERS IN INDUSTRY

Michelle Unger > ROSEN Group

INTRODUCTION

All professional engineers make a commitment to maintain and enhance their competence by undertaking 'Continuing Professional Development (CPD)'. CPD is the process of managing, and documenting the skills, knowledge and experience that a member of staff gains, both formally and informally. It is not simply training (learning how to do something, such as a skill) as it includes knowledge (understanding gained through experience or study), and experience (experience is the process of obtaining knowledge and skills from doing and/or participating in relevant projects).

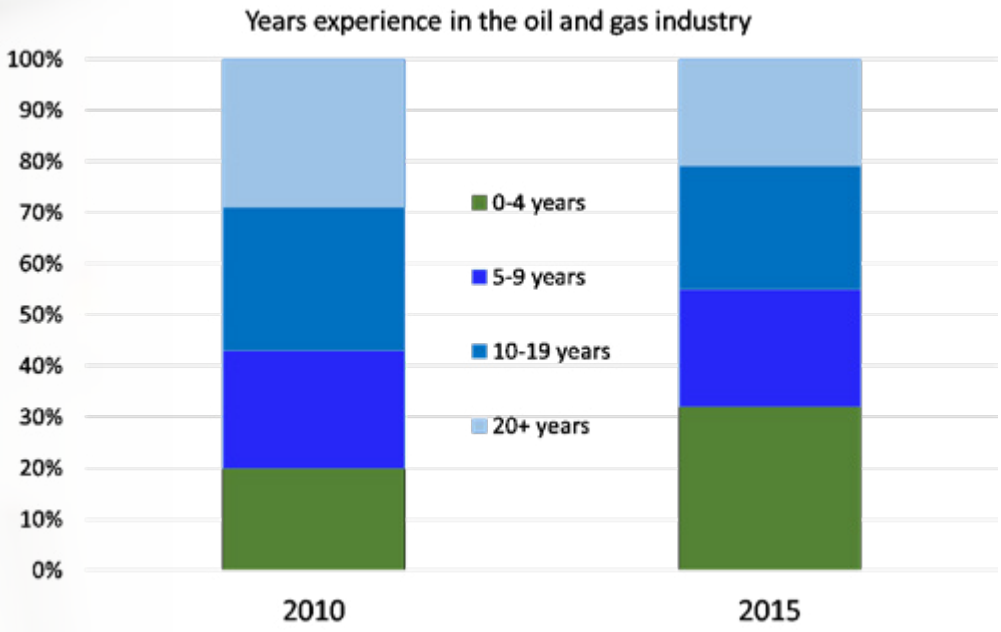

Figure 1: Increasing Skill/Age Gap in the Oil and Gas Industry [2]

Most of this CPD is informal learning during a working life, complemented by structured activities such as training courses [1]. This professional development is important to staff: professional development is the third most important factor for employees when evaluating their role [2].

Traditionally, this CPD has been provided by employers, but during periods of recession, there are often reductions in structured activities such as training courses; for example, the recent recession in the oil and gas industry has seen training course numbers and attendance plummet by over 75 percent. Add to this problem the continuing widening of the skills/experience gap in this industry as baby boomers retire (Figure 1), and it is not surprising that 36 percent of employers say that a lack of succession planning for knowledge transfer and skills retention is a contributing factor in their skills shortages [2].

Knowledge transfer seems an obvious attraction to workers, and a means of solving skills shortages. But it is not that easy... the current younger generations of engineers are inclined to move jobs more often: in the USA, the average tenure of workers aged 55 to 64 was 10.1 years, more than three times the 2.8 years of workers aged 25 to 34 [3]. This short tenure can both disrupt CPD, and also make employers cautious about spending time and money on knowledge transfer and CPD. This means that management of competence through CPD is becoming more and more difficult, in parallel with it becoming more important.

COMPETENCE AND EDUCATION

Competence is the ability to undertake responsibilities, and to perform activities to a recognized standard. It is a combination of practical and thinking skills, experience, and knowledge, with a heavy bias on experience in the engineering professions, Figure 2 [4–6]. Developing and maintaining competencies involves training, mentoring (coaching), and experience: typically this is made up of 10 percent training, 20 percent mentoring, and 70 percent experience, Figure 2. The definition of competence must also include 'values' or 'behaviors'. All these components of competency have overlap and dependency; for example, 'knowledge' is understanding gained through experience or study.

The role of CPD is to maintain competencies, and it is clear that this involves a mix of training, mentoring, and experience: it is not training alone.

Figure 2: Key Elements of Competency and How it is Gained

EDUCATING OUR ENGINEERS IS IMPORTANT...

Inadequate management of competence has contributed to disasters; therefore, competency management is critical [7]. Accordingly, industries are now requiring a more formal approach to competence and CPD. For example, engineering standards (e.g., [8]) and federal regulations (e.g., [9]) explicitly require engineers to be both competent and qualified in all the tasks they perform.

These requirements are supported by past major incidents: they show that the lack of certain skills or knowledge led to errors that contributed to the incident [10]. It had been assumed that:

- an individual with a certain level of experience or training would be competent; and/or,
- the dissemination of a procedure would be sufficient.

CHANGING HOW WE EDUCATE OUR ENGINEERS IN INDUSTRY: 'COMPETENCY STANDARDS'

Competency is a statement of desired knowledge, skills, and behaviors, but a competency:

- must meet an agreed standard;
- must be updated as competencies can deteriorate, or become dated with time, leading to a drift into incompetence ('competency decay'); and,
- must be continually assessed, as evidence is needed that it is being absorbed by the personnel ('demonstrable competencies').

Therefore, staff must:

- have their competencies assessed in relation to a standard; and,
- 'demonstrate' they are competent ('demonstrable' means supported by tangible evidence).

The assessment could be made based on examination, interview, performance, etc., but it must be formal and recorded. This means our CPD must relate to a 'competency standard' (e.g., [11-19]) that captures all the skills, knowledge and experience requirements of the competency.

The competencies of a job holder need to be assessed in relation to this defined standard to ensure validation. 'Competency standards' provide a common definition competency, along with its minimum requirements. It is best to keep these standards simple, measurable, and auditable. Hence, the competency standard must detail 'outcomes' : what the job holder will be able to do in some measurable way (there may be more than one measurable outcome defined for a given competency).

These outcomes should cover:

- 'ability'...
  is able to do a task (this is 'skill');
- 'understanding'...
  is able to understand and explain the task (this is 'knowledge');
- 'supervision'...
  is able to manage staff with these abilities and/or understanding;
- 'training'...
  is able to train staff with these abilities and/or understanding, and/or supervisory abilities.

The outcomes should be clear, detail the expected characteristics of the competency, and be phrased so as to allow an assessment: the outcomes infer the assessment criteria.

A typical competency standard would contain the detail presented in Table 1 [11-19].

The standard will also specify the method of assessment (e.g., by examination), and how long the competency is valid (i.e., when does it require reassessment).

A simple approach to writing competency standards allows for an easy guide and rapid adoption; therefore, competency standards need to be short (for example, limit competency descriptions to a single sentence).

ASSESSMENT USING A COMPETENCY STANDARD

Staff can be assessed in relation to the competency standard. First, the assessment of a competency will require the candidate to provide evidence of competencies, achievement, and qualifications. This evidence is essential, and should be tangible (e.g., examination results, or references), rather than intangible only (e.g., self-assessment).

Where evidence is not sufficient, the member of staff will require a formal assessment. The assessment should be conducted by comparing the required competencies for the job with those possessed by the candidate.

Competency standards give the necessary detail of the competency, and its level (e.g., Awareness to Expert). This allows a simple assessment in relation to the standards.

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Competency number.	e.g., 010
Competency title.	e.g., 'Onshore Pipeline Design'.
Competency level.	e.g., 'Awareness, Foundation, Practitioner, or Expert'.
Competency description.	e.g., 'The underlying principles, concepts, and technical parameters in onshore pipeline design, giving the individual an all-round understanding of pipeline design processes'.
Competency purpose	e.g., 'Give the individual the ability to design oil and gas pipelines, using prescribed standards'.
Competency outcomes.	Knowledge, understanding, skills, etc., are summarized in 'outcomes'. 'Outcomes' state what the holder should know, understand, value, or be able to do when they gain the competence (e.g., 'Can discuss pipeline design (front end engineering, and detailed design) principles, standards and regulations, and can outline and summarize the basics of the key contents of design standards including design for strength and fatigue'.).
Academic and professional qualifications.	The qualifications required to be considered before attempting to satisfy this standard; e.g., BSc or MSc, CEng or PEng.
Pre-requisites.	The required knowledge or conditions that should be satisfied before being considered for this competence (e.g., other competencies). A pre-requisite is a recommendation before attempting the competence, and may contribute to the competence being considered; for example, it may satisfy elements of the competence being taken.
Co-requisites.	A co-requisite is a recommendation that should be taken at the same time (e.g., other competencies). Co-requisites usually contain information needed to allow the specified competence to be achieved, and may contribute to the competence being considered; for example, it may satisfy elements of the competence being taken.
Skills and knowledge elements of the competency.•	Skills (e.g., 'Onshore pipeline design principles and processes').
	Knowledge (e.g.): • Feasibility studies, conceptual design, front end engineering design, detailed design. • Permits and quality plans. • Environmental impact of pipelines. • Routing (land purchase, land rights). • Construction and testing in a variety of environments (rural, mountainous, swamps, etc.), crossings, and construction costs. • Selection and properties of pipeline bends, components, and installations. • Substance and location classification, proximity distances, design factor, safety factors, stress calculations (including thermal and external loads, and fatigue), and equivalent stresses. • Theory of pipeline sizing and wall thickness calculations. • Pressure testing. • Materials selection, including line pipe types, effect of mechanical properties, and corrosion allowance. • Pipeline coatings and cathodic protection.
Training/mentoring [11]/experience recommended to gain competency.	Specify type, and timeline.
Assessment method.	Self-assessment, examination, performance, interview, etc..
Reassessment interval (years) and method.	e.g., 5 years.
Supervision.	Can the individual work on this competency with or without supervision?

Table 1: Typical Contents of a Competency Standard

The assessment should be conducted by a suitably qualified, and independent body. There are various methods of assessing competencies, including: Self-assessment; Performance; Examination; and, Interview. The competency standard will recommend a suitable assessment method.

SUMMARY

Continuing Professional Development is the process of managing, and documenting the skills, knowledge and experience that a member of staff gains both formally and informally. This wide remit can be simply described as developing and maintaining a staff member's competence: competence is the ability to perform a task to a specified level and it is demonstrated by appropriate levels of training, knowledge, skill, and experience.

Engineering standards and government regulations are now explicitly requiring engineers to be both competent and qualified in all the tasks they perform. This means that CPD has both a wide scope, and an increasingly important scope.

'Competency standards' provide a common definition of a competency, along with its minimum requirements. Competencies can be assessed against these standards.

The contents of a competency standard should clearly state its purpose and outcomes, and detail the knowledge, training, mentoring, and experience requirements, and an assessment method. Individuals who pass the assessment are qualified in this competency (as they have been assessed and have tangible evidence).

