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The impact of ICT on job quality: evidence from 12 job profiles

An intermediate report from the study "ICT for work: Digital skills in the workplace – SMART 2014/0048"

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Content

Abstract

This report presents 12 job profiles exemplifying a variety of occupations for which developments in ICT and its use have led to substantial changes in the work tasks and the skills needed to carry out the job. The job profiling is part of the study "ICT for Work: Digital skills in the workplace", launched by The European Commission, DG CONNECT, carried out by ECORYS and DTI in 2015-2016. The job profiles are based on desk research and interviews with trade union organisations and employers.

Executive summary

This report presents 12 job profiles exemplifying a variety of occupations for which developments in ICT and its use have led to substantial changes in the work tasks and the skills needed to carry out the job. The 12 job profiles include dairy farmer, machine operator, industrial designer, building electrician, transport clerk, car mechanic, police detective, VET teacher, property caretaker, doctor in a hospital, animator and desktop publisher. The job profiles selected for the job profiling do not focus on "office" occupations where the penetration of ICT is already high. Instead, the job profiles represent occupations in sectors such as the primary sector, construction, transport and storage, education and service jobs such as VET-teacher, property manager and doctor at a hospital, which are not office-based.

The main findings of the job profiling carried out are that the use of ICT profoundly affects the work tasks and skill requirements of the jobs. Looking across the profiles, some of the main findings are:

▫ *ICT increasingly take over routine, analytical tasks*, and this trend is not confined to repetitive, manual tasks in manufacturing, but also analytical tasks of decision-making, which can be supported by computers that support analysis, calculation and optimisation. ICT tools can do information retrieval and analyses of large data sets, complex calculations and logistic planning tasks much quicker and with higher precision than the human brain. For example, the transport clerk uses the software to find transport solutions that optimise the decided route, use of energy resources and ensures the best possible utilisation of transport vehicles, reducing empty mileage costs, etc. In parallel, a car mechanic uses analytical software to diagnose vehicles.

In fact, ICT does not only take over routine, analytical calculation tasks but also support highly complex analytical thinking of professions such as doctors and police detectives. For example, doctors and police detectives can use advanced tools and systems, which can do complicated analytical tasks based on information and data entered. Similarly, CAD/CAM systems become ever more advanced and can support and partly 'replace' human thinking and problem-solving in relation to the design of products. Furthermore, 3D printing can replace advanced manual work processes and crafts.

▫ *The use of ICT tends to increase the speed, flexibility and independency of work.* ICT tools enable time-consuming work processes to be done more quickly. For example, for animators, the use of ICT increases the speed of animation tasks that used to take more time - in particular the more repetitive tasks related to drawing and colouring thousands of in-between drawings. At the same time, ICT tools enable the employee to carry out more work tasks on their own and work more independently. For example, the building electrician is able to work more independently and alone on-site because relevant information and partners can be accessed on the internet. A similar pattern applies to machine operators who are increasingly expected to programme machinery and monitor production themselves.

▫ *The use of ICT tends to increase the differentiation of competence levels* among the employees. Trade organisations, experts and employers find that complex ICT systems have has increased the differentiation of competence levels among employees within the

same job profile. For example, experienced machine operators who can do programming and car mechanics with good digital skills can manage more advanced work tasks involving problem solving while less proficient employees tend to manage simpler work tasks.

▫ *The use of ICT affects skill requirements as regards digital skills as well as other complementary skills.* All job profiles require *digital skills at advanced user level* to apply specific software for the profession. In some of the profiles, the employee needs only *basic user skills* in general software and applications that are not specific to the profession. None of the job profiles can be categorised as ICT specialists, who work professionally with developing and maintaining ICT programmes and systems. However, the job profile of the building electrician may represent a specific exception because the building electrician to some extent develops, customizes, installs and maintains ICT systems and applications. New versions of animation software programs appear very often. Consequently, in all job profiles employees must be open to updating their digital skills continuously. In most job profiles, there is a generation problem as the older employees are typically less familiar with ICT and more reluctant to use computers at the beginning. Complementary skills in communication, service and documentation skills in relation to colleagues and customers become more important. The use of ICT enables the employee to complete more works task independently and to handle the relations with the customers.

▫ *The adoption of digital technologies takes time to become mainstream***.** Although digital technologies can drive innovation, efficiency and quality it can take considerable time before their use become mainstream at workplaces. The speed of adoption of digital technologies vary from sector to sector and is influenced by sector characteristics, market dynamics, public policies, the skills of the labour force and many other factors. In sectors, such as manufacturing and construction, with many SMVs the spread of investment in of digital technologies may be challenged by lack of economic resources and knowhow in the companies and lack of skills among the employees.

▫ *Lack of knowhow and skills is a challenge to future ICT adoption.* Lack of knowhow and skills among employers and employees challenge the adoption of ICT. For example, interviews indicate that the biggest challenge to the adoption of ICT in the field of property management is that many property managers are not used to working with ICT and exploiting its potentials for strategic long-term planning. Furthermore, the adoption of ICT and new approaches to work is also to some extent challenged by traditions and culture.

▫ *The use of ICT blurs the boundaries between occupations or merges them.* For example, technological development means that ICT software has increasingly permeated traditional electronics and the electricians' trade. This means that ICT permeation in electronics has blurred the boundaries between electricians and ICT professionals. Similarly, the use of ICT in desktop publishing industry may lead to merging and increasing interaction of various occupations, such as desktop publishers and multimedia artists because both occupations prepare publications for the printed and electronic media.

Introduction

This report presents 12 job profiles exemplifying a variety of occupations for which developments in ICT and its use have led to substantial changes in the work tasks and the skills needed to carry out the job. The job profiling is part of the study "ICT for Work: Digital skills in the workplace", launched by The European Commission, DG CONNECT, carried out by ECORYS and DTI in 2015-2016. The overall purpose of the study is to get a picture of the digital skills needs of the workforce, where skills are lacking most and how enterprises deal with lacking skills. The study is based on a survey of employers in six EU countries (DE, FI, PT, SE, SK and the UK) covering a broad selection of sectors and occupational groups.

The job profiles in this report complement the quantitative survey part of the study by providing a qualitative and holistic understanding of how the adoption of ICT and digitalisation changes the quality, work tasks and skills requirements of a job.

The 12 jobs selected for the study a wide spectrum of sectors and occupations:

Occupation/ISCO code	Job profile
1311 Agricultural and forestry production	Dairy farmer
7223 Metal working machine tool setters and operators	Metal machine operator in manufacturing company
2163 Product and garment designers	Industrial designer in manufacturing company
7411 Building and related electricians	Building electrician in construction company
4323 Transport clerks	Transport clerk in transport/logistics company
7231 Motor vehicle mechanics and repairers	Car mechanic
3355 Police inspectors and detectives	Police detective
2320 Vocational education teachers	VET teacher at school with high level of ICT use
5153 Building caretakers	Property caretaker working for an estate firm
2212 Specialist physician (internal medicine)	Doctor in a hospital (general internist physician)
2166 Graphic and multimedia designers	Animator
7321 Desktop Publishers	Desktop Publisher

The job profiles selected for the job profiling do not focus on "office" occupations where the penetration of ICT is already high. Instead, the job profiles represent occupations in sectors such as in the primary sector, construction, transport and storage, education and service jobs such as VET-teacher, property manager and doctor at a hospital.

The job profiles mainly represent jobs below top managerial level, because the top managerial level typically involves a lot of "office" work. However, as the job profiles in this report show, the penetration of ICT in many manual and crafts jobs such as car mechanic, animator and dairy farmer increases also their content of "office work".

Methodology

The job profiles are based on desk research and interviews with trade organisations and employers.

Desk research

For each job profile we have collected data on work tasks and technology use in **information databases** such as Skills Panorama http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

To supplement the information databases, we have researched **job advertisements** in order to collect authentic and updated information on job content and the skills requirements demanded by employers. Furthermore, we have researched publications, studies and articles.

Interviews with trade organisations, experts/researchers and employers

For each job profile, we have conducted interviews among trade organisations at EU-level or national level, employers and experts/researchers.

The relevant stakeholders and employers at national level were identified stepwise "top-down". First, we asked organisations at EU level which member organisations at national level that could provide examples of advanced use of ICT in the sector of interest. Subsequently, we interviewed organisations at national level and asked for examples of workplaces/employers with advanced levels of ICT use. In most cases, the employers have been suggested for interview by trade organisations.

Based on the initial desk research a preliminary job profile was developed to be used in the interview. The purpose of the preliminary job profile was to make clear to the interviewee what occupation and job field the interview would focus on. The preliminary job profile also provided a point or reference for the interviewee to add comments on work tasks or technology use to be expanded or corrected.

Based on these data we have developed final job profiles. In order to help the reader to get an overview of each job profile, we have developed a table, which presents the main work tasks and the use of ICT in relation to each main task. To the extent possible, the

main work tasks are ordered in a sequence of stages describing the 'workflow' of the job profile.

Key research questions and themes of the job profile

For each job profile, the interviews and desk research have helped to collect data to provide answers to the following key research questions:

The context – how and why ICT is used in the sector/job in focus
The first section of each job briefly introduces the broader context and overall dynamics of how and why ICT is used in the sector in question to create value. Based on this introduction of the broader context it is explained why a particular job has been selected as a relevant example for profiling.

What are the main work tasks of the job?
A work task is the smallest analytical unit of a job. A work task can be defined as a piece of work that has to be done within a certain timeframe. Each job can be broken down into a countless tasks and a complete description including all tasks would easily make the job profile too extensive. Hence, for analytical clarity we have selected and grouped the (sub-)work tasks into a sequential order of main work tasks that, to the extent possible, represent the 'workflow' of the job. For each job profile, all main job tasks and their subtasks are presented in a table.

For a dairy farmer, for example, the main work tasks 'feeding and breeding' are placed before milking. However, not all main work tasks, such as staff management and herd management, can be placed into such a sequential order. Nevertheless, the ordering of work tasks into a sequential order/workflow has been a good tool to help structure the interviews for the interviewees.

How is ICT used in the work tasks?
For each of the main work tasks the job profile describes (1) which work functions use ICT, (2) how ICT is used and (3) for what purposes. For each of the main work tasks in the left column, the right column briefly describes how various types of ICT can be used to carry out the work tasks. For example, for herd management, the dairy farmer can use herd management software that tracks and maintains detailed records on livestock by each individual or group as well as schedule vaccinations, testing, and breeding events. The key focus of the description is not the technical details of ICT systems/applications themselves but how they are used in relation to the work tasks and for what purpose.

In the analysis, we classify the use of ICT according to its generic purpose, e.g. automation, information management and support for decision-making. For example, in generic terms, a dairy farmer uses herd management software as an analytical tool to support decision-making.

How does ICT affect the quality of the work?
The concept of 'quality of work' that we used in this context is a multidimensional concept, which is more comprehensive than the term 'working conditions', which traditionally has to do with the ergonomic aspects of the workplace and those relating to the worker's health. Beside the physical environment and working conditions, the 'quality

of work' also comprises 1) the contractual situation of employees; 2) the objectives and organisational practices of companies; 3) the social climate in the workplace, i.e., the attitudes and needs of workers, correspondence between the worker's expectations and job characteristics. It also includes the perception that the employees have, in terms of job satisfaction and the opportunity to develop their skills through vocational training activities[1].

In the interviews, we have used this multidimensional concept by letting organisational representatives and employers describe how the use of ICT affects the 'quality' of the job. We found that it is important to have an open and flexible approach to capture profound qualitative changes in a job due to ICT. In the interviews, we asked questions such as 'How does the use of ICT change the quality of the job as a whole?' 'How is a typical workday in the job now compared to before?'

For dairy farmers for example, automatic milking means that milking no longer takes place at regular intervals. Traditionally, milking took place twice a day, early morning and evening, with a maximum time space between. Hence, automatic milking reduces the traditional 'rhythm' of the day. Overall, the use of ICT changes the workday of a dairy farmer to a more flexible workday with less physical work and more analytical problem solving, planning and management of information. To some farmers this is attractive, while others prefer the more traditional lifestyle.

How does ICT affect the skill needs of the job?

The key focus of this research question is what skills are becoming more important due to ICT use. In the job profile, we distinguish between digital skills and other complementary skills. Analytically, it can be tricky to distinguish clearly between digital skills and other complementary skills because the use of ICT and digital skills are deeply interlinked with other skills and work tasks. For example, car mechanics increasingly use ICT databases to find specific technical information on cars. Is that a digital skill (i.e. the use of databases) or a complementary skill (information search and management)? In the job profiles, we group skills as digital skills if they are directly related to the use of ICT. For each digital skill we describe how ICT is used and for what purpose.

Digital skill levels

In all job profiles, ICT is used in most work tasks and require digital skills at various levels. The OECD definition of ICT related employment (OECD, 2010[2]) distinguishes between three categories and levels of digital skills:

1. ICT specialists, who have the ability to develop, operate and maintain ICT system. ICTs constitute the main part of their job.
2. Advanced users, i.e. competent users of advanced and often sector-specific, software tools. ICTs are not the main job but a tool.

[1] *Centra Marco, Curtarelli Maurizio, Gualtieri Valentina "*From theory to practice: a methodological proposal for operationalising and summarizing the concept of quality of work", 46th Scientific Meeting of the Italian Statistical Society, Rome 2012, available at http://meetings.sis-statistica.org/index.php/sm/sm2012/paper/viewFile/1940/146.

[2] OECD 2010. *OECD Information Technology Outlook 2010*. OECD.

3. Basic users, i.e. competent users of generic tools (such as Word, Excel, Outlook, PowerPoint) needed for the information society, e-government and working life. Here too, ICTs are not the main job but a tool.

In the job profiles, these three categories and levels of digital skills are used to classify and describe the digital skills required. Most of the 12 job profiles require digital skills at the levels of advanced or basic user. None of the job profiles can be classified as ICT specialists, i.e. persons who work professionally with ICTs as the main part of their jobs. However, although none of the job profiles can be categorised as ICT specialists, the use of ICTs constitutes a very large part, if not the main part of the job, in some job profiles. For example, industrial designers, animators and desktop publishers use advanced ICT tools in a large part or their work tasks and working hours.

Other complementary skills

Beside digital skills, the job profiles describe other complementary skills, which become more important. Other complementary skills include

1. Professional skills (technical areas of knowledge and skills). For example, a dairy farmer requires skills and knowledge related to food production, cattle health, knowledge of vaccines to prevent disease, economics and accounting, knowledge of economic and accounting principles and practices as well as many other fields.
2. Personal skills/competences such as analytical skills, planning skills, to be service-minded towards customers, etc.

The key focus of the job profiles is how the use of ICT affects skill requirements. Hence, the job profiles do not attempt to present an exhaustive list of all the professional skills of a job. For example, the job as a doctor in a hospital (general internist physician) requires medical professional skills and knowledge in a very long list of different fields that are constantly evolving due to new scientific discoveries. This means that the job profiles mainly focus on professional skills and personal skill requirements that become more important due to the use of ICT.

The adoption or 'take up' of ICT in the job profiles

There are significant variations in the adoption and take-up of ICT across countries and sectors in the EU. The take up of ICT in a given job profile may take a long time before it becomes mainstream. Dairy farmers for example, still use traditional milking technology in most European countries. In other words, dairy farmers using automatic milking machinery are 'forerunners' and not representative of European dairy farmers in general. The job profiles are not intended to be representative of the 12 jobs in Europe in general. Instead, we primarily focus on the job profiles in the most ICT mature countries using ICT at an advanced level. By focusing on 'the frontrunners' the job profiles provide information about the latest developments and expected future trends. The interviews also included questions about whether the take-up of ICT in the job profile is progressing fast or slowly and the factors that influence the take-up.

The future

Digital technologies are constantly evolving which means that the job profiles' work tasks and use of ICT are changing constantly too. In the interviews and desk research, we have collected data on the following main research questions:

- Will the use of ICT spread to more work tasks in the future? Which tasks?
- What digital skills will become more important in the future?
- What other professional and personal skills will become more important in the future?

Main transversal findings

Each of the 12 job profiles present many findings as regards how the use of ICT affects the quality of the job, main work tasks and skills requirements. The adoption of ICT affects each job profile in a complex process, and each job and industry have their own unique qualities and dynamics. However, looking across the job profiles, we have identified some general, transversal findings. The following sections present some of the main transversal findings.

How ICT is used in the job

Although ICT tools, their functions and utilisations are very specific to each job profile, we have identified some transversal generic purposes across the profiles. These are some of the most typical:

- **To provide access to technical information and databases**. For example, a car mechanic can use online databases to access information on technical specifications and standards for specific types and brands of car, year of production, etc. Modern cars are becoming increasingly differentiated and complex and some brands have 40-50 different types of cars. This means that the technical standards and specifications related to cars have become enormous amounts of data. Before the advent of online databases, car mechanics had to search through big paper files. Similarly, building electricians use various digital referencing tools that provide efficient access to relevant information on technical terms, standards and calculations. Such digital referencing tools can be accessed via APPs on a smartphone, enabling the building electrician to use it on-site when needed.

- **To support analysis, calculation and logistics/planning.** ICT tools can do information retrieval and analyses of large data sets, complex calculations and logistic planning tasks much quicker and with higher precision than the human brain. For example, the transport clerk uses the software to find transport solutions that optimise the decided route, use of energy resources and ensures the best possible utilisation of transport vehicles, reducing empty mileage costs, etc. Similarly, a car mechanic uses analytical software to diagnose vehicles.

- The car mechanic uses software to diagnose the cause of vehicle operating problems by tracing and locating defects and repairing malfunctions. A doctor in a hospital can use medical expert systems for diagnosis and treatment to help develop a diagnosis. However, interviews among organisations and employers highlight that the use of ICT does not in itself guarantee the quality of the doctors' professional medical assessment and decision-making. The use of ICT, even advanced expert systems, cannot automate or replace the very complex medical interpretation of health data and symptoms, which requires deep medical knowledge and long clinical experience.

- **To automate and monitor repetitive, routine tasks.** The classical application of ICT to automate repetitive, routine tasks is related to industrial manufacturing. However, ICT is increasingly automating complex work tasks in other sectors and occupations. For example, the dairy farmer can use automatic milking systems (AMS). A fully automated milking system with a robot arm automates the tasks of teat cleaning and milking attachment and removes the final elements of manual labour from the milking process. The design of the robot arm and associated sensors and controls enables robust unsupervised milking. Similarly, the machine operator can use computer-aided manufacturing (CAM) to automate the production process fully or partly, which reduces the amount of repetitive, manual tasks. While the automated machine is running, the machine operator monitors the machinery to detect malfunctions. The machine operator checks the quality of the finished products and adjusts the programming of the machines accordingly.

- **To develop complex visual presentations.** Several job profiles exemplify that ICT enables the development of complex visual presentations, which would have been very difficult and time-consuming to develop. For example, the animator can use computer programs for 3D modelling, animation and pre-visualisation. The animator can use 3D programs for modelling and movie effects such as shaders, dynamic simulation, particle systems, radiosity, normal map creation and global illumination. Similarly, the industrial designer can use computer aided design software (CAD) to aid in the creation, modification, analysis, or optimisation of a design. CAD software can be used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and create a database for manufacturing.

- **To communicate and share information efficiently with colleagues and partners.** Across all job profiles, the communication and exchange of information increasingly takes place digitally via e-mail or specific web-platforms or other digital media. For example, national ICT systems to record and store information digitally instead of paper-based filing enable police detectives to access and share relevant information much more efficiently with colleagues and other police units, who can be engaged in the case when relevant, irrespective of time and place. For example, by using IPads, patrol cars can look up and check number plates instead of having to call the police station or operations centre. Similarly, the property manager's administrative tasks can be supported by property management software enabling interaction between accounting systems, billing systems for work orders, the rent roll and many other functions.

How ICT affects the quality of the job

Across the job profiles, we find some common ways that ICT affects the quality of the job:

- **Increasing speed and efficiency of the job.** This is the most typical effect across all job profiles. For example, for animators, the use of ICT increases the speed of animation tasks that used to take more time - in particular the more repetitive tasks related to drawing and colouring thousands of in-between drawings. In parallel, ICT enables test and detection of malfunctions that previously would have taken long time. For example, diagnostics systems mean that car mechanics often do not need to take apart a car manually to identify a problem. Instead, problems can be detected using computer-based software. Instead of repairing a defective part, mechanics more often replace the defective part since many parts are no longer made to be repaired. Similarly, use of ICT enables doctors in hospitals to save time and work more efficiently, because ICT provides electronic and quick access to relevant health data, expert information, and knowhow. The use of ICT enables doctors to work faster and handle more patients, in particular because ICT has relieved the doctors of paperwork and made the handling of information and communication faster.

- **Less manual work.** Using ICT for automation of routine tasks, test and detection of malfunctioning systems means less physical, manual work. For example, the use of computer-based diagnostics systems means that car mechanics often do not need to disassemble the car manually to identify the problem. Instead, problems can be detected using computer-based software. Instead of repairing a defective part, mechanics more often replace the defective part since many parts are no longer made to be repaired. Similarly, automatic milking means less hard physical work. An interviewed dairy farmer said that because of his relatively high age he had invested in automatic milking because he was no longer able to manage the hard work on his own. If he had not invested in automatic milking, he believed that he would have had to employ more staff.

- **To work more independently and flexible.** For example, the building electrician is able to work more *independently* and alone on-site because relevant information and partners can be accessed on the internet. For example, the building electrician must be good at using digital referencing tools on site to search and find relevant technical information on given components and systems. Such digital referencing tools can be accessed via APPs on a smartphone. It also means that the building electrician is able to work more independently and alone on-site because relevant information and partners can be accessed on the internet. In order to work efficient building electricians are increasingly expected to finish tasks/installations independently. A similar pattern apply to machine operators who are increasingly expected to programme machinery and monitor production themselves. The job profile of the dairy farmer also provides a significant example of how ICT used for automation affects the workday as a whole. The workday becomes more *flexible*, because automatic milking means that milking no longer takes place at regular intervals. Traditionally, milking took place twice a day, early morning and evening, with a maximum time space between. Hence, the traditional milking routine places restrictions on the time management and personal life of the dairy farmer. In contrast, automatic milking

systems make the workday more flexible because milking no longer takes place at fixed times.