CPD using competency standards satisfies both the ethos of CPD, and requirements in standards and regulations. It will also assist in transferring knowledge to future generations and address a recognized skills gaps in many industries.

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THE ADVANTAGES OF DVGW TSM – A TECHNICAL SAFETY MANAGEMENT SYSTEM

Peggy Zeppei > ONTRAS Gastransport

ABSTRACT

Companies that operate technical systems, e.g. the German gas transmission system operator ONTRAS Gastransport GmbH, must ensure operational safety at all times, that all associated procedures and processes comply with the applicable laws and regulations, and that the company is also prepared to react in case of emergencies. Haphazard trial and error might be a possibility to achieve this. However, considering that the methods used should fit process control as well as legal requirements, some kind of organised management system featuring concrete steps in a predefined order is necessary. A practicle example is the QM System of ONTRAS.

THE ADVANTAGES OF DVGW TSM – A TECHNICAL SAFETY MANAGEMENT SYSTEM

Companies that operate technical systems, e.g. the German gas transmission system operator ONTRAS Gastransport GmbH, must ensure operational safety at all times, that all associated procedures and processes comply with the applicable laws and regulations, and that the company is also prepared to react in case of emergencies. Haphazard trial and error might be a possibility to achieve this. However, considering that the methods used should fit process control as well as legal requirements, some kind of organised management system featuring concrete steps in a predefined order is necessary. In order to build up such a system, it is best to start with a plan that sets defined targets. In the first instance, the individual steps for various procedures are analysed to define the processes. After implementation, it is necessary to develop a comprehensive review process that determines which envisaged goals have been achieved and to what extent. The results of this review process will make it possible to adapt or correct processes, where necessary. It is important to document all the steps and resulting processes as well as implementation methods and progress.

> *"TSM Systems provide processes to ensure a safe operation and to minimize risks of organisational faultssystems.*
>
> *Peggy Zeppei*

GENERAL REMARKS

All the management systems presented here follow the same scheme (fig. 1):

- Plan: Defining targets and the action required for implementation
- Implement: Installing the planned steps to achieve the envisaged targets
- Check: Checking to be sure that the implemented action generates the expected effect
- Act: Learning from and improving the system continuously

There are two groups of common management systems:

- Management systems for defining and improving a company's quality and safety of processes: Quality (and safety) management systems (QM)
- Management systems to minimise risks of organisational faults: Technical safety management systems (TSM)

QUALITY AND SAFETY MANAGEMENT (QM)

There are several standards that fulfil quality and safety requirements. Most important, nationally and internationally, is the common standard ISO 9001 from 2015. It covers quality management (QM) and aims at a continuous improvement of the company's internal quality management system. ISO 9001 is process-oriented and specifies the minimum requirements for a quality management system. A QM system of this kind should enable an organization to, at least, reduce its error rate and resultant costs.

Another commonly used standard is ISO 14001, last updated in 2015. It defines the requirements for the certifiable environmental management system (EMS) of an organisation. The standard should allow an organisation to continuously improve its environmental impact, achieve compliance with legal and other environmental requirements, and reach its environmental objectives. Therefore, the organisation needs to identify its significant environmental aspects and the associated impacts as well as suitable criteria for controlling the environmentally relevant processes. This standard also monitors whether the environmental goals have been achieved and documents the continuous improvement with suitable indicators.

A common standard for occupational health and safety (OH&S) is OHSAS 18001. It defines the requirements for the occupational health and safety management system of an organisation. These requirements include, for example, a suitable OH & S management system, including mechanisms for organising occupational health and safety and its hazards and risks within a company.

TECHNICAL SAFETY MANAGEMENT (TSM)

Technical Safety Management Systems aim to minimise risks of organisational faults. The German DVGW TSM system is based on compliance with laws, regulations and the generally accepted rules of technology that apply

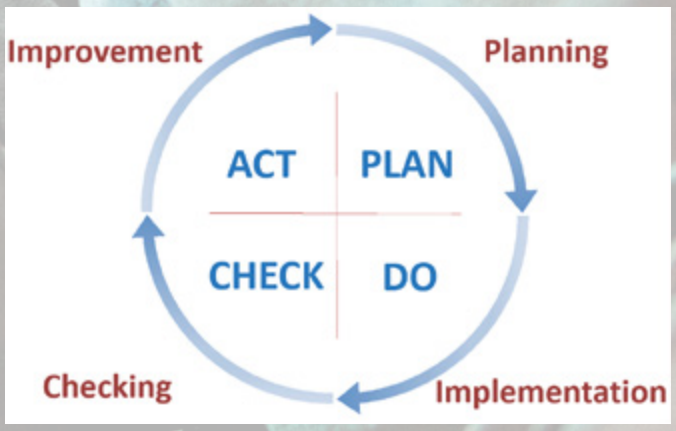

Figure 1: TSM implements a continious cyclic process of planning, checking and improving

throughout the industry and are the same for all companies. Thus, the technical rules and DIN standards of the German DVGW regulations provide legal certainty and a basis for all activities in the gas industry. The advantage is that as an association, the DVGW acts economically independently, neutrally and is not profit-oriented. Thus, the DVGW ensures transparent rulemaking processes.

For ONTRAS as Germany's second-largest transmission system operator, the relevant TSM regulations are the technical rule G 1000 from 2005 defining requirements for the qualification and organisation of the normal operation of gas infrastructure, and the technical rule G1001 from 2015 defining the risk management of the technical gas infrastructure. As the company is also responsible for operating 22 biomethane injection plants, the technical rule G 1030 from 2010 is also relevant defining the requirements for organisation and qualification of operators of biogas plants.

In detail, the TSM of the DVGW (referred to from here on as "TSM") comprises a process of constant updating to reflect the latest statutory requirements. As a management system for technical safety, it has been well established in the German utilities industry since 1999. It provides an outstanding component of technical self-administration in the energy industry and is essentially based on the know-how and the engagement of the experts of the sector. A regular recertification process provides systematic updates of the whole system and its benefits.

TSM focusses on the organisation of the company. Like the camera in a classic Hollywood movie that zooms from a wide angle with landscape, horizon and people into the smallest detail, in the total view TSM analyses the organisational structures and looks for clear definitions of technical disciplinary responsibilities and functions. It prevents in particular an overlap in competence, being one of the main causes of faults. Zooming in, TSM considers the processes within the organisation and the departments of the company. It looks for the acquisition of important work processes, the coordination among involved units of the organisation and aims to create transparent processes that can be updated if necessary.

In order to help a company in establishing its individual TSM system, DVGW offers a wide range of guidelines with checklists and questionnaires. These aids can assist the respective company to systematically review its structural and procedural organisation by self-assessment.

ONTRAS TSM AND RELATED DOCUMENTS

Since its foundation in 2006, ONTRAS has been developing its own company rules and regulations for relevant standards in addition to or due to a the lack of existing regulations. We do this in order to ensure that all our documents fit perfectly to our business needs. Typical applications include:

> *"With such a system a company ensures professional reaction during normal operation and in cases of emergency.* Peggy Zeppei

- checklists for construction site inspections, also available as an app
- various documents for the cooperation with service providers
- audit of service providers according to ISO 9001
- question catalogue for service providers, e.g. checklists for on-duty vehicle equipment
- ONTRAS regulations for service providers regarding on-call service and maintenance
- on-call service organisation
- operating instructions for the operation/maintenance intervals of biomethane plants,
- concrete regulations for liquefied petroleum gas suppliers (e.g. safety plan for LPG filling)
- comprehensive service contracts using the SAP-system (access for service providers - activation orders and billing)

Example 1: Construction Site Inspection

Our construction site inspection app for iPhones helps auditors with their work in the field. Detailed and easy to handle checklists guide them through their tasks and document all the steps and results transparently (fig. 2).

The auditor has to check, among others:

- Whether site documentation is available and complete.
- Whether site equipment/first aid equipment is satisfactory.
- Whether fire protection has been correctly organised and equipment and information about this are available.
- Whether hazardous substances are present, and if so, whether they are being properly handled.
- Whether the necessary materials are available and are properly stored.
- Whether the security of the site is satisfactory.
- Whether scaffolding, ladders and stepladders are available and in the right place.
- Whether the people at the site use their personal protective equipment correctly.
- ...
- Whether construction machines (such as diggers, cranes, and drilling instruments) are satisfactory and are properly positioned.

Example 2: Check-Up of On-Call Duty Vehicles

ONTRAS has developed another app to check on-call duty vehicles.

The app considers the on-call schedule (timeliness/up to-date, telephone list) and whether a mobile phone is on

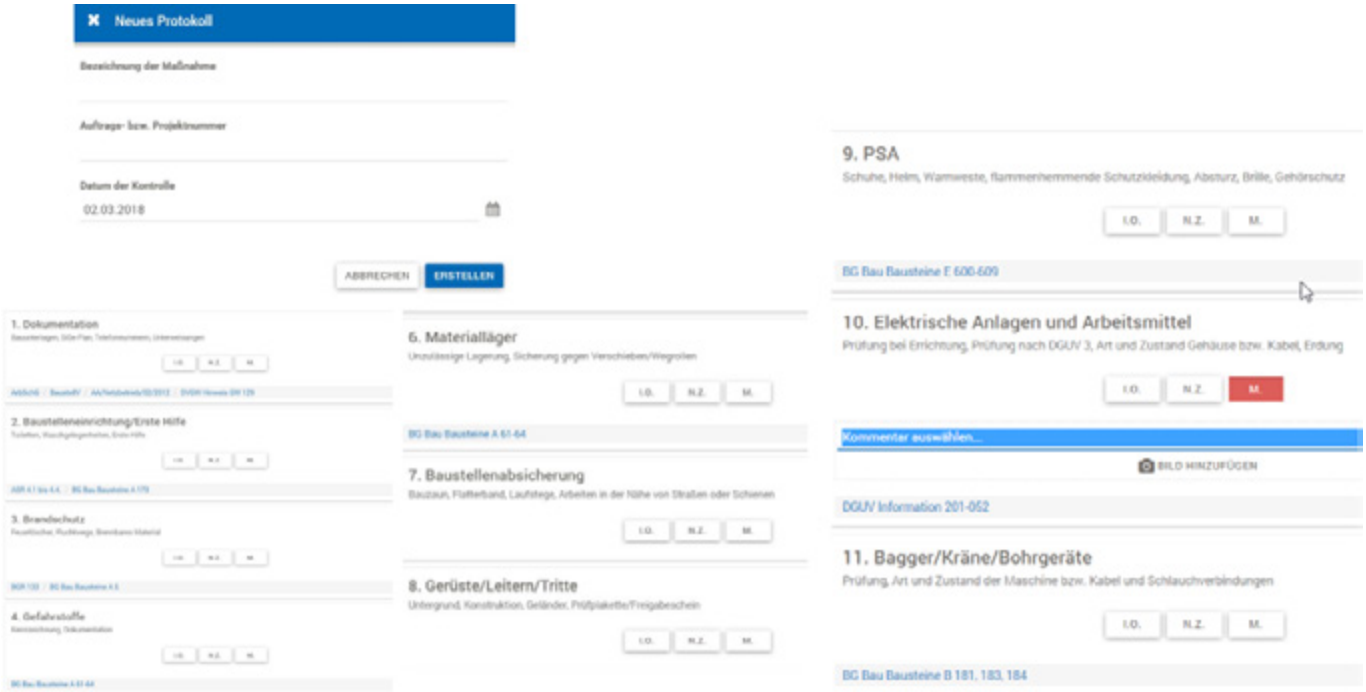

Figure 2: A systematic check list provides easy and quick handling of site checks

board. It enables the user to determine quickly whether the respective vehicle is properly equipped by checking the barrier materials, measuring equipment, emergency lighting, tool kit, plans and documentation, camera and other photography equipment, fire extinguisher and so on.