- **To sort and analyse more information from multiple sources.** The use of ICT tools and systems for storing, managing and exchanging of information means that increasing amounts of information have to be sorted and analysed. For example, the use of ICT makes the dairy farmer's job more analytical, e.g., the dairy farmer spends more time on information management, problem solving, planning and decision-making. In many work tasks, such as herd management, staff management and financial management, ICT systems record and provide a broad collection of data that enables the farmer to conduct analytical, systematic and evidence-based planning and management of the dairy farm. Similarly, a police detective also has to sort and analyse increasing amounts of information from digital tools such as digitally controlled surveillance systems and automatic number plate recognition systems used to monitor and spot vehicles.

Skills that become more important

As the use of ICT affects the work tasks and the quality of the job, this also affects skill requirements as regards **digital skills** as well as other **complementary skills.** These are some of the typical skills that tend to become more important:

- **Digital skills at advanced user level to apply specific software for the profession.** In all job profiles, the work requires digital skills at advanced user level to use software programs that are specific to the occupation. In some of the profiles, the employee need only basic user skills in general software and applications that are not specific to the profession. Using the OECD three-level distinction between ICT-specialists, advanced users and basic users, all job profiles require advanced user skills of software programmes and applications that are specific to the profession. For example, the car mechanic uses diagnostic software to detect malfunctions in vehicles and specific technical databases to find information on technical standards on given trademarks of cars. I many of the job profiles the software programs are quite advanced and complex to use. For example, animators have to be familiar with 3D animation programs, which are complex and include a huge number of functions. To become familiar with the functions of such programs, animators must learn by doing, persevere and keep looking for the functions they need when working. The use of complex ICT systems tend to *increase the differentiation of competence levels* among the employees. Trade organisations, experts and employers find that complex ICT systems have increased the differentiation of competence levels among employees within the same job profile. Experienced machine operators who can do programming and car mechanics with good digital skills can manage more advanced work tasks involving problem solving while less proficient employees tend to manage simpler work tasks. None of the job profiles can be categorised as ICT specialists, that work professionally with developing and maintaining ICT programmes and systems. However, the job profile of the building electrician may represent a single exception because the building electrician to some extent develops, customizes, installs and maintains ICT systems and applications, for example in building automation software. Compared to the other job profiles, the building electrician needs quite advanced digital skills to install, integrate and test electronic systems with embedded ICT components and control units.

- **Openness to continuously updating of digital skills.** New versions of animation software programs appear very often. Consequently, in all job profiles employees must be open to updating their skills continuously. In most job profiles, there is a generation problem as the older employees are typically less familiar with ICT and more reluctant to use computers at the beginning.

- **Complementary skills in communication, service and documentation skills in relation to customers.** The use of ICT enables the employee to complete more works task independently and to handle the relations with the customers. For example, an experienced car mechanic is increasingly expected to handle all main steps before, during and after a car repair. The car mechanic increasingly handles communication and relations with customers. Before the repair, the car mechanic must be able to conduct a systematic dialogue with the customer to get information on symptoms and problems with the car. During the repair, the car mechanic must be able to develop documentation on problems detected and the deficient parts that have been repaired or replaced. Similarly, building electricians are confronted with increasing complexity in their installation assignments. The increasing use of advanced building automation systems means that the building electrician must be able to advise the customer on the delivery and use of total, integrated systems.

The future

I all the job profiles, the digitalisation of work tasks and processes is expected to continue. Looking across the profiles, these are some of the main findings related to the future:

- **The adoption of digital technologies takes time to become mainstream.** However, although digital technologies can drive innovation, efficiency and quality it can take considerable time before their use become mainstream at workplaces. It must be highlighted, that the job profiles presented here represent examples of "forerunners" with advanced levels of ICT. The speed of adoption of digital technologies vary from sector to sector and is influenced by sector characteristics, market dynamics, public policies, the skills of the labour force and many other factors. In sectors, such as manufacturing and construction, with many SMVs the spread of investment in of digital technologies may be challenged by lack of economic resources and knowhow in the companies and lack of skills among the employees. For example, the adoption of ICT in car repair workshops has become quite mainstream. Interviewed organisations and employers find that this development has taken place over long time, which means that there has been time to invest in training to update employees. However, interviewed organisations at EU-level find that some countries and areas, such as Greece and Eastern Europe, tend to lag behind, still focusing and traditional mechanical skills. The market dynamics and prices of digital technologies are also important factors for the future speed of ICT takeup. For example, the interviews indicate that the use of ICT in property management and building automation is only in its infancy and will continue to develop. A factor contributing to this is that the price of property management software is falling and that some software programs are accessible as freeware on the internet.

- **Lack of know-how and skills is a challenge to future ICT adoption.** Lack of knowhow and skills among employers and employees challenge the adoption of ICT. For example, interviews indicate that the biggest challenge to the adoption of ICT in the field of property management is that many property managers are not used to working with ICT and exploiting its potentials for strategic long-term planning. They need expert assistance and advice to prepare for the investments in such systems. Technologically, it is also a challenge to integrate the various components and systems. Furthermore, the adoption of ICT and new approaches to work is also to some extent challenged by traditions and culture. For example, interviewed experts and police detectives highlight that the most important future challenge is that the police must become better at understanding and following society to be updated in connection with the many new crime forms that ICT and the internet enable. They think that that the police may need to have technological procedures and tools that match the contemporary digital activities of people better. For example, digital social media can be used when the police need help or information from the public. Similarly, social media can be used to research online activities and interactions between persons involved in a case.

- **The use of ICT blurs the boundaries between occupations or merge them.** For example, technological development means that ICT software has increasingly permeated traditional electronics and the electricians' trade. This means that ICT permeation in electronics has blurred the boundaries between electricians and ICT professionals. Increasingly, building electricians and ICT specialist companies compete on the markets for building installations an building automation systems. Facing this competition, senior building electricians may need continuing education and training to develop digital skills.Similarly, the use of ICT in desktop publishing industry may lead to merging and increasing interaction of various occupations, such as desktop publishers and multimedia artists because both occupations prepare publications for the printed and electronic media.

- **'Routine' analytical tasks are taken over by ICT.** Routine tasks are increasingly taken over by ICT, and this trend is not confined to repetitive, manual tasks in manufacturing, but also analytical tasks of decision-making, which can be supported by computers that support analysis, calculation and optimisation. For example, doctors can use advanced tools and systems, which can do analytical tasks and propose a preliminary diagnosis, which can support the doctor's medical analysis. Similarly, transport clerks can use analytic tools to optimise transport routes and propose various route options. Another example, the technological development provides CAD/CAM systems that become ever more advanced and can 'replace' human thinking and problem-solving. For example, CAD software incorporating information about the nature of materials such as their weight, tensile strength, flexibility and other qualities. By including this and other information, the CAD system could then 'know' what an expert engineer knows when that engineer creates a design.

1. Animator

The context: computers changed the art of animation

Many years before the invention of computers, animators used hand drawings to create their animated characters. This was a very tedious task and involved the creation of thousands of drawings and keeping track of each physical drawing that made up an animation sequence. The advent of computers and graphic processing hardware has changed this process fundamentally. Much like the use of robots in manufacturing, the new technology has meant that machines can do more of the drawings.

During the last decades, 3D computer animation has evolved significantly and added new dimensions and possibilities to the art of animation. 3D computer-generated animation enables the animator to model the objects and characters on a plane with an X-, Y- and Z-axis, which he or she cannot do using pencil and paper. Using mathematical algorithms, animators can program objects to adhere to (or break) physical laws like gravity, mass and force, or they can create huge herds and flocks of animals that appear to act independently, yet collectively. With computer-generated animation, instead of animating each hair on a monster's head, the monster's fur can be designed to wave gently in the wind and lie flat when wet (Roos, 2015).

Thanks to technological advancements, Pixar Animation Studios (Pixar) has created computer-generated animation films that have achieved great success and have set new standards for computer animation as an art form. Using a complex system of model articulation and motion control coding Pixar has developed characters with each their own set of motion controls (Gilbey, 2010).

Contrary to expectations, computer animation has not replaced traditional animation. Traditional animation remains a prominent form of animation to this day and continues to grow with new animators joining the industry each year. Computer animation has not completely replaced traditional hand-drawn characters. Rather, it can be viewed as another tool in the animator’s toolbox. Today, traditional animation and computer animation coexist and are used in combination on some films (Meyer, 2013).

Selection of job profile

On this background, we selected the job profile 'computer animator' to analyse how using ICT affects the work of an animator and the skills needed. Many job advertisements ask for animators who can work with traditional animation as well computer-generated animation. Therefore, the job profile requires ability to work with both types of animation.

 Main work tasks	 Main use of ICT
Story development • Develop idea for film and propose it to the customer/client • Develop the script and characters for the animated story • Create storyboards that show the flow of the animation including key scenes and characters • Present and discuss the storyboard with colleagues who are involved in the film or sequence	**Digital storyboard and pen** Creating a digital storyboard is just like creating a normal storyboard, but instead of drawing on paper, the animator draws on a special tablet using a program and a pressure-sensitive digital pen.
Animating the story • Draw pen-and-paper images to be scanned, edited, coloured, textured, or animated by computer • Capturing motions enacted by a person and then transforming the motions to be used in 3D animation • 3 D computer animation using key frames that define the starting and ending points of a smooth transition. • Apply models to simulate the movements of animated characters or objects in film/sequence • Make objects or characters appear lifelike by manipulating light, colour, texture and shadows	**Motion capture software** Motion software capture is the process of **recording** a live motion event and translating it into actionable data that allows for a 3D recreation of the performance. In other words, transforming a live performance into a digital performance. **Computer programs for 3D modelling, animation and pre-visualisation**. The animator uses 3D programs for modelling and **movie** effects such as shaders, dynamic simulation, particle systems, radiosity, normal map creation and global illumination. Programs include Autodesk 3ds Max Design, Autodesk Alias Surface and AutoDesSys form Z.
Editing film adding background and effects • Cooperation with other professionals (such as background artists, photographers, layout artists, voice actors and musicians) who develop elements to be integrated into the	**Computer programs for graphics or photo imaging.** The **animator** uses these programs for presentation, editing and manipulating photos to be used in 3D animations. Programs include Ability Photopaint,

 Main work tasks	 Main use of ICT
animation • Adding colours digitally • Adding soundtrack • Installing special effects and 3D graphics, such as illumination, spectacular highlights and cast shadows	Adobe Systems Adobe Illustrator, Corel Painter and VectorDesigner.
Presentation and delivery • Internal presentation of draft film to the director and production team for comments • Finish draft film/sequence according to production deadlines to meet requirements of the client • Presentation and delivery of film to the client	**Video creation and editing software.** The animator uses these programs for editing film **including** colour grading and sound design and outputting the video in different formats. Programs include Apple Final Cut Studio. Adobe Systems Adobe Director.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

How ICT is used in the job

As the above table shows, ICT can be used in most main work tasks throughout the creative process of developing an animation film or sequence. Looking across all work tasks, ICT does not replace the creative process of developing ideas, stories and characters nor the craftsmanship of drawing and sculpturing. ICT is a tool that helps the animator to do some of the drawing and colouring tasks quicker. At the same time, it *enables 3D dimensioning and other effects* that are not possible in traditional animation. Motion capture software enables the animator to record motions digitally, and then the animator can transform them directly to animation. In traditional animation, capturing motions is one of the most fundamental and most challenging artistic skills. Hence, motion capture software provides a very easy shortcut to animating motions and making them look realistic.