HOW THE TSM CERTIFICATION PROCESS WORKS

How the process of a typical TSM audit works and how to get the envisaged certificate is explained using the example of ONTRAS TSM certification.

After the company indicates to DVGW its intention to be TSM certified, it receives an examination catalogue with the respective guidelines. On this basis, the company answers an extensive questionnaire for preliminary examination and prepares the requested documents, such as organisational charts, organisation of departments, relevant regulations among others. In the first audit, the DVGW auditors will randomly test the resulting documents during several examination talks and look at specific processes in detail. Afterwards, the auditors will give their first impression and present initial results of their examination. If everything was as expected and all results were positive, DVGW will send the complete examination report along with the coveted TSM certificate that is valid for at least two years. After expiry, it has to be renewed by a new audit that will mainly focus on selected processes. If the result of the first audit is negative, the company may repeat the whole process, taking into account the first audit results and trying to update and optimise the negatively rated processes and documents.

"The systematic approach enables a continuous learning from and improvement of the processes and further education of employees.

Peggy Zeppei

By certifying its TSM system, ONTRAS improved the safety of its employees, its transmission system and facilities whilst also minimising the organisational risks and organisational negligence. Furthermore, interaction with our service providers is much easier and the involved processes are more transparent. The introduced comprehensive site inspection system avoided technical faults and violations of legal as well as internal regulations. For example, in 2017 we inspected about 880 construction sites and registered approx. 80 findings, most of which could be quickly eliminated. Generally, it makes sense and is cheaper to prevent incidents before they occur than to deal with the consequences afterwards.

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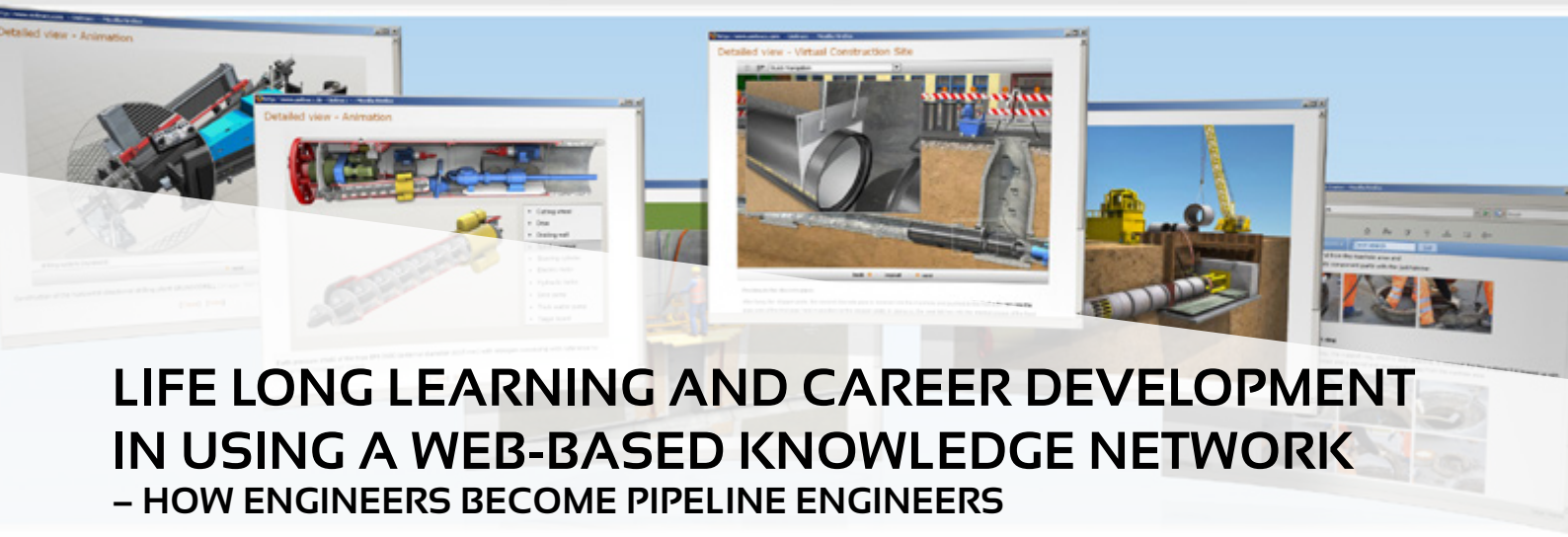


LIFE LONG LEARNING AND CAREER DEVELOPMENT IN USING A WEB-BASED KNOWLEDGE NETWORK
– HOW ENGINEERS BECOME PIPELINE ENGINEERS

Dr. Robert Stein > Prof. Dr.-Ing. Stein & Partner GmbH

ABSTRACT

The paper deals with Life Long Learning (Vocational Education and Training (VET) system) by providing adaptive learning resources for work-based learning in the water industry. The emphasis is on the presentation of concepts, methodology and media examples. The necessity to develop such a concept is directly connected to the huge qualification problem within the international water industry. The expertise required for engineers and technicians for the operation & maintenance and management of urban water supply networks and wastewater disposal networks is not usually taught at universities and educational institutions. Thus the qualification takes place within the enterprises/authorities and with the help of water associations. The quality of the professional further education and thus the career opportunities are limited by the knowledge of the enterprises/authorities or the vocational training offer of the water associations.

Due to the global importance of drinking water, a new education initiative of German Water Industry with partners from the areas of education and research, funded by the German Government, tried to harmonize vocational training by providing a web-based knowledge network for life-long-learning and career development. The challenge of the project was, on the one hand, the heterogeneity of the educational level of the target groups, which includes technicians, engineers and decision-makers, and, on the other hand, the provision of a wide range of specialist knowledge covering the entire life cycle of urban water infrastructures. To this purpose, an innovative didactic concept adapted to the needs of the target groups was used.

Based on the existing experiences, the work processes of the employees should be used for learning to a greater extent and merged in the learning processes.

By using digital media, the non-formally and informally acquired competences of the learners are recorded, documented and related to the requirements of the profession and compiled on the basis of individual qualification demands. In the focus of attention - also with regard to the requirements of the target groups - is ubiquitous learning in everyday professional activity by means of short learning sequences (microlearning) and narrowly delimited contents (microcontent), which complement more extensive learning formats (lessons and modules) and supports them with personal learning process support. Thus, the project combines work-process-oriented digital support and information systems and knowledge tools, such as virtual construction sites, construction site documentation, process manuals, and multimedia textbooks with self-directed online learning (learning steps, lessons, modules) with tutorial support by learning process assistants as well as classical classroom learning. In the end, a work-process-oriented life-long-learning approach for improving demand-oriented knowledge transfer and career development was achieved.

This concept is already integrated in the German Water Industry by organizations like German Association for Water, Wastewater and Waste (DWA), RAL-Gütegemeinschaft Kanalbau and in the United States by the Trenchless Technology Center.

TARGET GROUPS

The entry into the career path (Figure 1) in the field of civil engineering and environmental technology is marked by trainee beginners, who - in Germany - experienced no eduction (6%) or only secondary education (61%). The sector-specific actors (public service/municipal service), service providers (engineering firms, SMEs), industry/trade (construction/refurbishment companies) find it difficult to offer these semi-skilled and unskilled employees high-quality training opportunities. Due to the dependence of learner typologies (care-oriented learners, less-learners, learners, informal learners), different needs of the individual types in terms of content, ways and methods of further education are met.

Figure 2: Integration of competences to be developed into professional, institutional and spatial working contexts

With a web-based knowledge network, the special needs (e.g. flexible scheduling, individual learning control, multiple access paths, and skills acquisition close to the workplace) should be considered by the learner due to the diverse professional contexts (Figure 2). This should enable the sector-typical actors (public service, association, municipality), service providers (engineering firms, SMEs), industry/trade (construction/refurbishment companies, SMEs) - even with limited personnel and financial resources - to offer high-quality training opportunities to untrained and trained employees in the future. Along the career path shown in Figure 1, depending on the learner typologies (care-oriented learners, less-learners, learners, informal learners), different needs of the individual in terms of content, ways, and methods of further education need to be met.

In the following, the 3 main target groups are described:

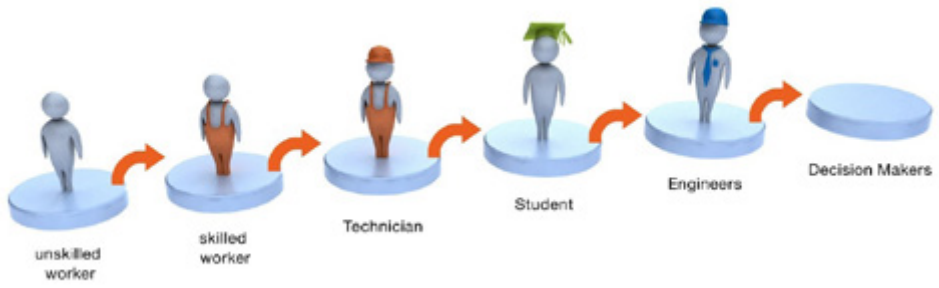


Figure 1: Career path in the water industry

Students

Internationally, there is a broad offer of different courses, related to the issue of water, that mainly focuses on the topics of Urban Water Management, Hydrology and Integrated Water Resource Management (IWRM). The existing study programmes provide a profound knowledge basis, including, inter alia:

- Understanding of the individual processes of the water cycle (Hydrology)
- Quality and quantity aspects of water management
- Basic knowledge in science and technology regarding the processes of water supply, sewage disposal and waste disposal – basic knowledge regarding the planning of installations in the field of urban water management and municipal waste management
- Professional qualification regarding an unassisted dimensioning of sewers, sewer networks and other structures of urban drainage systems

"The expertise required for engineers for the operation, maintenance and management of urban water supply and wastewater disposal networks is not usually taught at educational institutions.

Dr. Robert Stein

Training offers in the field of IWRM are of particular importance.

In recent years, their number increased considerably, especially because of the commitment of the UN in this matter.

IWRM has developed into a commonly accepted guiding concept of water management. It implies a complex integration of managing different resources, sectors, management principles and normative guidelines.

This comprehensive approach is especially important to break down the ever growing competition between rural and urban areas, but also between irrigated agriculture, industry and households. Thus, IWRM shall pave the way for a "fair" and sustainable redistribution of the resource of water between regions, sectors and user groups. While the knowledge acquired in the above-mentioned specialist disciplines is important for the future shaping of a well-functioning water management, its application depends on the practicability of the gained skills and the institutional, economic and political environment of the specific country.

The current students' training in water management is not in line with practical requirements. However comprehensive and excellent the education of students is, there is still a lack of practical skills relating to the management of the already existing infrastructures for supply and disposal of water.

These systems need to be managed more efficiently by optimizing all of their operation, maintenance, rehabilitation, and expansion potential to maximize the reduction of water losses and protection of groundwater.

In addition, students are insufficiently qualified in applying state of the art methods and technologies. Because of the enormous technical developments of recent years, e.g. in the fields of management approaches, trenchless installation and rehabilitation, sewage treatment and environmental technology, the ever more rapidly changing international standards and regulations, as well as the increased amount of measurement, steering and control data and their management, it is almost impossible for students to cope with these challenges.

The broad technical spectrum mentioned above underlines the necessity to include additional learning tools, such as e-lectures, web-based training, and multimedia elements to facilitate the reception of knowledge.

Engineers

However comprehensive and excellent the education of civil engineers is, there is a lack of especially practical skills on how already existing infrastructures for the disposal of wastewater have to be managed with respect to their operation, maintenance, rehabilitation and expansion and how potentials concerning the reduction of groundwater infiltration and protection of groundwater can be exhausted best. Because of the enormous technical developments of recent years, e.g. in the fields of trenchless installation and rehabilitation, sewage treatment and environmental technology, the ever more rapidly changing international standards and regulations, as well as the increased amount of measurement, steering and control data and their management, it is almost impossible for the engineer to cope with the changes without further education.

Given the immense environmentally relevant, social, cultural and economic importance of the water supply and sewage disposal infrastructures, the engineer will increasingly have to consider economic aspects, and he will also have to question the consequences of his decisions when applying his technical know-how. In the process, an important prerequisite of his successful work is the understanding of management aspects in relation to a future-oriented rehabilitation and maintenance of these infrastructures.

The supply and disposal networks represent an essential part of the overall capital of water management facilities and they will have to serve several future generations. For that reason engineers must be able to foresee and react to future needs of the networks, i.e. they have to assess the need for action realistically and control the development of costs and conditions to suit the requirements.

This task is a huge challenge because the pipeline networks for water supply and sewage disposal are not homogeneous systems.

The regional variety of pipe materials, age groups, installation quality etc. b display very different aging patterns and risks of malfunction and downtime. In addition, there are interactions depending on how the systems are operated and maintained. Hence, a network management is required that considers not only the actual state of the networks but also the local aging patterns and the need for rehabilitation in the future. For that reason, engineers must be able to develop targeted rehabilitation strategies that are adjusted to the specific local needs allowing an effective distribution of the investments over long periods of time alongside with the sustainable development of existing assets.

Therefore additional training and further education should be made available for engineers where it is most need - on the job.

Technicians

Staff and technicians employed in the industrial sector are particularly disadvantaged regarding their training situation, because in many countries, there are no such occupational profiles like in Germany as e.g. specialist for water supply engineering, specialist for sewage technology, specialist for sewage services, etc., even though the requirements for these staff positions is increasing continuously. In Europe, less and less staff is employed to operate ever more expensive and ultra-modern systems.

Detailed knowledge of operational processes becomes essential (method technology, environmental technology, energy consumption, resources, product quality, etc.). With the increasing number of stringent international environmental constraints and demands for higher efficiency, the personnel is facing higher expectations to live up to.

The qualification of the group described is realized via equipment and plant manufacturers and mainly focused on the correct and proper handling of both equipment and plants. It is not enough on its own to keep up the high standards and to satisfy the need for competent personnel that carries out their duties in the context of an effective operation and maintenance of water supply and sewage disposal systems.

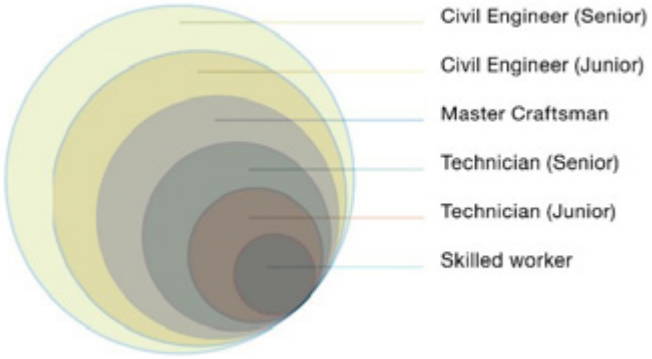


Figure 3: Principe representation of the common subject-theoretical knowledge requirement depending on the level qualification

For that reason, this concept wants to lay the groundwork for a specialist education and training of this target group. The concept is based on high-quality media-didactic training materials and guides for learners.

They are intuitive, self-explanatory and do not require the understanding of additional literature. Essential skills for the construction, operation, maintenance, and rehabilitation of water supply and sewage disposal infrastructures are acquired during the training.

Figure 4: Existing digital learning resources

Figure 1 and Figure 3 illustrate that - regardless of the entry level and the current position in the career path - all participants share a common technical knowledge requirement.

This leads to ever greater intersections with regard to the common knowledge requirement depending on the position in the career path. This common knowledge requirement provides the basis for a comprehensive, methodical vocational training and qualification approach, which addresses all levels of qualification for the sewer and pipeline construction from skilled worker to engineer and thus also supports all job-relevant activity profiles in the course of professional careers.

INNOVATIVE DIDACTIC TRAINING CONCEPT

The innovative didactic training concept envisages providing digital media (learning resources) for work and vocational teaching and learning processes for all the contexts shown in Figure 2. The focus is on the common intersection of knowledge requirements. The learning resources are classified into three functional areas of learning, informing (know-how) and working.

Media type	Quantity
3D-Images	3,152
Pictures/ Fotos	17,463
News and articles	3,752
Tables	1,185
Formulas	503
Animations	261
Videos	150

Table 1: Overview of UNITRACC- Media elements (2017)

The basis for LIFE LONG LEARNING AND CAREER DEVELOPMENT is an evaluated and established Vocational Education and Training (VET) system.

It is based on the already internationally available teaching, learning and working platform "Underground Infrastructure Training and Competence Center" UNITRACC (www.unitracc.com).

For the planning, construction, operation, maintenance and rehabilitation of municipal infrastructures, UNITRACC provides expertise in the form of web-based communication, information, learning and work environments.

In terms of content, didactic and technical aspects, UNITRACC is the leading e-learning platform in the construction sector.

In order to network the learning resources and forms of learning as needed and to adapt them to the functional, individual, methodological competencies for different qualification levels, different support intensities and impulses are needed to ensure an individualization of learning. To achieve this customization of digital learning, the user can access a wide range of learning resources for non-formal and informal learning.

Non-formal learning is strengthened by the granularization of learning content in learning steps and lessons.

A learning step represents the smallest, self-contained learning unit and has a net learning time of a few minutes. Lessons are made up of learning steps and are structured according to a fixed pattern in order to optimally support the orientation of the learners and thus their learning process.

They usually consist of a brief technical introduction to the subject, a practical example that explains the problem and is explicated through multimedia elements.

Lessons conclude with a part of the tutorial in which a knowledge check is made possible via transfer tasks.

Lessons have a net learning time of several hours. Learning units from a few minutes to hours allow a high level of flexibility and a high demand orientation, which support learning in the workplace, whether on the construction site or in the office.

Figure 5: Examples of different media types

"The basis for LIFE LONG LEARNING AND CAREER DEVELOPMENT is an evaluated and established Vocational Education and Training (VET) system. It is based on the already internationally available teaching, learning and working platform "Underground Infrastructure Training and Competence Center" UNITRACC (www.unitracc.com).

Dr. Robert Stein

An even greater flexibility and need-orientation make it possible to search in the area of "KNOW-HOW" due to the versatility of learning resources available there.

Informal learning is ensured through the search capabilities in the diverse digital media, elements and learning resources.

In particular, integration with the construction site/office work contexts (Figure 2) requires the availability of learning resources for mobile learning with smartphones and tablet PCs for non-formal and informal learning.

This variety of non-formal and informal learning alternatives strengthens accessibility to formal learning.

Formal learning is largely represented by a blended learning concept. It is based on the existing curricula (see also section Technicians) of the national and international partners like DWA in Germany and the Trenchless Technology Centre in the USA, which is taught in the form of attendance phases in seminars, instructions, workshops, etc. and complemented by e-learning components in the form of modules in coordination with the partners. Modules are technically superior thematic learning units (Figure 6).

They usually consist of several lessons and require a net learning time of several days.

All together UNITRACC provides more than 120 lessons composed of more than 5,000 pages and numerous exercises and questions.

With the provision of the above-mentioned learning resources and their distribution within a partner network consisting of associations, institutes and academic partners, the knowledge network UNITRACC provides an additional educational component that essentially contributes to a harmonization and distribution of the intended education and training activities.

The opportunity of decentralized learning is a chance for all parties involved to learn in a self-determined and lifelong way as part of daily working routines and deci-

Figure 6: Examples from an E-Module: Top: Introduction page, Middle: Introductory video, Bottom: Content page

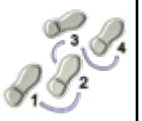
	E-Books and e-Scripts represent expert knowledge based on renowned standard works on technical literature. The content is enhanced by means of animations and 3D-visualisations and clarifying hypertext links.
	Construction site documentations provide a detailed description of representative constructions sites. Here, every detail from task formulation, construction preparation, construction site preparation, rehabilitation preparation, rehabilitation work up to final work and tests is document via hundreds of pictures and process and method descriptions.
	Virtual construction sites illustrate different methods and working sequences and integrate the user into all the things happening at the site. By combining the above-mentioned media types, processes taking place at real sites are virtually recreated. The working sequences can be shown in both general and detailed form (Figure 7). The technical format is HTML5/Flash.
	E-Lessons consists of a number of learnings steps to explain a specific matter. Lessons can include all media types available and have a net learning time of several hours.
	E-Modules are technically superior thematic learning units. They usually consist of several lessons. After each lesson, there is a self-test and at the end of the e-Module, there is a written exam. The learner is supported by a tutor. Each successful learner receives a certificate. An e-Module requires a net learning time of several days.
	Guided Tours are accompanied instructions for different subjects. They serve to introduce new matters and facts to the user or to assist beginners in orienting and navigating in complex hypertexts and subjects.
	E-Exercises: The interactive exercises allow the user to apply and deepen acquired knowledge. The user can check what he has already learned and understood. The exercises are structured in basic modules, knowledge deepening modules and comprehension modules. The answers given result in detailed feedback in the form of solutions, links to reference books and error checking.
	Mobile Learning: Mobile learning is of special importance as a teaching and learning instrument. Learning content and instructions relevant for practical work can be accessed via interfaces on smart phones. Thus, information is available directly at the construction site. That way, the required competence to act and decide can be imparted even for specific problems. It ensures that the gained knowledge is applied immediately.
	An e-Journal provides news and technical articles and adds extra up-to-date knowledge from the water industry.
	A simulation is the imitation of the operation of a real-process or technical system. To achieve this degree of reality, complex, interactive and parametrizable animations are used.
	Self-tests allow for an independent review of the level of knowledge and support the acquisition of knowledge through a guided tour of relevant learning steps.