The interviewed animators find that by using ICT animation can be done quicker because the animator only needs to draw some key frames while the frames in between can be done by computer. Digital animation also makes it easier to go back, correct mistakes and make changes. The use of ICT can also speed up the creative process where the animator tries out how characters look and act.

> *'When you draw something (digitally), you can immediately play it, instead of old fashioned drawings that would need to be recorded before you could see how they looked and acted.'* (Interview with animator working in an animation company)

In the development of the story, the animator can use a digital storyboard and a digital pen as an input device that captures the writing, drawing or brush strokes of the user and converts the analogue information into digital data, enabling the data to be utilised in various applications. The interviewed animators consider that the advantage of a digital storyboard it that it enables the animator to transfer work and cooperate with other artists on a story independent of place and time, and export the digital objects and characters to other programs. Similarly, the animator can use ICT for 3D modelling, animation and pre-visualisation. Using ICT enables the animator to do 3D modelling and complex movie effects that would not possible with traditional animation.

How ICT affects the quality of the job

Viewed as a whole, the use of ICT changes the job quality of animators as it increases *the speed of animation tasks* that used to take more time - in particular the more repetitive tasks related to drawing and colouring thousands of in-between drawings. According to the interviewed animators and experts, the use of ICT has become mainstream in animation, and it has generally made production time shorter and reduced costs and budgets for animation projects.

Animation has always been a teamwork, involving many different artists contributing to specific tasks of the production. Some animators develop backgrounds; others develop specific characters, while others develop colours or special effects. The use of ICT has increased the *transferability of animation work* throughout the whole process because the digital drawings and other elements of the production can be sent or accessed via the internet. Compared to traditional animation work, computer generated animation has made animators' *work less isolated* than before.

The increased transferability enables animators to cooperate and do co-productions with companies all over the world. For example, animators who lack sound or background specialists in-house can involve such specialists in the production via the internet. The increased transferability of animation work has *increased the specialisation* of animators because it has become easier to access and cooperate with other animators with the complementary skills needed in the production.

Digital skills

Advanced user skills using software for animation

Using ICT throughout the whole animation process implies that the animator needs solid digital user skills to apply the software programs. The animator has to be familiar with all the functions in the programs in order to exploit their full potential. 3D animation programs are complex and include a huge number of functions. To become familiar with the functions of such programs, animators must learn by doing, persevere and keep looking for the functions they need when working.

Advanced user skills using software for graphics or photo imaging.
The animator must have advanced user skills to apply programs for presentation, editing and manipulating photos to be used in 3D animations.

Advanced user skills for video creation and editing software.
The animator typically works in teams, and often he or she needs to present parts of an animation film to others. Therefore, the animator must have advanced user skills to apply software for editing films including colour grading and sound design and outputting the video in different formats.

Openness for continuous update of digital skills
New versions of animation software programs appear very often. Consequently, the animator must be open to updating his or her skills continuously. The interviewed animators described how some of the older animators were reluctant to use computers at the beginning. However, when they had become familiar with computer-generated animation they did not want to go back to the traditional methods.

Other complementary skills

Order and logical skills
Computer generated animation has not changed the need for creative and drawing skills. These are still fundamental to animation work. However, ICT means that the animator must have a more logical and stepwise approach to the work because this makes it easier to transfer the work to others and cooperate on the production. ICT also means that the animator must organise a well-ordered system of files and folders and be able to make his or her work transparent to co-workers on the production. The interviewed animators highlight that these skills and 'computer discipline are very important because computer problems can seriously delay or impede a production.

To work efficiently under tight deadlines
Animation has always been based on teamwork and temporary project organisation. The production of a film or sequence is typically organised as project with its own budget, deadlines and schedule. This was also the case in traditional animation. However, computer generated animation has increased the speed of production and the intensity of teamwork because the work can be divided into sub-tasks to be done in online collaboration. Although the animator may only be responsible for specific subtasks of a production, the animator must still understand the entire workflow.

The future

Computer generated animation and the use of 3D, motion capture software and other tools have become mainstream. In short, today animators work in front of a screen using a digital pen. In the future, it is possible that technology will provide new ways for the animator to interact with the computer. For example using motion sensors or through a natural user interface using gestures and spoken commands.

The interviewed animators and organisations expect that animation technology will evolve and provide more tools that will make 3D animation ever more realistic with sophisticated visual effects. However, some of the interviewees emphasised that no matter how advanced the tools that the animator has at hand, they cannot replace creativity and being able to develop a good idea or story.

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Interviewees

Animator, Frits, Walking the Dog, Belgium (company)

Animator, Jules Stevenson, Kettle Studio, UK (company)

Animator, Kristel Tõldsepp, A Film Estonia, Estonia (company)

Animator, Petra Monheim, Fido, Sweden (company)

Expert, Lana Nikolic, The Animation Workshop, Denmark (organisation)

2. Building electrician

The context: how building electricians increasingly deal with ICT

Traditionally, an electrician is known as a tradesperson specialising in electrical wiring of buildings, stationary machines and related equipment. Electricians may be employed for the installation of new electrical components or the maintenance and repair of existing electrical infrastructure. Electricians may also specialise in wiring ships, airplanes, and other mobile platforms as well as data and cable.

Over the last decades, ICT technology and the use of ICT software has increasingly permeated traditional electronics and the electricians trade. Today's electrician today has become a high-tech worker. Buildings are increasingly run by complex systems that use computer processors, sophisticated controls, fibre optics, and other networking gear. Building electricians increasingly handle ICT in relation to building automation. Building automation is the automatic centralised control of a building's heating, ventilation and air conditioning, lighting and other systems through a Building Management System or Building Automation System. The objectives of building automation are improved occupant comfort, efficient operation of building systems, and reduction in energy consumption and operating costs (Patrascu & Dragoicea 2014).

Building automation can be described as a distributed control system - a computer networking of electronic devices designed to monitor and control the mechanical, security, fire and flood safety, lighting (especially emergency lighting), heating, ventilation and air conditioning (HVAC) in a building

This means that electricians who install such systems and maintenance workers who monitor them have to be almost as skilled as the people who designed the equipment. Advanced training is required not only for those who install these modern systems but also for those who maintain them daily. The increasing use of ICT has made manual skills less important than digital skills for building electricians. 'Where 20 years ago, it was mostly hands-on, learn on the job, today you have to have good computer skills,' says Jim O'Connell, director of the IBEW's (International Brotherhood of Electrical Workers) training centre in Dorchester.'[3]

This job profile focuses on the job of a building electrician who works with adaption, installation and maintenance of building automation systems and other electronic installations in buildings.

The table below shows the main work tasks of a building electrician related to the use of ICT. The main tasks are presented as a sequence starting with the initial contact with the customer to clarify the installation or maintenance to be done followed by inspection, planning and carrying out the installation.

[3] Ted Siefer, 2013, 'Electricians' skills are going high-tech', Globe Correspondent May 27, 2013. https://www.bostonglobe.com/business/2013/05/26/electricians-skills-going-high-tech/29fjxYcFO1DWqFy4WfRbfI/story.html

 Main work tasks	 Main use of ICT
Definition of installation or maintenance to be done in the building • Initial contact with the customer describing installation or maintenance to be carried out • Prepare sketches or follow blueprints to determine the location of wiring or equipment	**Customer relationship management programs (CRM)** to manage and analyse customer interactions and data throughout the customer lifecycle
Inspection and planning • Inspect electrical systems, equipment, or components to identify defects, or the need for adjustment or repair • Diagnose malfunctioning systems, apparatus, or components, using test equipment and hand tools to locate the cause of a breakdown and correct the problem • Advise customer/management on whether continued operation of equipment could be dangerous • Provide preliminary sketches or cost estimates for materials or services • Plan layout and installation of electrical wiring, equipment, or fixtures based on job specifications and local codes	**Testing equipment** such as ohmmeters, voltmeters, or oscilloscopes, to ensure compatibility and safety of system. **Analytical software for calculating electrical services and functions** The electrician uses computer-based programs for pre-installation, calculations and simulations. **Digital referencing tools for electricians** The tools can provide reference materials such as visual references for resistors and other components, and generally encyclopaedic access to all the technical information that an electrician may need to make important decisions about an installation or maintenance project.
Installation, maintenance and test of systems • Assemble, install, test, or maintain electrical or electronic wiring, equipment, appliances, apparatus, or fixtures, using hand tools or power tools • Work from ladders, scaffolding or roofs to install, maintain or repair electrical	**Digital calculators and converters that** offer commonly used equations, calculations, and unit conversion that electricians typical need **Digital reference and simulation tools for circuits** enable the electrician to design and experiment with passing electrical current through circuits, which

 Main work tasks	 Main use of ICT
wiring, equipment, or fixtures • Connect wires to circuit breakers, transformers, or other components	is one of the basic operations of every electrical installation project. **Testing equipment** such as ohmmeters, voltmeters, or oscilloscopes, etc., to ensure compatibility and safety of system.
Test of systems and service/facilities management • Test electrical systems or continuity of circuits in electrical wiring, equipment, or fixtures • Delivery of test report to the customer • Instruction of customers on how to use and monitor the electronic systems in the building • Subsequent service and maintenance of the system, delivery of spare parts, etc. • Perform business management duties, such as maintaining records or files, preparing reports, or ordering supplies or equipment	**Service management programs** to provide instant service to the customer in case of technical incidents.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

The building electrician installs and repairs electrical systems, equipment and components in buildings following the electrical code, manuals, schematic diagrams, blueprints, and other specifications. The electrician uses hand tools, power tools, and electrical and electronic test equipment. The table above shows that the building electrician can use ICT tools in relation to all main tasks carrying out installation and maintenance of electronic systems in buildings.

In the contact with customers, the building electrician can use CRM systems to manage and analyse the interactions.

As building automation systems become more advanced and comprehensive, the subsequent service and maintenance becomes increasingly important. Therefore, the building electrician can use service management programs to *support and improve the service to customers*, subsequent to installation. The building electrician can use service management systems to provide instant service to the customer in case of technical incidents. Managing incidents and having a system of *record for documentation* of incidents can be important for building electricians, such as for running maintenance on building automation systems for many different customers.

During the inspection and planning stage, the building electrician can use various ICT tools to support the analysis and planning of the installation or maintenance project, including analytical software for calculating electrical services and functions. Such programs enable the building electrician to use computer-based programs for pre-installation calculations and simulations, such as panel sizing and balancing, conductor and conduit sizing and voltage drop. During planning and installation, the building electrician can use various digital referencing tools that *provide efficient access to relevant information* on technical terms, standards and calculations. During the installation and maintenance stage, the building electrician also uses testing equipment such as ohmmeters, voltmeters, or oscilloscopes, etc., to ensure compatibility and safety of the system.