Table 2: Teaching-, Learning Tools

sion-making. The available knowledge base is already very comprehensive. It includes multimedia-based reference books, site documentations, instructions, scripts, lectures, exercises and knowledge on key and target figures. The most relevant teaching and learning tools are documented in Table 2.

CURRICULUM

As mentioned above, formal learning is represented by a blended learning concept based on curricula of the national and international partners. The circumference of a curriculum is just limited by the number of modules to combine with. The modular structure of the learning resources to tailor-made a curriculum to specific country requirements. Clearly defined educational goals for each teaching unit enable the level of training received and knowledge transferred to be measured.

The qualification "Certified Consultant for Rehabilitation and Management of Wastewater Infrastructures" is based on a curriculum which covers all aspects of operation, maintenance, rehabilitation and management of drain and sewer systems.

In 260 hours, (including exam) knowledge and expertise is provided on key topics such as pipe laying, cleaning, inspection, damages and causes of damages, condition and substance assessment, accident prevention regulations, material science,

structural analysis, repair, renovation and renewal procedures, tendering and construction, development of rehabilitation concepts and rehabilitation strategies as well as asset management.

After successful participation, a certificate is issued based on a final examination. The certificate proves this is a professionally qualified graduate able to understand sewer rehabilitation and management in all its complexity.

The qualification is divided between an online phase and a classroom phase.

The online phase includes 208 hours of preparatory studies. Here, knowledge transfer takes place via online delivery of content and instruction. The participants have 6 month time to pass the online training and have free control over time, place, path or pace.

The advantage: All participants will have the same technical background when the classroom phase starts. This phase includes 3 weeks (120 h) instructor-led classroom training including exercises, excursions plus exam.

SUMMARY

Without proper training and qualification of all parties involved in the life cycle of the water supply and sewage disposal infrastructure, there is a risk that well-known and preventable technical, ecological and economic consequences (loss, damage) might occur after new constructions or rehabilitations. So, all efforts and costs taken now and in the future to construct these systems and improve their condition, would be to no avail.

A sustainable way to secure the extensive investments in infrastructure projects should therefore also consider training and education measures as an integral part both in the run-up to starting a professional career and on the job. Because of the high degree of specialized, practical engineering knowledge, the educational opportunities required for this purpose are currently not available. This applies in particular to the availability of digital, multimedia-based and interactive learning material.

The introduced web-based knowledge network bridges the gap to practice and integrates all parties involved in the life cycle of water supply and sewage disposal infrastructures in one qualification process. This approach is not competing with already existing educational alternatives, but it is rather a sensible supplement to them. That is because it enables life long learning and career development by a combination of self-directed online learning, work process-integrated qualification and classical classroom learning, thus interlinking learning processes and work processes.

While learners with a high level of self-learning competence independently use the system, caregiving by the instructor is used by care-oriented learners. The media didactic qualification of the trainers takes place by means of a train-the-trainer approach.

This enables them to design teaching/learning scenarios independently and to include them in the educational products to be developed.

The adaptability of this concepts leads to an easy implementation of this concept into the US Market.

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Figure 1: EDP group working in the shop

ENGINEERING DEVELOPMENT PREPARES THE NEXT GENERATION OF PIPELINE PROFESSIONALS

Eric Freeman > T.D. Williamson

ABSTRACT

The transfer of business-critical knowledge from key technical staff to the next generation workforce is of significant concern to the energy pipeline industry. For T.D. Williamson (TDW), the issue is nothing new. As a global pipeline solutions provider with a history reaching back nearly a century, the company implements formal knowledge transfer processes as part of talent development. One way is through its Engineering Development Program (EDP) for selected entry-level engineers, which begins at its Tulsa, Oklahoma, headquarters.

The EDP has enabled a diverse group of talented young professionals across the company's international footprint to complete rotations in more than a dozen key areas of the business. Over the course of 12 to 24 months, EDP engineers assume a variety of technical, operational and hands-on manufacturing and service roles. Tenured business and technical leaders provide meaningful mentoring and professional guidance, as well as rich knowledge transfer. Visiting TDW core technology centers across the world promotes strong, lasting connections with subject matter experts as well as insight into the company's full local technical, manufacturing and services capabilities.

Graduates of the Engineering Development Program have grown in their value and contributions to the organization – and have realized advancement opportunities – significantly quicker than typical entry-level engineers.

This article will highlight details of the program, benefits to the company and the industry and lessons learned.

INTRODUCTION

During nearly a century providing technological solutions to pipeline operators, T.D. Williamson (TDW) has witnessed more than a few industry crew changes, where oil and gas professionals retire en masse and are replaced by new talent. Of course, nothing in the past has come close in magnitude to the pending exodus of baby boomer engineers and other professionals. It's been estimated that about a third of the current workforce is 55 or older (1), which means there's less than a decade to find a vast number of replacements.

Of course, the departure of the most senior members of the industry is made all the more difficult by what is essentially a lost generation of industry professionals – people now in their late 30s and 40s who were discouraged by the lack of jobs in oil and gas in the 1980s and entered other fields, instead. Between the loss of experienced leaders and the absence of middle-aged middle managers, the hiring gap can seem more like an abyss.

To prevent any possible void in our own engineering ranks and maintain our position of leadership and trust among customers, TDW in 2011 launched an Engineering Development Program (EDP) for high-potential new college graduates.

The EDP doesn't replace direct hiring. It is not an internship or stepping-stone to a job: participants selected for the program are brought on as full employees from day one, with an identified role they'll fill at TDW when they graduate from the program.

Instead, the EDP prepares a small cohort of young engineers to develop their talents and become more effective in their prospective roles. They learn from senior leadership, from high-level managers and field technicians, mentors and one another. They have the opportunity to solve problems within the company and for customers. And they are encouraged to advance and share their knowledge as they continue to grow into industry subject matter experts.

Our estimates suggest that in the 18 months it takes to complete the EDP, the engineer has accumulated the equivalent of three years of experience.

FROM A SINGLE FOCUS TO A COMPREHENSIVE PROGRAM

What is now known as the EDP began as a pilot program by the Houston, Texas, and Stavanger, Norway, Offshore Technology groups in 2009.

It was designed to advance engineering for the SmartPlug® isolation system. Four engineers were in the original training and development group.

> *"To maintain our position of leadership and trust among customers, TDW launched an Engineering Development Program (EDP) in 2011 for high-potential new college graduates.*
>
> *Eric Freeman*

After a two-year trial, the Human Resources Talent Development group formalized the EDP program in 2011. A steering committee of engineering managers representing the company's four main areas of technology – pigging, hot tapping and plugging (HT&P), pipeline integrity and offshore applications, including SmartPlug – co-directed the program in its earliest days. Now, it's led by a seasoned engineering manager under the direction of the vice president of Engineering and senior director of Engineering Systems and Governance. In true "it takes a village" nature, members of the Engineering Directors Council representing each technology or business line, hiring managers, and other operations and human resource professionals influence everything from recruiting and onboarding to coaching and mentoring.

Since the EDP began, 30 young engineers have completed the rigorous program. Most are still working for TDW and have been promoted rapidly to positions of increased responsibility. Some remain deeply involved in advancing technology, while others are moving into engineering and other leadership positions. This is consistent with, and enhances, our philosophy of developing and promoting technical and operational leadership primarily from within our company.

FOUR PHASES PREPARE FOR TARGET ROLES

The EDP is designed to help early career engineers gain a deep and thorough understanding of TDW technologies, insight and experience in nearly every area of the company, and accelerated development in technical and business leadership. They also learn to live the three I's that constitute our core values

– **Integrity**, **Interdependence**, and **Initiative**.

The program is divided into four phases – orientation, site visits, technical rotations and what we call "finishing," or final preparation for working in the target role for which each engineer was hired.

Orientation

During the first several weeks of the EDP, orientation introduces participants to TDW culture and history and exposes them to the wide variety of business practices, technologies and core skills required to achieve optimal

effectiveness as engineers in a variety of roles. There's time to improve interpersonal skills, work on professional development, delve deeper into TDW technologies, and meet and learn from senior leaders.

Orientation begins in Tulsa, where all participants – even those who live in the city and were recruited from area colleges and universities – stay in the same hotel and travel to meetings and events together. Spending so much time in each other's company is a precursor to building effective, collaborative working relationships. Classmates establish rapport and create lasting bonds: our earliest EDP graduates have been working in their target roles for more than five years, yet they remain well-connected to one another. Not only do these relationships facilitate problem-solving and teamwork, they improve retention.

Site visits and core technical rotations

With group ties firmly in place, EDP participants next strike out on their own individual rotation plans, visiting a variety of business units, including their target technology workgroup. During their site visits and working rotations, which last anywhere from a few days to several months, the young engineers meet key personnel and begin developing a solid working knowledge of TDW technology and business processes, including:

- Technology development
- Manufacturing and supply chain
- Engineered to order and sustaining engineering
- Applications engineering
- Various product and service delivery value stream groups

Part of the time is dedicated to shadowing team members and gaining hands-on experience at the company's major technology centers and manufacturing and operations facilities in the United States and internationally. In fact, willingness to travel extensively is among the EDP requirements, as well as one of its perks. For some participants, the chance to relocate long-term to another country – or to return to their native home – is part of the program's attraction. That is how we were able to identify a young engineer in Scotland, whom we targeted to a role in our Nivelles, Belgium, office, and to recruit an Indian national studying in Tulsa, who returned home as an engineer at our Savli, India, facility.

For Irina Konovalova, who was in the 2014-2015 EDP class, the program took her more than 10,000 miles around the world, from the college town of Arkhangelsk, Russia, to our facilities in Tulsa, Oklahoma, then back to Europe, where she completed core technical rotations in Research & Development and in Sustainable Engineering in Stavanger. Now, she makes the Norwegian city her home, where she works as a Project Engineer.

> *"Our estimates suggest that in the 18 months it takes to complete the EDP, the engineer has accumulated the equivalent of three years of experience.* Eric Freeman

The core rotations represent high-value opportunities for the EDP engineer to become more effective and make meaningful contributions in his or her target technical group. As an example, if the engineer has been hired to work in the technical development group for in-line inspection (ILI), the rotation will include observing service technicians in the field and helping them execute jobs. But that's not all. The rotations might also include building tools on the shop floor, working on data analysis after field runs, developing software tools and participating in the commercial side of the business. Upon completion of the rotation phase, the engineer is prepared to enter the target workgroup with a much broader perspective and meaningful connections with team members in other areas. As Konovalova, who completed a month-long rotation with the pigging group in Tulsa, pointed out, networking has considerable benefits aside from hearing a friendly voice at the other end of the phone.

Figure 2: Irina Konovalova Offshore Platform

Figure 3: EDP Group Millcreek Canyon team activity

"I think the most important thing I gained from that month is the network," she said. "Now, whenever I have a pigging question during my work as a project engineer, I know who to ask and always get a good response. I think that would be impossible without having had a personal presence in the Tulsa department."

The finishing phase. During the last four to six months of the EDP, the program focuses on fine-tuning the engineer for the target role within TDW, including optimizing individual strengths relative to business needs. This is the final preparation for the real world. And in some instances, entering the real world is like being thrown into the fire.

That was the case for P.J. Robinson, who graduated from the EDP in 2014 and is now a Field Support Engineer.

Robinson, who had also interned at TDW during college, was targeted to pigging services and joined the department right after the supervisor left. That meant he had to immediately begin providing field services to customers. Fortunately, his experience with the EDP allowed him to easily identify the team members who could provide the technical support he needed – enabling him to assemble solutions much faster and more effectively than he might have without his EDP training.

"All the training really opens your eyes to how every group operates," he said. "We gained knowledge on how we might be able to coordinate with other areas of the business when trying to provide the best solution to the customer. Often, things you did in one group would carry over to other groups. Spending time in the shop or in the field helped you to understand better ways to engineer a product or a service."

Aside from helping him get off to a running start, Robinson said the multi-faceted program altered the way he thinks about challenges.

"As an engineer, you are taught to solve problems and develop tools to solve those problems, however you do not learn much about cross-communication," he added. "You very rarely get to spend time doing hands-on activities, seeing things in a real life scenario. EDP really changed the way I approach every problem."

RECRUITING STRONG, TALENTED CANDIDATES

Like Robinson, some of the EDP engineers were TDW interns. Others were recruited from colleges and universities as far away as Russia and as close as our company's backyard.

What they all have in common is that they exhibit the potential to become recognized industry experts or solutions-oriented technical leaders.

Winnowing out the best candidates is a grueling process. Or at least that's how Irina Konovalova remembered it, especially considering that she was one of 100 Russian engineering students vying for two EDP positions. Her first five interviews were by phone, with a recruiter, the Human Resources and Operations managers from the TDW office in Moscow and, finally, with two technology directors for hot tapping and plugging (HT&P) and the SmartPlug system. For the last stage of the interview process, the field had been whittled to six successful applicants, who were brought together at the Moscow office for an assessment by a third-party evaluator. Finally, each candidate met with a Talent Management Director.

"Even after almost five years, I remember each and every step I went through, since that was so important for me," Konovalova said. "The last stage was the most memorable for me, however. That was an assessment of our social skills more than any technical background. I had to become a recruitment agency leader for a while and persuade a picky potential client to choose us. Another task was to imagine I am a new executive of a company with quite a few problems, and in 30 minutes go through some hundreds of pages of reports and information about the company's latest affairs and present my vision of the future steps to take to solve those problems. I also had to become a manager and dive into some interpersonal conflict between my employees and help them solve the issues."

"I had been through similar type interviews before, but never on that scale," she added. "That just showed me the highly critical process TDW uses to choose their employees."

Although being a recent engineering graduate is mandatory, not all EDP participants are 21 or 22 years old. Some are like Brent Whipple, EDP class of 2016, who had a 10-year career in the home security business before returning to school for his engineering degree. His life experience proved to be a significant benefit during and since completing the EDP: he has already been promoted twice and is now manager of Manufacturing Engineering. He also continues to be active in the EDP; with one of our incoming EDP engineers reporting to Whipple, it will be the first time a second generation EDP participant has managed a new class member – but probably not the last.

New classes generally begin in June but have also coincided with December graduations. However, the hiring process for each cohort begins a year in advance. That's when engineering managers and directors across TDW have a chance to request an EDP engineer. Locating qualified candidates takes us to college recruiting fairs where we can meet a large number of diverse individuals. Our target hiring managers cast a broad net, then screen precisely for the jobs we need to fill. Altogether, it may be two and a half years between the time we identify the need for an EDP engineer for a specific work group and the time that person is on the job after their rotations. That means we need to always be thinking about the future and filling our "pipeline" with strong prospective technical contributors and leaders.

Although campus events have been the backbone of our recruiting efforts since 2011, we're gradually shifting our focus to become less dependent on them. Instead, we're looking to expand our internship program and move more interns into the EDP. The reason is simple: our interns understand us and our culture, and we know them and their strengths. That further ensures the quality and commitment of EDP participants.

MENTORING HELPS BUILD THE KNOWLEDGE BASE

It's well-known that mentoring promotes a better-trained, more engaged workforce and the EDP is no exception. While mentors have been instrumental in the program from the start, we are modifying our approach there, too. Previously, mentors were rotation-specific; that is, one mentor guided the EDP in a particular area while another mentor helped in the next. While that format will continue going forward, we're also enhancing our coaching efforts by assigning a dedicated mentor to each EDP participant for the duration of their program. The pair will meet regularly to discuss challenges and opportunities, and the mentor will have a chance to share knowledge and experience in an informal setting.

Figure 4: EDP Class group photo

Senior Engineering Manager Todd Mendenhall has been an EDP mentor for about five years. Among other responsibilities, he creates the rotations through different departments and disciplines within the ILI technology division, assigning engineering-specific projects involving design development. His overarching goal, he said, is to create experiences that will benefit the engineers as they transition into full-time positions. That includes making presentations about completed projects at engineering staff and team meetings – content that is captured and becomes part of the TDW knowledge base.

Woody Smith, Senior Manager, New Product Development, began mentoring EDP members nearly four years ago. He often asks his mentees to teach him what they've

learned. That can open the door to a very specific and valuable discussion about technical topics related both to TDW and the industry.

"We both individually prepare a mind map or other presentation format," Smith explained. "Then we get together and discuss and compare the critical information that should have been absorbed and organized from the material. If there is a presentation deliverable, we schedule a kickoff meeting, progress meetings and final review before they present their material to a larger audience."

Mendenhall and Smith said that as much as they enjoy sharing information with younger engineers, they've benefited from the mentoring relationships as well. For Mendenhall, mentoring has provided insight into what motivates engineers coming out of college, and has helped him tailor the onboarding and training experience for the existing engineering group and new direct hires. Smith said he feels encouraged when he connects with young engineers who are really committed to developing themselves, and appreciate and value the knowledge he shares.

Knowing that some of those strong engineers wouldn't have been interested in the oil and gas industry without a program like the EDP is a point of pride for both.

CREATING BETTER SOLUTIONS, FASTER

So, what have talented, high-performing engineers accomplished following their EDP experience? As full-time employees in departments ranging from project management and integrity services engineering to product management and sales, they have strengthened TDW as a whole. For example, while he was still in the EDP, one engineer solved an inventory management problem that saved the company hundreds of thousands of dollars. In another cohort, several EDP engineers worked together to create software tools that can automate decision making, while others contributed significantly to hyperelastic simulations and electronic connector solutions. Although some of these might not be classical engineering issues, they demonstrate how applying engineering methodologies can create solutions faster and more efficiently.

The graduates are having a similar impact on the industry as a whole. That includes advancing quickly toward subject matter expertise in a specific area of competitive technology and becoming thought leaders sharing information of industry-wide value at conferences and trade shows.

How did the EDP experience prepare Konovalova for life as a working engineer? For one thing, it gave her a head start in her own department and greater appreciation for the synergies between groups.

As the changes related to interns and mentoring suggest, the EDP isn't static; we're continually improving it. For example, when we started, rotations were shorter, which allowed for exposure to a greater number of different business areas. However, we discovered that the participants weren't getting enough time to really delve into a project or develop an in-depth understanding about the department. Now, we tend to have fewer, longer rotations so they can both learn and contribute more. Future plans include opening EDP professional development and technology training sessions to mid-career engineers and others within the organization.

CONCLUSION

We are currently gearing up for our next EDP cohort, which will start in a few months. Four young engineers are currently slated to participate, and they will complete the program at the end of 2019, ready to solve problems, build connections, take on leadership roles and, perhaps most importantly, help fill the void left by retiring baby boomers.

And one day, they'll become mentors themselves, training the next generation of engineers and passing on their knowledge and experiences.

The program continues to evolve as industry needs change and new challenges arise, but one thing we can say is that, so far, it has been a win-win for everyone involved. Not only does the EDP help us avert the potential shortage of talent brought about by The Great Crew Change, it also ensures that the new generation feels confident, capable, and ready for anything.

"I came into my department already knowing what the tools are, how they work, how to assemble them, how the purchasing and commercial departments work," said Konovalova. "In my opinion it is essential to understand the other departments work flow and their issues and needs. As an EDP I was well prepared for that."

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Young Pipeline Professionals Europe

GETTING THE NEW GENERATION TO CHOOSE FOR PIPELINES – AND KEEP THEM!

Cindy Dirkx > IRM Systems / Young Pipeline Professionals Europe

INTRODUCTION

Knowledge transfer from senior to junior pipeline specialists and attracting young pipeliners to our industry is a topic on the agenda of many Pipeline Events. The few events that the writer of this article has attended have at least addressed these challenges.

During one of the venues, a participant stated that his company could not attract some of the high potentials, because they simply did not want to work in the fossil industry. They explicitly chose to apply their knowledge and skills in the renewable industry.

Another participant of a discussion panel did a round in his own family and found out that none of the 15-20 youngsters chose a technical education. They want to do something "nice "- like marketing, leisure sciences and international relationships.

And in a recent venue with 50 young Dutch Pipeliners, the question was asked who of the participants explicitly chose for the pipeline industry. Two hands were raised. The same amount as at a session at the PTC in Berlin in 2018, where approximately 30 persons were present.

How come that the Pipeline Industry is considered not to be 'nice'? What is the new generation (Y and Z) looking for and how can we attract them to our industry? Should we be capable of turning the current energy transition into one of our strengths and what could we do to make ourselves better known?

This article will provide a (non-exhaustive) overview of the challenges that the Pipeline Industry might be facing and includes suggestions on how to deal with these challenges. A Cross-border approach for attracting youngsters to our industry will be beneficial to the pipeline industry, which is supported by the recently established Young Pipeline Professionals Europe.

> ***"We need to convince young people that a technical career in this industry is both stimulating and worthwhile –meeting challenges that matter to the world***
>
> *CEO, Shell*

> ***"There has never been a time when our industry so needs outstanding talent. Older professionals will need to be replaced in a few years. At the same time, we have seen a drop in students taking science-based programs in the United States***
>
> *CEO, Exxon Mobil.*

CHALLENGES OF THE PIPELINE INDUSTRY

The work that changes

The focus of the pipeline construction industry has for a long time been on the long-distance transportation networks, requiring the pipeline industry to focus on these skills. The ageing of many of these assets requires a different skillset which is not based on the 'greenfield' engineering, but which is more integrity based. This includes the (often challenging) activities of gathering information about the operational phase of a pipeline, judging the data and define how this asset can be used as long as possible without causing any safety-risks for the surroundings.

Next to this, the current development towards reduction of fossil fuels requires different skills from the pipeline industry. The expectation is that the challenge of our industry will be to guarantee the sustainability of our Assets e.g. how can we use the existing assets as long as possible and which alternatives do we see for the future use of pipelines?

Research on transportation of hydrogen through pipelines currently transporting natural gas is ongoing, and the first results show that this change of medium should be technically feasible. This would open the road for the energy transition from fossil energy towards hydrogen, produced in hydrogen-installations processing green wind energy into oxygen and hydrogen.