How ICT affects the job

The interviewed organisations and employers find that overall the use of ICT tools enables the building electrician to work more *efficiently and safely*. Thus, the digital analytical tools make it possible to do complicated calculations and simulations of the circuits on-site at the customer in a safe way that reduces the dangers to the electrician or the systems. Similarly, digital referencing tools make it possible to provide *better access to relevant technical information and standards*. The building electrician also increasingly *manages the supply chain* of components and materials on the web.

> '*Through ICT the electricians can order the material to do the job directly from the supplier of the material. Using ICT you may be able to do the whole job without involving other persons: The electricians can fix it all from their computers now.' (Interview with trade organisation)*

Hence, using ICT tools reduces the amount of paperwork and use of paper-based manuals. It also means that the building electrician is able *to work more independently* and alone on-site because relevant information and partners can be accessed on the internet.

In many buildings without advanced building automation systems, the basic tasks and skills required of building electricians installing traditional electronic systems, circuits and wires remain the same. However, the increasing use of embedded ICT components in electronic systems and wireless communication means that building electricians tend to work less with traditional tasks such as drawing cables and wires.

In addition, the permeation of ICT in electronics means that building electricians increasingly install advanced, preconfigured systems such as in building automation

systems. The preconfigured systems can be 'stand-alone' systems as well as systems that are integrated in building parts to be collected on-site. This trend implies that building electricians increasingly must be skilled at installing and integrating preconfigured systems and components. The interviews among employers indicate that increasing use of preconfigured systems may imply increasing demands for efficient installation at low costs and reduced service time as the installation is expected to be done only once.

Digital skills

Updated digital knowledge to counsel the customer on the delivery of integrated systems/solutions

The interviewed organisations and employers think that building electricians are confronted with increasing complexity in their installation assignments. The increasing use of advanced building automation systems means that building electricians must be able to advise the customer on the delivery and use of total, integrated systems.

> *'The electrician must be able to manage and implement a total system delivery, for example, to communicate with the customer, clarify the customer's requirements, and present the whole system to the customer.' (Interview with employer)*

Even minor installation projects require that building electrician has comprehensive knowledge on how to integrate systems and is able to conduct advanced tests and trouble shooting. Many assignments for building electricians may involve installation of traditional electronic system combined with more advanced building automation systems.

ICT specialist skills to install and integrate ICT- and electronic systems

The building electrician needs digital skills to install, integrate and test electronic systems with embedded ICT components and control units. These tasks require that the building electrician has quite advanced digital skills and knowledge of the functionalities and compatibility of the software components. The interviewed organisations and employers consider that young building electricians tend to be more used to using computers and learning about new software programs than their older counterparts. The employers emphasise that the installation and maintenance of complex building automation systems require continuing education and training of building electricians.

ICT specialist skills for efficient digital information search and fact-finding on-site

The permeation of ICT in electronics and the complexity of building automation systems mean that the building electrician must be able to find increasing amounts of technical information on components, standards, codes and system configurations. At the same time, the demand for efficiency and quick installation is growing. Consequently, the building electrician must be good at using digital referencing tools on site to search and find relevant technical information on given components and systems. Such digital referencing tools can be accessed via APPs on a smartphone.

'As building electrician on site you are often standing with a component you are to install, where you lack the manual and technical specifications, but such information you can get on the web. Mostly we use smartphones. That makes the work much more efficient. All information is accessible on the web.' (Interview with employer)

Other complementary skills

Self-management –ability to work independently

ICT tools enable the building electrician to reduce the amount of paperwork and use of paper-based manuals. It also means that the building electrician is able to work more independently and alone on-site because relevant information and partners can be accessed on the internet. In order to work efficient building electricians are increasingly expected to finish tasks/installations independently.

To carry out quality control of own work on-site

The digital analytical tools make it possible to do complicated calculations and simulations of the circuits on-site at the customer in a safe way that reduces the dangers to the electrician or the systems. Therefore building electricians increasingly do quality control of own work on site.

The future

The interviewed organisations and employers think that the use of ICT tools will continue to increase among building electricians and that their trade will increasingly tend to overlap with the fields of other ICT-professionals. The technological development means that ICT software has increasingly permeated traditional electronics and the electricians trade. In other words, this ICT permeation in electronics has blurred the boundaries between electricians and ICT professionals. The climate agenda and increasing demands for sustainable use of energy means that building automation is an increasing market for building electricians. However, the permeation of ICT in electronics means that the building electrician trade is exposed to increasing competition from ICT professionals and the ICT industry. Facing this competition, senior building electricians may need continuing education and training to develop digital skills.

'In general, they (building electricians) lack specific skills. However, this is a generational problem. There are no problems with the digital skills of young people – it is a part of their education and their social life. Senior electricians, on the other hand, they are challenged when it comes to ICT in the workplace. They need additional training – we promote courses for that group. More a question of age!' (Interview of trade organisation)

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Interviewees

Bernard McAulay, National Officer, Unite the Union, UK (organisation)

Jan Olauf Andersen, Trade Union President of the Electrician and IT Workers Union, Norway (organisation)

Joseph Velle Ottosen, electronic technician, Kamstrup, Denmark (company)

Niels Abildgaard, Service Manager, Kjærgaard AS, Denmark (company)

3. Car mechanic

The context: the electronic innovation of cars

During the last decades, electronic innovations have accounted for the overwhelming majority of advances in modern vehicles. Multiple ICT software systems have been integrated into cars, which means that today's average high-end cars have roughly seven times more codes than a Boeing 787. Modern-day cars may now have more than 100 electronic parts ranging from electric windows and heated seats to collision avoidance systems. In the future, digital innovation may transform cars into becoming ever more intelligent vehicles that are connected to large mobility systems. The car of the future will be connected and able to not only monitor in real time its own working parts and the safety of conditions around it but also communicate with other vehicles and an increasingly intelligent roadway infrastructure. (Gao et al. 2014)

As the increasing use of electronics and ICT has made cars more complex, this also affects the work tasks and skill needs that car mechanics need. Car mechanics increasingly use software systems to detect and diagnose malfunctions in cars as well as databases and knowledge management systems to access relevant technical documentation.

Job profile in focus

This job profile focuses on a car mechanic working in car repair shop or garage with an advanced level of ICT use. It should be emphasised that this job profile to some extent is a generalisation of the work tasks of car mechanics and it may not be representative of all car mechanics, as the work organisation may vary from repair shop to repair shop. In some repair shops, the car mechanic may be responsible for only some of the tasks. Auto mechanics may work for a general repair shop that deals with a large variety of vehicle problems and systems. The bigger the repair workshop, the more car mechanics need to specialise in specific tasks.

There can also be differences in car mechanics' jobs depending on whether they work in independent repair shops or in brand repair shops. In brand repair shops, car mechanics are specialised and certified to work with specific cars brands, while car mechanics in independent workshops have a more general and broad field of work.

 Main work tasks	 Main use of ICT
Examination of car and preparation of repair • Examine vehicles to determine extent of damage or malfunctions • Follow checklists to ensure all important parts are examined • Identify malfunctions of the car manually or by means of computerised diagnostic tools • Ordering parts from suppliers	**Analytical software to diagnose vehicles.** The car mechanic uses software to diagnose the cause of vehicle operating problems by tracing and locating defects and repairing malfunctions.
Repair car • Disassemble and repair car • Replace parts • Test and adjust repaired systems to meet manufacturers' performance specifications • Perform routine and scheduled maintenance services	**Online information databases for repair of vehicles** The databases provide service and repair information that helps the car mechanic to ensure that the repairs meet the manufacturers' standards. The Technical Service Bulletins, or TSBs, are specific for each vehicle.
Pre-repair dialogue with customers • Confer with customers to obtain descriptions of vehicle problems and discuss work to be to be done and future repair requirements. • Provide the customer with an estimate of the costs of repairing the car	**Automotive Customer Relation Management (CRM)** The car mechanic can use CRM software specifically developed for the automotive industry. Such CRM systems can be used to organise and keep track of all activities and services taking place between the customer and the repair workshop, such as scheduling repair appointments, progress of service and repair requests, invoice, past sales and repairs, etc.
Returning car to customer • Calculation of costs/hours spent on repair to prepare the bill • Inform customer about work performed, overall condition of car and future repair requirements • Return customer's car in a clean condition	

 Main work tasks	 Main use of ICT
General work planning and maintenance • Review work orders and plan work/staffing in dialogue with managers/supervisors • Maintain inventory of parts, tools and resources • Plan work procedures, use charts, technical manuals, and experience • Maintain clean work area	**Automotive facilities management software** Handles all activities and transactions related to the company such as maintaining history of work orders, tracking income, maintaining inventory and tracking employee hours.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

As the above table shows the car mechanic can use ICT in all main work tasks. The communication with customers may be supported with automotive CRM systems that can help to schedule repair appointments and keep track of past sales and services. Such CRM systems can also enable segmentation and retention of customers as well as marketing and sales activities. The introductory pre-repair dialogue with the customer about problems experienced with the car provides important indications for the car mechanic to identify the malfunctions.

When the car mechanic examines the car, computer-based diagnostic tools can be used to test and detect problems. Such software can be defined as expert systems supporting the car mechanic with artificial intelligence. In relation to the examination and repair of a car, the car mechanic can use online databases to access information on technical specifications and standards for specific types and brands of car, year of production, etc. Modern cars are becoming increasingly differentiated and complex and some of the brands have 40-50 different types of cars. This means that the technical standards and specifications related to cars have become enormous amounts of data. Before the advent of online databases, car mechanics had to go through big paper files. With the online databases, access to information has become more efficient. Each car brand has its own technical specifications, and some brands only pay for replacement of defective parts on the condition that the repair is carried out by a car mechanic who is specifically certified/authorised by the brand in question.

For the general planning of work orders, staffing, maintaining inventory, etc., specific automotive facilities software (ERP-systems) are available for managing car repair shops.

How ICT affects the quality of work

Overall, our interviews indicate that the increasing use of ICT in car repair shops means that car mechanics carry out fewer manual tasks while the number of analytical and problem-solving tasks has increased.

> *'Today the work needs fewer muscles and more brain'. (*Interview with employer)

The use of computer-based diagnostics systems means that car mechanics often do not need to disassemble the car manually to identify the problem. Instead, problems can be detected using computer-based software. Instead of repairing a defective part, mechanics more often replace the defective part since many parts are no longer made to be repaired.

The increasing use of complex ICT systems has broadened the span of skills and competences of car mechanics. The interviewed experts and employers find that this has increased the differentiation of competence levels for car mechanics. Experienced car mechanics with good digital skills can manage more advanced work tasks involving problem solving while less proficient car mechanics manage simpler work tasks. The use of ICT enables the car mechanic to handle all main steps before, under and after a car repair – from the introductory dialogue with customer, over the examination and repair - to returning the car to the customer. This is particular the case in small, independent car repair shops, while large brand repair shops often let customer relationships be handled by a separate organisational unit.