Another transformation in the use of pipelines can be found in the distribution of waste heat from industrial installations to other users (such as green houses), transportation of CO2 or any other medium that might be suitable for pipeline transportation. This requires an 'out of the box' mentality of our industry.

Activities for which young, ambitious and intelligent people should be attracted.

The professionals change

Whereas the Baby Boomers were loyal to the company, used to working long hours and valued loyalty and benefits such as pensions and company cars, the generation X is already looking for a different work-life balance and the generation Y is looking for happiness, balance and opportunities.

> ***"Members of Gen Y – those born between 1984 -2004 – are blessed with entrepreneurial spirits, can rapidly adapt to changing business environments and are great at bringing new ideas and ways of getting things done to the table. But whether or not you like their free-thinking ways, your business isn't going to be able to survive without them.***
>
> *Chad Halvorson - Whenlwork.com – Understanding Gen Y's workplace expectations*

Generation Y sees a job not just as a means to pay the rent, rather a route to exploring their passions, hobbies and philosophies.

To attract and keep this generation within our industry, we will need to adapt to this changing philosophy and provide the new generation the opportunities and responsibilities that they are looking for.

PIPELINE SPECIFIC EDUCATION

Development of pipeline knowledge in the Netherlands

In 1959 the gas from the Groningen Gas field in the Netherlands was discovered, which turned out to be one of the biggest onshore gas fields in Europe.

This discovery was followed by heavy pipeline construction activities in the next decades and the first pipeline technical specifications were developed in the early 1970's. These further evolved into the NEN3650 - a technical standard that defines all requirements for pipeline systems in the Netherlands, first published in 1992 and still valid today.

> ***"To attract and keep the new generation within our industry, we will need to provide them the opportunities and responsibilities that they are looking for.***
>
> *Cindy Dirkx*

The young engineers that were involved in the engineering and construction activities in that time, have almost all retired.

A number of them recognized the fact that they should find a way to transfer this knowledge to the new generation Pipeliners – which ultimately led to the establishment of an accredited education for Master of Pipeline Technology MSc in 2003 – an education that is supported by the Dutch pipeline industry and which still exists.

Next to a more Practical Pipeliner Education that will start its first trimester in Q2 2018, this is the only pipeline specific education available in the Netherlands.

Other Pipeline Educations in Europe

The path that has been followed for the Netherlands, can be considered representative for more countries. It is therefore relevant to know which other pipeline specific educations are available throughout Europe.

An internet research shows the following specific Pipeline educations available in Europe and Russia.

Figure 1: BIG youth event

Figure 2: YPPE at PTC 2018

- UK: Newcastle University - Pipeline Engineering MSc, PGDip, PGCert
- UK: University of Strathclyde, Glasgow - Subsea & Pipeline Engineering MSc/PgDip
- UK: Northumbria University, Newcastle - Pipeline Integrity Management - MSc/PGDip/PGCert
- UK: Cranfield University, Offshore and Ocean Technology with Pipeline Engineering MSc.
- NL: Avans + Hogeschool, Breda – Master of Pipeline Technology, MSc
- GE: Oldenbrug University of Applied Science (Fachhochschule) – Rohrleitungsinstitut.
- Norway - University of Stavanger – Master level course Pipelines and Risers
- Russia – Gubkin University – Faculty of Design, Construction and Exploitation of Pipeline Transport Systems.

There is a large number of Master educations, quite closely related to the pipeline industry (such as Oil & Gas/ Petrochemical/ Offshore/ Subsea), which might include some pipeline related topics, however the pipeline specific educations, majors or minors can be considered scarce.

> *A Cross-border approach for attracting youngsters to our industry will be beneficial to the pipeline industry*
>
> *Cindy Dirkx*

Improvement steps

The interest of young professionals for the pipeline industry can be improved by increasing the visibility during the education. By initiating pipeline dedicated majors or minors at Universities, students are introduced to the pipeline industry and might make a conscious choice to look for a job in our industry.

It shall be relevant to adjust the contents of the education to the changing circumstances in the pipeline industry (ref Chapter 2), the role pipelines can play in the energy transition and the social impact this might have.

A second step could also be to expand the focus for education one layer deeper and start including pipeline and / or energy education in colleges.

YOUNG PIPELINER ASSOCIATIONS

The establishment of a platform where young Pipeliners can get in touch with other Young Pipeliners, exchange information, learn from each other or learn from seniors, might be a contribution to the consistency, familiarization and retention of young professionals in the pipeline industry.

Existing platforms

There is a number of Young Pipeline Associations already active, which are listed in the next paragraphs.

YPAC – Young Pipeliners Association Canada

According to their website, they have the following goals:

Facilitate passing technical/engineering knowledge from mature to young pipeliners, and, as a result, build a positive future for Canada's pipeline industry.

Provide opportunities for young individuals to learn the breadth and depth of the industry.

Be a Canada-wide network of pipeline professionals focused on attracting and retaining young people to this industry

"The energy transition requires an 'out of the box' mentality of our industry – a mind-set for which young, ambitious and intelligent people should be attracted. Cindy Dirkx

YPF – Young Pipeliners Forum Australia

According to their website, they have the following goals:

Aims of the YPF to provide information to younger people about the tremendous opportunities and the variety of interesting careers available in the pipeline industry.

To build relationships with and between younger APGA members and experienced APGA members.

To assist in enhancing the career development of younger people, thus helping to address the industry's skills shortage.

To encourage information-sharing and to provide a gateway for the transfer of knowledge to and from the more experienced members.

To provide a conduit for young members' ideas to help shape an even better future for the pipeline industry and its participants.

YPP – Young Pipeline Professionals USA / Brazil/ Argentina/ Mexico

According to the YPP USA - website, they have the following goals:

To prepare ourselves to accept the transfer of the duty of care for the pipeline industry:

Educate young professionals about the pipeline industry

Create leadership opportunities for the next generation of pipeline professionals within YPP and other industry organizations

Foster relationships and build a network for the advancement of the industry

YPI - Young Pipeliners International

YPI is an umbrella organization that links all of the YPP organizations around the world (ref previous paragraphs). They don't have events per say - when there is an international conference such as IPC, the Young Pipeliner initiatives will all organize under the YPI banner instead of the individual YPP organizations, as a way to pool resources. YPI have periodic conference calls to discuss challenges, accomplishments, and lessons learned.

Figure 3: BIG Youth event nov 2017

Initiatives in Europe

Next to a YPP initiative that was already established in France, the Young Pipeline Professionals Europe (YPPE) was founded in Q1 2018, which will be further treated in the next chapter.

YOUNG PIPELINE PROFESSIONALS EUROPE (YPPE)

YPP Europe is a group of highly motivated young professionals working within the pipeline industry with the aim of knowledge sharing to ensure the longevity of the industry, address the industry's skill shortage, and foster relationships. YPP Europe was founded in 2018 to connect both new and experienced professionals working

> *Pipeline specific educations on the market can be considered scarce.* Cindy Dirkx

within the pipeline industry across the continent.

YPPE is currently a group of approximately 50 young pipeline professionals with a vested interest in advancing the pipeline industry to a safe and sustainable future.

They aim to grow this number through educational, social and networking events, while connecting young professionals with pipeline experts throughout Europe.

Representatives of the YPPE have successfully attended a number of seminars in Germany, UK and the Netherlands. Responses from visitors are positive and currently approximately 50 members from several countries all over Europe (Netherlands UK, Germany, France, Italy, Lithuania, Poland and Ukraine) have signed up.

The initiative is supported by other YPP organizations, several recognized companies and senior leaders in the industry.

A welcome package for all new members is currently under development the first YPPE event will be organized in Q2/Q3 2018. Next to the European platform, national platforms will gradually be established to organize activities on a regional / national level.

YPPE has close contact with the other Young Pipeline Platforms who have offered their support and cooperation.

The following activities will be addressed by YPPE:

- Knowledge sharing and capturing through technical conferences and paper contests
- Networking amongst the members and outside of the members
- Social events
- Involve companies in actively offering traineeships / internships / investigations etc.
- Contact with Universities to include pipelines in technical studies
- Stimulate innovation and look for Governmental (European) subsidies/ involvement
- Etc ….

The Added Value for the participants will be their Exposure and Leadership Development.

Want to join or support?
YPPE is still expanding and all support is welcome:

- Are you under 35 and looking for an opportunity to expand your knowledge and network => JOIN US! You can become a member and/ or you can become a part of the organizing committee.
- Are you over 35 and looking for an opportunity to share your knowledge, support youngsters and/ or help the organisation => SUPPORT US! You can become a speaker in one of our venues, mentor to our members or jury in a future paper contest we might have.
- Do you have some left overs in your budget and are you looking for a way to close you balance => SPONSOR US! You can stimulate the YPPE initiative by offering locations for venues and excursions, provide budget for education and seminars, making prices available for contests etc - any contribution is welcome!

The YPPE can be contacted per e-mail through contact@yppeurope.org. Our website will be launched shortly (yppeurope.org) and for the time being you can join the LInkedin Group 'Young Pipeline Professionals Europe'.

Authors

Cindy Dirkx

IRM Systems; Young Pipeline Professionals Europe

Operations Manager; Founder and Chairwoman

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14TH PIPELINE TECHNOLOGY CONFERENCE

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EVENT REVIEW

657 DELEGATES | **73** EXHIBITORS | **54** DIFFERENT NATIONS

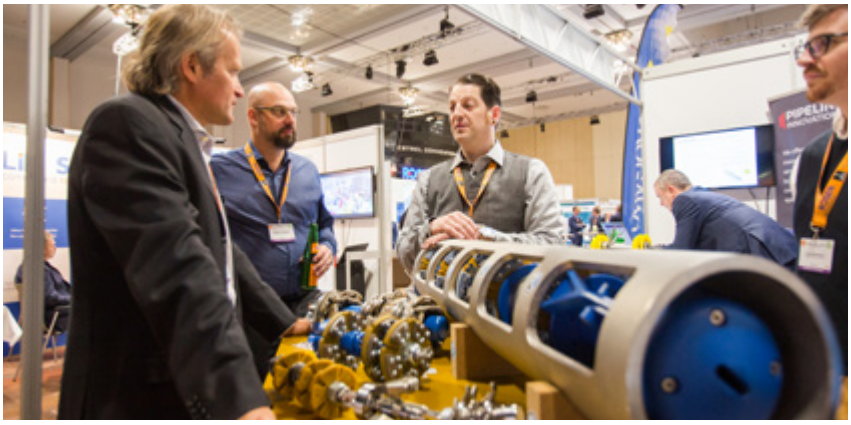
With 657 delegates from 54 different nations including staff and management of 69 international pipeline operators, 73 exhibitors and 100 technical presentations the 13th Pipeline Technology Conference (12-14 March, Berlin) has been a pivotal event for the global pipeline community.

The purpose of the Pipeline Technology Conference (ptc) is to gather pipeline operators as well as technology and service providers from all around the word in order to exchange state-of-the-art pipeline technology and best practice solutions. Therefore the conference addressed in its technical sessions and the Panel Discussions the major challenges faced by the pipeline community today. A wide range of recent and future "safety" aspects were presented by experts from international key players form the oil and gas pipeline industry.