Digital skills

Advanced user skills to apply analytical software to diagnose vehicles.
The car mechanic must be able to use software to diagnose the cause of vehicle operating problems by tracing and locating defects and repairing malfunctions.

Advanced user skills for online information databases for repair of vehicles
The car mechanic must have advanced user skills for on line databases with technical specifications/information to provide service and repair information that helps the car mechanic to ensure that the repairs meet the manufacturers' standards. The Technical Service Bulletins, or TSBs, are specific for each vehicle.

Basic user skills for CRM-systems Automotive Customer Relation Management (CRM)
The car mechanic will typically need basic user skills to apply CRM software specifically developed for the automotive industry. Such CRM systems can be used to organise and keep track of all activities and services taking place between the customer and the repair workshop, such as scheduling repair appointments, progress of service and repair requests, invoice, past sales and repairs, etc.

Digital skills integrated with professional skills of car mechanics

Car mechanics need digital skills to use relevant software tools in carrying out the work. Interviews with experts and employers indicate that digital skills in themselves are of no value because they have to be integrated with deep knowhow on how a car functions and can be repaired. For example, when a car mechanic uses diagnostics systems to examine a car, he must understand how a car works to be able interpret the output and results of the diagnostics system. So apart from being able to read and understand an electric diagram, the car mechanic must also have a deep knowledge about the electronic network of a car.

Other complementary skills

Systematic diagnostic, problem-solving abilities

Use of diagnostic software to examine cars does not automatically produce a final and complete diagnosis of a problem. Instead, the car mechanic must be able to use his knowhow about the car's internal functions and reflect critically on the validity of the results. During such reflections, the car mechanic may need to do his own analysis and draw on his own or others' experiences with the same problem. The car mechanic may also need to gather further technical information from online information databases and other sources to make a sound analysis.

> *'Only every other fault can be identified by software, the rest must be found by using the brains. Therefore they must have an understanding of the car and the connections of things in it.'* (Interview with expert)

Ability to search, review and handle large amounts of information

Modern cars are becoming increasingly advanced and new versions appear at short intervals. Consequently, the amounts of information on technical specifications and standards for cars have increased significantly. Online databases enable car mechanics to access relevant technical information quickly. Consequently, the car mechanic must be able to search, review and handle large amounts of information to filter out the relevant information needed to understand the technical problems detected in the car. The interviewed experts highlight that manuals for car repairs are much longer and more detailed than they used to be. The car mechanic must have the ability to find the right page to get the information on how to fix the car. The technology and information change all the time, but they must be able to find the correct information in the online environment.

Communication, service and documentation skills in relation to customers

As the use of ICT enables the car mechanic to handle all main steps before, during and after a car repair the car mechanic increasingly handles communication and relations with customers. Before the repair, the car mechanic must be able to conduct a systematic dialogue with the customer to get information on symptoms and problems with the car. During the repair, the car mechanic must be able to develop documentation on any detected problems and which deficient parts that have been repaired or replaced. After the repair, the car mechanic must be able to inform the customer about his work the overall condition of the car and future repair requirements.

Self-learning competences and an open mind

The frequent new versions of cars and software systems mean that the car mechanic's skills must be continuously updated. Most of this updating takes place as informal peer learning or the car mechanics manage self-learning, e.g., reading manuals and instructions on their own.

The future

The adoption of ICT in car repair workshops has become quite mainstream. Interviewed organisations and employers find that this development has taken place over long time, which means that there has been time to invest in training to update employees. However, interviewed organisations at EU-level find that some countries and areas, such as Greece and Eastern Europe, tend to lag behind, still focusing and traditional mechanical skills.

Some of the interviewed organisations and employers also expect that the use of ICT in all work tasks will enable the car repair shops to do more 'data-driven business development'. The CRM systems make it possible to segment customers and improve the marketing of services to address specific customer segments.

Looking to the future, the interviewed organisations and employers find that there are challenges that complicate the work of car mechanics and repair shops. In order to be competitive, each brand tends to develop their own advanced ICT systems, which can only be used by certified car mechanics and car repair shops. This is a challenge to car repair shops because it restricts their markets. In addition, the many complicated systems make it difficult for independent all-round repair shops to span over all these systems.

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Interviewees

Henrik Pedersen, Din Bilpartner Amager, Denmark (company)

Georg Spöttl, Bremen Universitet, Germany (expert)

Michael Stabell, TEC Hvidovre, Denmark (ekspert)

Luc De Moor, EDUCAM, Belgium (organisation

Torben Krebs AIRC/SKAD, Denmark (organisation)

4. Dairy farmer

The context: ICT a solution for many challenges

The agricultural sector is facing a conflicting challenge, i.e. to produce more food and maintain high food quality and animal welfare standards while reducing its environmental footprint. The agricultural sector in Europe is under strong competition, because many other countries in the world are able to produce at a lower cost. Furthermore, cutbacks in subsidies at both the European and national levels are imminent.

ICT is regarded as having a great potential for addressing these challenge, because ICT can increase efficiency and productivity in a sustainable way. For example, with ICT, fertilisers and pesticides can be applied by machines guided by a GPS (Global Positioning System) to avoid overlapping applications, while sensors in the field can provide information on the state of the crop so that chemicals are only applied to the parts of the field where they are needed. Similar systems can be used to control irrigation helping farmers to reduce the amount of water supplied to the crop. For dairy farmers, robotics and ICT can also assist with livestock management, and large amounts of data can be gathered by automatic feeding systems, milking robots, milk analysis and sensors mounted on animals. Furthermore, automatic milking systems can reduce a lot of repetitive and physical hard manual work (European Commission, ERANET, 2010; ICT in Agriculture, 2012; ICT AGRI, 2015).

The job profile in focus: dairy farmer using automatic milking robots

On this background, this job profile focuses on dairy farmers who use automatic milking robots, ICT systems for herd management and other main functions on a dairy farm. Dairy farmers using automatic milking have been selected because such systems imply a significant change in the work, more radical than the use of ICT systems for staff planning, financial management and other office work. As dairy farmers often also grow crops to produce food for their livestock, the job profile also includes crop production.

The adoption of ICT in the European agricultural sector is still in its infancy, and there are major differences between the levels of farmers' use of ICT (ICT AGRI, 2014). Many farmers face technical, financial and skill related challenges when investing in ICT. Moreover, the size and diversity of farm structures in Europe complicate the adoption of ICT. Therefore, it must be emphasised that the present job profile describes dairy farming at advanced level of ICT use, which cannot be regarded as representative of the current dairy farmers in the EU.

The table below shows an overview of a dairy farmer's main work tasks and how ICT can be used to carry them out. The main work tasks in the left column are related to the main use of ICT in the right column.

 Main work tasks	 Main use of ICT
Herd management • Segregating animals according to weight, age, colour, and physical condition • Maintaining records on animals and examine animals to detect diseases and injuries • Working in conjunction with veterinarians to provide veterinary treatments, and to administer routine vaccinations and medications • Directing the breeding of cattle using recognised breeding practices to ensure stock improvement	**Herd management software** that tracks and maintains detailed records on livestock by each individual or group and to schedule vaccinations, testing, and breeding events.
Feeding and breeding • Routing the cattle into the milking parlour • Monitoring the automatic feeding of cattle	**Software for automatic feeding system** An automatic calf feeder dispenses a programmed amount of feed, which the calf can eat through a nipple feeding station.
Milking • Collecting the cows before milking and routing them into the milking parlour by 'forced traffic systems' • Monitoring automated inspection and cleaning of teats, • Monitoring automated attachment of milking equipment to teats • Monitoring extraction of milk and removal of milking equipment, routing of animals out of the milking parlour.	**Software for automatic milking systems (AMS)** A fully automated milking system includes a robotic manipulator in the milking unit. A robotic arm automates the tasks of teat cleaning and milking attachment and removes the final elements of manual labour from the milking process. The design of the robot arm and associated sensors and controls enable robust unsupervised milking.
Crop production • Inspecting fields to determine crop maturity and detecting disease or insect infestation. • Inspecting and directing crop production operations, such as	**Farm management software** to keep crop records, track harvest inventories, and handle irrigation. etc. **Satellite farm monitoring system** that supplies real-time data on crop

 Main work tasks	 Main use of ICT
planting, fertilising, cultivating, spraying and harvesting. • Monitoring and adjusting irrigation systems and fertilising systems according to crop needs and to avoid waste of resources	conditions in the fields. **Map creation software,** field mapping using GIS data and GPS data collection software capturing, editing, and displaying geographic information.
Staff management • Hiring, training, or supervising workers engaged in planting, cultivating, irrigating, harvesting, or marketing crops, in raising livestock	**Farm management software (ERP-system)** that supports planning and management of all the farm's functions
Financial management • Evaluating marketing or sales alternatives for farm or ranch products • Determining types or quantities of crops and livestock to be raised, according to market conditions • Preparing budgets for farm operations • Maintaining financial, operational, production, or employment records for farms.	**Farm accounting software** that manages accounting, cashbook and budgets.

Sources: interviews, job advertisements, www.animalcareers.com, www.ictcw.com, www.dutiesjob.com

Use of ICT in the job

Based on the above table and interviews, this section analyses (1) the work functions that use ICT, (2) how ICT is used in the job, and (3) for what purposes. In the analysis, we categorise the use of ICT according to its generic purpose, e.g. automation, information management and support for decision-making. As the table shows, a dairy farmer can use ICT in all main work tasks. In most work functions, *ICT is used for information management* and to *support decision-making.*

In herd management, for example, ICT can help the farmer to keep track of each individual cow and its condition, milk production, vaccinations and breeding. Similarly, in crop production, the farmer can use farm management software to optimise irrigation and administration of fertilisers by using GIS-data and GPS-systems to provide real-time data on crop conditions in the fields.

In staff management and financial management, the farmer can use farm management systems and farm accounting software to support decision-making in optimising the farm's production and sales. In these two functions, ICT is used for ERP-systems like in other sectors.

In feeding and milking, *ICT is used for automation* by replacing repetitive and manual work. A fully automatic milking system (AMS) has removed all manual tasks related to milking, including the cleaning of teats, fixing and removal of milking equipment, which are complex task requiring advanced robots. Some milking systems are semi-automatic because they leave some of these tasks to be done manually.

The interviewed representatives from agricultural organisations say that the use of full automatic milking robots is still not very common among dairy farmers and should not have the main role in the job profile. In contrast, they find that the use of ICT applications has penetrated many other work tasks – from herd management to financial management. They also comment that ICT for herd management that record the cattle's performance has become more common and that traditional milking equipment has imbedded ICT systems that record the milking process. Online banking is also considered to be important for farmers.

How ICT affects the job

In this section, we analyse how ICT affects the job profile, i.e. (1) how the use of ICT affects the overall 'quality' of the job, and (2) which skills become more important due to ICT use.

Overall, the use of ICT changes the workday of a dairy farmer to a more flexible workday with less physical work and more analytical problem solving, planning and management of information.