A technical exhibition accompanied the conference offering the opportunity for pipeline companies to presented themselfes to an attrictive audience. Followed by a poster show, post conference workshops and social programs the delegates took advantage of the sheer wealth of experience available to them and thus gaining a comprehensive understanding of key industry issues and new solutions.

The unique Panel Discussions on "Pipeline Safety" and "Public Perception" focused on questions surrounding the future of pipelines regarding their publicly perceived security level and their actual one.

All abstracts and papers of the conference are published on the ptc wwebsite and are now publically accesable from all over the world. For more information visit www.pipeline-conference.com.



69 Pipeline Operators

22 thematic focuses at ptc 2018

- Pipeline Safety
- Public Perception
- Inline Inspection
- Challenging Pipelines
- Integrity Management
- Cyber Security
- Operational Improvements
- Environmental Impact
- Offshore (Materials&Design)
- Offshore (Inspection)
- Materials
- Fiber Optic Sensing
- Leak Detection
- Monitoring/Internet of Things
- Maintenance & Repair
- Trenchless Technologies
- Construction
- Planning & Design
- Asset Management
- Supply Networks
- Valves & Fittings
- Management & Qualification

Details about the conference program can be found here:

ptc

13TH PIPELINE TECHNOLOGY CONFERENCE & EXHBITION

EUROPE'S BIGGEST PIPELINE EVENT

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After starting as a small side event of the huge HANNOVER MESSE trade show in 2006 in Hannover, the Pipeline Technology Conference developed into Europe's largest pipeline conference and exhibition. Since 2012 the EITEP Institute organizes the ptc on its own and moved the event to Berlin in 2014.

PIPELINE SAFETY DISCUSSION ptc 2018

ptc 2018 offered two top-class pipeline panel discussions generating insights into current and future pipeline challenges worldwide: "Pipeline Safety" and "Public Perception"

PRESENTED IN THE NEXT ISSUE OF PTJ

"Pipeline Safety"

The technical safety of pipelines will always be a top priority of the ptc panel discussions due to its highly important nature for safe and economic pipeline operations.

THE PANEL

Heinz Watzka
Senior Advisor
EITEP Institute

Gerald Linke
Chairman
DVGW

Olugbenga Adebayo
Head Pipe- and Flowlines
Shell Nigeria

Tobias Walk
Head Pipeline Systems
ILF

Editorial Board Inauguration Meeting

Minutes

First Meeting of the ptj and ptj-newsletter Editorial Board
12 March 2018, 11:00
Berlin, Germany

Participants:

- Dr. Klaus Ritter, EITEP Institute (President)
- Dr. Michael Beller, ROSEN Europe (Director Global Market Strategy)
- Asle Venas, DNV GL (Senior Principle Pipeline Specialist)
- Belkacem Bechka, Freelance Pipeline Consultant
- Michael Schad, DENSO (Director Sales Pipelines International)
- Rana Alnasir-Boulos, EITEP Institute (Director Marketing)
- Admir Celovic, EITEP Institute (Director Publications)

Not present:

- Tobias Walk, ILF (Business Area Manager Projects Pipeline Systems)
- Mark Iden, SkyData Air & Space (Chief Executive Officer)
- Mahmoud Abdel Hakim, ADNOC Offshore (Pipeline Engineering Team Leader)

Dr. Klaus Ritter welcomed the attendees and asked for a short introduction of each participant.

Dr. Ritter thanked all experts who agreed to be members of the Editorial Board, (EdBo) ptj and ptj Newsletter to provide professional advice and support. In particular, he thanked Dr. Beller for his willingness to lead the EdBo. He will be supported by Ms Alnasir Boulos and Mr Admir Celovic from the EITEP office.

The aim and task of EdBo should be to achieve the following:

- to ensure the quality of the content of the ptj and
- to increase the topicality of the ptj newsletter.

The following activities performed by the board members were highlighted in the discussion:

- Providing up-to-date authentic pipeline-related-information from various regions
- Using available contacts to give ptj access to interesting papers and first-hand industry news and PR-Reports
- Using available knowledge about the industry to support the editorial calendar of ptj, (e.g. to identify topics of interest to the industry or to open new subject areas
- Reviewing submitted contributions (papers, comments, news)
- The committee members shall occasionally contribute essays or write editorials for ptj
- Generating comments and statements to be published in the ptj newsletter
- Using available networks to increase the proliferation of ptj and ptj newsletter (e.g. verbal propaganda)

It was stressed that the workload for the members of the Committee should be as low as possible.

Dr. Beller agreed to prepare a detailed paper with the EITEP staff and to make it available to all AdBo members for discussion.

Dr. Ritter thanked everyone involved for their commitment and the stimulating discussion that preceded.

EITEP Institute
May 2018

Dr. Klaus Ritter
President
EITEP Insitute

Dr. Michael Beller
Director Global Market Strategy –
ROSEN Group

ptj JOB & CAREER MARKET

YOUR OPPORTUNITY TO ATTRACT PROFESSIONALS AND HIGH POTENTIALS

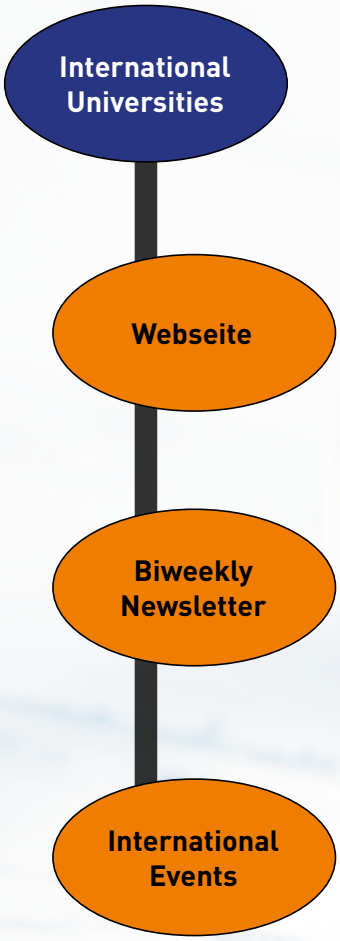
The international pipeline community is in need of additional personnel.

We need more experienced professionals, but we also need young graduates to join our ranks. Despite attractive working conditions, many companies encounter problems while they are reaching out to potential recruits. There are many competing industry sectors who are also in need of high potentials. This results in many vacant jobs in the pipeline community, for operators, technology providers and service providers alike.

This necessity has driven us to develop a new service for the global pipeline industry.

The **ptj job and career market** is the right service to support existing recruitment efforts, and to boost their range and effectiveness.

ONE SERVICE - MULTIPLE CHANNELS



Offensive approach: We push forward and generate attention to our career market directly at the universities. We also collect CVs from international graduates and experts and forward it directly to you.

Continuous promotion : Your vacancies are published on the Pipeline Technology Journal (ptj) website for a year. In Addition, the ptj contains your vacancies too.

Dead on target: We send your vacancies or your company profile to our database of 50.000 international pipeline professionals.

Physical appearance: The job & career market has an individual booth during all EITEP events in Berlin, Cairo and upcoming event locations.

Questions?

Please contact Mr. Admir Celovic for further information and booking requests.

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KÖTTER Consulting Engineers
Germany
www.koetter-consulting.com

Inline Inspection

3P Pipeline, Petroleum & Precision Services
Germany
www.3p-services.com

A.Hak Industrial Services
Netherlands
www.a-hak-is.com

KTN AS
Norway
www.ktn.no

LIN SCAN
United Arab Emirates
www.linscaninspection.com

NDT Global
Germany
www.ndt-global.com

Pipesurvey International
Netherlands
www.pipesurveyinternational.com

PPSA - Pigging Products and Services Association
United Kingdom
www.ppsa-online.com

Romstar
Malaysia
www.romstargroup.com

Rosen
Switzerland
www.rosen-group.com

Inspection

Ametek – Division Creaform
Germany
www.creaform3d.com

Applus RTD
Germany
www.applusrtd.com

EMPIT
Germany
www.empit.com

Integrity Management

Metegrity
Canada
www.metegrity.com

Pipeline Innovations
United Kingdom
www.pipeline-innovations.com

Leak Detection

Asel-Tech
Brazil
www.asel-tech.com

Atmos International
United Kingdom
www.atmosi.com

Direct-C
Canada
www.direct-c.ca

Entegra
United States
www.entegrasolutions.com

GOTTSBERG Leak Detection
Germany
www.leak-detection.de

MSA
Germany
www.MSAsafety.com/detection

OptaSense
United Kingdom
www.optasense.com

Pergam Suisse
Switzerland
www.pergam-suisse.ch

PSI Software
Germany
www.psioilandgas.com

sebaKMT
Germany
www.sebakmt.com

SolAres (Solgeo / Aresys)
Italy
www.solaresweb.com

COMPANY DIRECTORY

Materials

egeplast international
Germany
www.egeplast.de

Monitoring

Krohne Messtechnik
Germany
www.krohne.com

Pump and Compressor Stations

TNO
The Netherlands
www.pulsim.tno.nl

Repair

CITADEL TECHNOLOGIES
United States
www.cittech.com

Clock Spring
United States
www.clockspring.com

RAM-100
United States
www.ram100intl.com

T.D. Williamson
United States
www.tdwilliamson.com

Research & Development

Pipeline Transport Institute (PTI LLC)
Russia
www.en.niitn.transneft.ru

Safety

DEHN & SÖHNE
Germany
www.dehn-international.com/en

HIMA
Germany
www.hima.de

TÜV SÜD Industrie Service
Germany
www.tuev-sued.de/is

Standards & Regulations

DNV GL
Norway
www.dnvgl.com

DVGW - German Technical and Scientific Association for Gas and Water
Germany
www.dvgw.de

Surface Preparation

MONTI - Werkzeuge GmbH
Germany
www.monti.de

Trenchless Technologies

GSTT - German Society for Trenchless Technology
Germany
www.gstt.de

Rädlinger Primus Line
Germany
www.primusline.com

Valves & Fittings

AUMA
Germany
www.auma.com

IMI Precision Engineering
Germany
www.imi-precision.com

Zwick Armaturen
Germany
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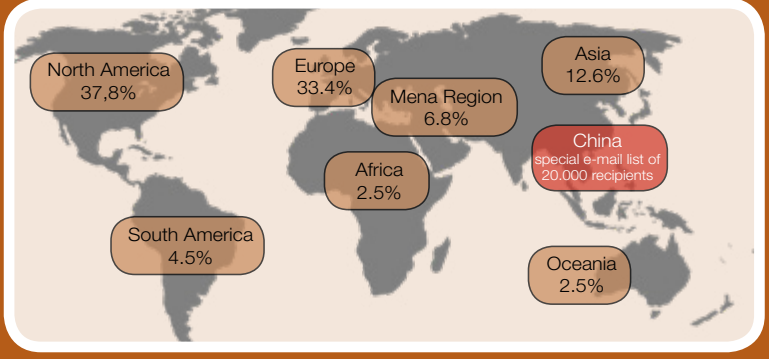

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