The workday becomes more flexible, because automatic milking means that milking no longer takes place at regular intervals. Traditionally, milking took place twice a day, early morning and evening, with a maximum time space between. Hence, the traditional milking routine put restrictions on the time management and personal life of the dairy farmer. In contrast, the automatic milking systems make the workday more flexible because the milking does not take place at fixed times. Instead, each cow voluntarily enters the milking equipment when it is ready to be milked, while the farmer monitors the milking process, feeding and other operations concurrently. Hence, this means that the farmer must be able to handle a more flexible workday where milking is taking place over a longer space of time.

Automatic milking also *reduces the hard physical work*. The interviewed dairy farmer said that because of his relatively high age he had invested in automatic milking because he was no longer able to manage the hard work on his own. If he had not invested in automatic milking, he believed that he would have had to employ more staff.
The use of ICT makes the job *more analytical,* e.g., the dairy farmer uses more time for information management, problem solving, planning and decision-making. In many work tasks, such as herd management, staff management and financial management, the ICT systems record and provide a broad collection of data that enable the farmer to conduct analytical, systematic and evidence-based planning and management of the dairy farm.

Consequently, the use of ICT requires the farmer to have sufficient digital skills to use the software, but also that the farmer is able to interpret the data and use the results consistently for planning and optimising the farm's production.

Digital skills

Advanced user skills for herd management software and automatic feeding systems
The dairy farmer needs advanced user skills for herd management software that tracks and maintains detailed records on livestock by each individual or group and to schedule vaccinations, testing, and breeding events. Similarly, advanced user skills are needed for automatic feeding systems that dispenses a programmed amount of feed, which the calf can eat through a nipple feeding station.

Advanced user skills to manage automatic milking systems (AMS)
The dairy farmer needs advanced user skills to manage automatic milking systems (AMS). However, the dairy farmer may buy expert advice from ICT specialist who help to install and calibrate the systems.

Advanced user skills for ERP-systems
Depending on the size of the farm and the number of employees, the dairy farmer may need advanced user skills for ERP-systems that supports planning and management of all the farm's functions, such as staff management and farm accounting software that manages accounting, cashbook and budgets.

The farmer needs continuously update on ICT
The dairy farmer needs a basic level of digital user skills to use the software applications. The various software applications are frequently updated and this requires the farmer to update his or her digital skills continuously to be able to use them efficiently. According to the interviewed organisations and employers, the software suppliers typically instruct the farmer in how to use the software and its functionalities. In addition, farmers can buy help from agricultural consultants on how to use the software. The interviewed dairy farmer told us that he continuously participates in ICT courses provided by the farmers' association. However, he explained, he is self-taught in many programs.

Other complementary skills

Information management and analysis
The use of ICT to support decision-making implies that the farmer needs skills to deal with the large amounts of data generated by ICT systems in herd management, feeding systems, financial management, map creation, etc. For example, milk processors in the automatic milking system deliver information to the farmer over the internet. Hence, the farmer can monitor the production on a daily basis and use the information to optimise the production.

Analytical skills to interpret data
As described above, in many work tasks such as herd management, staff management and financial management, ICT can be used to support decision-making. The ICT systems record and provide a broad collection of data that enables the farmer to conduct analytical, systematic and evidence-based planning and management of the dairy farm. Such data allow the farmer to improve his management through analysis of trends in the

herd such as the response of milk production to changes in feeding. The history of each cow may also be examined to identify unusual changes indicating illness or injury. Such information management is important in automatic milking. However, correct interpretation and use of such information are highly dependent on the skills of the dairy farmer. The dairy farmer also needs digital skills to handle the programs and use computer algorithms to create attention reports.

Innovation and planning skills

Automatic milking systems and advanced use of ICT is still not widespread among dairy farmers. The most innovative and curious farmers go ahead while many remain reluctant. Although most programs and applications are mature technology, which can be handled by non-ICT professionals, it requires careful planning and preparation to implement an automatic milking system. For example, the layout of the barn must be planned to enable 'forced traffic' of the cows to enter the milking machines. Furthermore, the barn should be set up in a way that ensures that the cows have access to feed and water. Moreover, they need a comfortable place to lie down and must be motivated to visit the milking system because good feed is available there. Hence, the implementation of automatic milking requires that the farmer has innovative skills and is prepared to reorganise his farm.

Combination of digital and business skills

Over the last decades, the agricultural sector in the EU has undergone major structural changes. The farms have become fewer and bigger, and farmers have become more specialised in their production. (European Commission, 2011). Hence, the establishment of a dairy farm requires a high level of financial investment and business skills to ensure a return on investments. The individual farmer needs digital skills to use ERP-systems for staff management and financial management of the farm's costs and revenues. ERP-systems generate many data. Consequently, the farmer also needs analytic skills to use these data for optimising and planning.

The future

This section focuses on the expected future use of ICT in the job, in particular whether the use of ICT will increase and what the drivers of and barriers to this development are. Interviews and desk research indicate that the use of ICT will continue to increase in agriculture driven by the need to increase economies of scale, quality, animal welfare, traceability of food production and sustainability in the use of resources. In particular, it is expected that use of ICT will enhance in the assessment of field and crop conditions. For example, drone technology, which is becoming cheaper, can save on labour for inspecting fields.

Although ICT can be found in many work functions, the interviewed organisations think that many farmers, especially older ones, are reluctant to make large investments in new technology. In Denmark, some dairy farmers who had invested in milking robots have gone back to manual milking and are recruiting manual labour, because they have found that the investments in and cost of automatic milking were too high (JP, 2015).

In general, many farmers depend on help from consultants to help them with implementation and management of ICT systems.

Looking to the future, ICT is not only regarded to have potential for improving production efficiency, but also to strengthen rural communities' ability to interact with other stakeholders, thus reducing isolation. ICT can widen the perspective of local communities in terms of national or global developments, open up new business opportunities and allow easier contact with friends and relatives (Stienen, Bruinsma & Neuman, 2007).

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Interviewees

Otto W. Pedersen, dairy farmer, cattle farm in Veflinge, Denmark (company)

Tom O'Dwyer, contact person Dairy, Ireland (expert)

Henri Holster, Engineer, Wageningen UR Livestock Research, the Netherlands (expert)

Mansel Raymond, Chairman of Copa-Cogeca, WP on Milk and Dairy Products, Belgium (EU-organisation)

Vibeke Christensen, Department manager - KvægIT (Cattle IT), SEGES - Danish Agriculture and Food Council, Denmark (national organisation)

5. Desktop publisher

The context: How ICT has changed the graphical and printing industry

Although the term 'desktop publishing' is a very commonly used term, it is relevant in this context to define and explain key elements of the concept, and how the technology of desktop publishing has been transformed by the use of ICT and the evolution of the internet. In fact, some of the interviewed organisations and employers find that the term 'desktop publisher', though still used, is an unclear and old-fashioned term because it mainly refers to various tasks in office and administration that have to do with the production of information, newsletters and other printed media.

Desktop Publishing (DTP) is a system of software and hardware that allows a user to create and print documents such as books, magazines, newspapers, etc. DTP software enables the user to see the document layout look the same on the screen, as it will when printed. The document layout is produced using 'frames', i.e. areas of the page that can contain text or images. The technology enables the user to handle text, images and layout in a very flexible way, such as letting text in frames 'overflow' into other frames. In addition, images can be added from scanners or digital cameras, then cropped, rotated, resized, etc. Where text and images overlap, text can be 'wrapped' around images.

ICT has transformed the production of graphics, text and images radically, and has made DTP technology easy to use and accessible to non-professionals. Before DTP became available, the production of a printed document with images required a professional designer and printer to do the work. In other words, before the advent of ICT, printing and publishing required creative craftsmen, whereas today it requires digital communicators. Now, with relatively cheap DTP software and a good quality laser printer, it is easy for anyone to produce their own posters, etc.

The use of ICT has blurred the distinction between DTP and multimedia-design. The difference between the two concepts is that 'multimedia' refers to a broader collection of media forms than DTP. Multimedia refers to documents or software applications that contain a mixture of text, images, animations, video, and audio.

The evolution of the World Wide Web has transformed printed information into electronic communication, and websites use many of the techniques that printed documents have used for hundreds of years, i.e. headings, columns of text, etc. For many people, most of the information that they consume each day comes via the web, rather than from printed documents.[4]

On this background, this job profile focuses on a desktop publisher working in an information/communication company. To illustrate how ICT has broadened the variety of media forms used, the profile's desktop publisher works with printed hard copy documents and creates graphic designs, layouts and finished artwork for various types of print materials and clients.

[4] The description of the context draws on interviews and the following sources: (Seligman, 2009) 'A Profile in Print. How technology has affected the industry through the years' and information from http://www.igcseict.info/index.html

 Main work tasks	 Main use of ICT
Contact with clients • Contact with the client clarifying their requests for the assignment/project • Electronic transfers of documents to and from clients and customers • Provide support to clients and end users, coordinate the development and transfer of files and documents	• **Presentation software** to present initial ideas and drafts to the client
Planning and implementation of the production • Planning how to solve a task by studying layout or other design instructions to determine work to be done and sequence of operations. • Prepare, edit and position text and graphic elements into a planned layout • Select the colours to be used • Create and revise work product using direct keyboard entry, scanner and electronic conversion methods of input. • Create special effects such as vignettes, mosaics, and image combining, and add elements such as sound and animation to electronic publications • Edit graphics and photos, using pixel or bitmap editing, airbrushing, masking, or image retouching	• **Desktop publishing software to** generate layouts and produce typographic quality texts and images comparable to traditional typography and printing. • **Graphics or photo imaging software** to manipulate visual images on a computer. • **Video creation and editing software** to make and edit films or animations • **Development environment software** An environment program is a computer system in which a computer program or software component is deployed and executed. • **Information retrieval or search software** to find relevant pictures or graphics. • **Optical character reader OCR or scanning** software to scan pictures to be integrated in the document
Collaboration with others • Collaborate with graphic artists, editors and writers to produce master copies according to design specifications.	• **Project web software/platform** for collaborating on project and exchanging information • **Web platform development software** to design, build, debug, and deploy websites
Quality assurance • View monitors for visual representation of work in progress • Check layout, font sizes, spelling, grammar, punctuation, sentence structure, etc.	• **Spell checkers,** e.g., spelling and grammar checking software

 Main work tasks	 Main use of ICT
Conversion of the product to various media forms • Finalise formatted files or documents for printing or electronic publication • Convert various types of files for printing or for the internet using computer software.	• **Data conversion software** to convert computer data from one format to another • **Web page creation and editing software** to create, edit, and update web pages and websites.
Client feedback and confirmation • Receive feedback on draft production from client • Delivery and accept of final product.	

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

As the table shows, the desktop publisher uses a wide variety of ICT tools in relation to most of the main work tasks. It must be emphasised that the ICT development of DTP is progressing continuously and that the list of ICT tools mentioned above is not exhaustive.

In particular, the desktop publisher uses ICT in the production of documents, publications or websites. ICT tools enable the desktop publisher to work more efficiently, edit and manipulate the documents or publications in many different ways by combining text, images, videos and audio. In short, the ICT tools increase the forms of expression and flexibility. The ICT tools also enable the desktop publisher to do quality assurance more efficiently. Depending on how complex or advanced a given assignment is, the desktop publisher will typically have to cooperate with other professionals such as graphic artists, editors and writers to produce master copies according to design specifications. Web-based platforms make it possible to cooperate via the internet enabling the desktop publisher to draw on relevant experts internationally independent of place and time.

How ICT has affected the quality of the job

Overall, the interviewed organisations find that the use of ICT has increased the speed of the DTP-production process. The use of ICT enables effective creation of visual media, better efficiency and quality as well.

The use of ICT has enabled the desktop publisher to produce more and be involved throughout the whole process of preparing and producing publications. Before, in the times of printed media, the desktop publisher would often be responsible for more specific tasks, such as typing or operating a scanner. Today, the desktop publisher needs to understand the entire chain of production.

> *'Back in the days you could be just a scanner operator or a typer, now you need to know the entire chain'. (Interview with employer)*

If the desktop publisher is familiar with the ICT tools, they enable him or her to process and manipulate the document or publication in a flexible and efficient way. Modern DTP software is very advanced, offering an almost overwhelming variety of editing functions. An experienced desktop publisher, who knows how to use the right ICT tools, can have a high level of productivity and manage more clients and assignments at the same time.

However, the interviews also warn that the speed of the production process may involve the risk of having less time for creativity and reflection. The interviews highlight that DTP is basically a *creative* job and that a good desktop publisher can create value for his or her clients by developing new and innovative solutions. However, the speed of the production process and the ICT tools that make copying and reusing elements very easy involve the risk of losing creativity and originality.

Digital skills

Advanced user skills to apply desktop publishing software
The desk top publisher needs advanced user skills to apply desktop publishing software to generate layouts and produce typographic quality texts and images comparable to traditional typography and printing.

Advanced user skills for editing software
Advanced skills are need to apply graphics or photo imaging software to manipulate visual images on a computer and video creation and editing software to make and edit films or animations

Digital skills for collaborating with others on web-platform
Very often desktop publishers co-work with graphic artists, editors and writers to produce master copies according to design specifications. This requires digital skills to use project web software/platform for collaborating on project and exchanging information.

ICT specialist skills for web platform development
Desktop publishers need skills to use web platform development software to design, build, debug, and deploy websites.

To be updated and familiar with relevant ICT tools – to be efficient
The interviews indicate that desktop publishers often work under tight deadlines, because their clients typically have to use the publications just-in-time for certain campaigning or business purposes. To keep deadlines, it is important that the desktop publisher is able to select and use the right tools for a given project.

Other complementary skills

Creativity combined with solid digital user skills

The interviews as well as desk research of job advertisements indicate that a good desktop publisher possesses solid creative skills, in particular in the field of design. The desktop publisher has to have a broad orientation in the field of design considering the aesthetic, functional, economic and socio-political dimensions of both the design object (the publication) and the design process. The creative design competences must be solidly integrated with technical and digital skills at user level, enabling the desktop publisher to navigate efficiently and use all relevant ICT tools and functions available for DTP. It is also important that the desktop publisher is able to adapt the design solutions to the technical requirements of the platforms used, e.g., Pitstop or Adobe Acrobat.

Colour management competences

Desktop publishers must be able to prepare publications for many different media platforms enabling multiple and colourful forms of expression and effects. Consequently, it is important that the desktop publishers have solid competences in colour management such as handling different files for different outputs and knowing the different settings for different colourings. This requires that they have solid digital competences and are experienced in using the software in graphic programs that manage and manipulate colours.

> *'The desktop publisher needs to know that colour management is an important variable for getting a good result.'* (Interview with employer)

To be able to handle many different media platforms

The general penetration of ICT and the internet in society has widened the range of media platforms for which the desktop publisher has to prepare publications. The interviews indicate that desktop publishers must be able to prepare publications for many different media platforms, from printed hard copy to mobile phones, tablets and websites. The key point today is that the publications are rarely limited to the printed media or electronic media.

The future

The interviewed organisations and employers believe that the adoption of ICT in the industry is progressing very fast and will continue to do so in the future. They expect that this development may lead to merging and increasing interaction of various occupations, such as desktop publishers and multimedia artists because both occupations prepare publications for the printed and electronic media. Both occupations also handle multiple media forms ranging from printed media to video, audio, and 3D animation.

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Jos Teunen, GOC (company)

Magnus Sandström, TMG Sthlm (company)

Paul Heide, Media College Aalborg (Ekspert)

Andrew Bracey, BPIF (organisation)

Karl Michael Meinecke, BVDM - German Printing and Media Industries Federation (organisation)

6. Doctor in a hospital (general internist physician)

The context: the potential of using ICT in health care

In parallel with any other industry, the healthcare sector is striving to reduce costs and increase productivity. The use of ICT provides potentials to address the following main challenges that confront the health care sector:

The aging population is causing an increase in the treatment of chronic disease. By their very nature, chronic diseases are expensive to treat while simultaneously burdensome on time for both patient and care providers. As populations age, there is a measurable increase in the cost of providing healthcare, which is compounded by shifts in the rates and types of illnesses being treated by clinicians. To combat disease and illness medical professionals are becoming more innovative in their treatments while expanding their areas of treatment from medical sites such as hospitals to engaging patients in a mobile setting.

In the world's developed economies, healthcare providers are not only tackling issues such as rising costs but also a fundamental shift in the way healthcare services are accessed. Patients are also looking to access healthcare services across borders - whether they are across counties, states or nations (Oostveen, 2014). The use of ICT (also called eHealth technologies) allows a mutually beneficial collaboration and involvement of patients and medical professionals in the prevention and treatment of chronic diseases. Overall, ICT can be used to ensure the top-quality health care of citizens.[5]

ICT is being adopted in all sectors of the health care systems in the developed economies. However, the most diverse and advanced use of ICT takes place in hospitals. Modern hospitals are very technical places with complex ICT equipment in wards, laboratories, pharmacies, and offices. They are also very large and so they need communication equipment to keep everyone in touch.

On this background, this job profile focuses on a 'doctor at a hospital'. As there are many types of specialisations, we have chosen to focus on a general internist physician. A general internist can be defined as a physician who diagnoses and provides non-surgical treatment of illnesses and injuries in internal organ systems.

The table below presents a general and simplified description of the main work tasks and ICT use a doctor can have at a hospital with an advanced level of ICT use. In real life, the organisation of work may differ from the profile description, as the doctor may be responsible for only some of the tasks.

[5] ICTforhealt.net : Why 'ICT for Health'? http://www.ictforhealth.net/index.php?option=com_content&view=article&id=45&Itemid=27

 **Main work tasks**	 **Main use of ICT**
Dialogue with patient • Dialogue with patients about symptoms • Explain procedures, prescribed treatments to patients and discuss test results • Advise patients and community members concerning diet, activity, hygiene, and disease prevention.	**Digital dictation & transcription software** Voice recognition software that enables the doctor to transcript dictation **Electronic dialogue translation systems** Computer based dialogue translation systems enable the doctor to translate and transcript interviews with foreign language patients without the personal presence of an interpreter.
Collecting/recording patient information • Collect, record, and maintain patient information, such as medical history, reports, and examination results • Prepare government or organisational reports on birth, death, and disease statistics	**Electronic Medical Record (EMR-systems)** EMR-systems are electronic medical records of patients' diagnoses, health condition, diagnoses, treatments and medicine administered over time. Typically, multiple healthcare providers can access an EMR-system and this allows for a better continuation of care as the patient moves to different locations throughout or outside the hospital. **Patient administration system** For keeping track of waiting list, appointments, coding of procedures and diagnoses, and patient billing.
Examination / monitoring of patient • Examination of patient and scanning of internal organs, if relevant	**Patient monitoring systems** Sensors attached to the patient monitor pulse, temperature, breathing rate, blood pressure and other parameters. The sensors feed information back to a computer, which processes the data to check for problems. In case of problems, an alarm can notify the nurse or doctor.
Developing diagnosis • Analyse records, reports, test results, or examination information to diagnose medical condition of patient	**Medical expert systems for diagnosis and treatment** The doctor can use expert systems to help develop a diagnosis. The doctor enters multiple data on the

Main work tasks	Main use of ICT
	patients' health status by answering questionnaire. Based on the data the expert system generates a prioritised diagnosis indicating the likelihood of certain diseases and may recommend treatments or additional lab testing. The system may also generate follow-up questions. (For example Analyst TM)
Treatment • Prescribe or administer medication, therapy, and other specialised medical care • Treat internal disorders/diseases • Direct and coordinate activities of nurses, students, assistants, specialists, therapists and other medical staff	**Body scanners** CT scanners and MRI scanners allow doctors to investigate what is happening inside a patient's body without intrusive surgery. The signals from the scanners are picked up by sensors and fed into a computer, which processes the data and develops output in full-colour images, sometimes in 3D, giving views of the inside of the patient's body. A physician with expertise in understanding the images interprets the images.
Evaluation of treatment • Refer patients to medical specialist or other practitioner when necessary • Monitor patients' conditions and progress and re-evaluate treatments as necessary.	**Electronic Medical Record (EMR-systems).** EMR-systems are used at this stage to document the patients' health record, diagnosis and the treatment.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

The above table shows that the doctor can use ICT in all the main work tasks related to the chronological process of a patient going through all the stages from the dialogue with the doctor, examination, diagnosis, treatment and evaluation.

In the dialogue with the patient, the doctor can *save time and be more efficient* by using digital dictation & transcription software and voice recognition software. In addition, electronic dialogue translation systems enable the doctor to translate and transcript interviews with foreign language patients without personal presence of an interpreter.

In the examination of the patient, the doctor can use scanning equipment as well as patient monitoring sensor systems providing information on the patients' pulse, temperature, breathing rate, blood pressure and other parameters. Data can be transferred wirelessly and digitally via a mobile phone. The use of ICT for examination and monitoring enables the doctor to save time and be *efficient*, as well as giving the patient more freedom and *flexibility* to continue their daily life, without having to be present all the time at the hospital.

In the *analysis* of health data and information about the patient, the doctor applies his key professional knowledge, competences and experience to develop a diagnosis. However, as medical research and knowledge is growing constantly, it can difficult and time-consuming for any experienced doctor to research and access updated knowledge. In order to save time and validate the doctors' own analysis, the doctor can use expert systems to help develop a diagnosis. The doctor enters multiple data on the patients' health status by answering questionnaire. Based on the data the expert system generates a prioritised diagnosis indicating the likelihood of certain diseases and it may even recommend treatments.

Throughout the whole process, Electronic Medical Record systems (EMR-systems) are used for documentation by updating the electronic medical records of the patients' diagnoses, health condition, diagnoses, treatments and medicine administered over time as well as for evaluating the treatment and referring the patient to medical specialist or other practitioner when necessary. Typically, multiple healthcare providers can access the EMR-system, and this allows for a better continuation of care as the patient moves to different locations through or outside the hospital. Furthermore, computerised EMR-systems are used for *communication and cooperation* by enabling patient data to be shared between doctors, pharmacies and other hospitals, but restricted and regulated by legislation on data protection.

How ICT affects the quality of the job

Overall, the interviews indicate that the use of ICT enables doctors in hospitals to save time and work more efficiently, because ICT provides electronic and quick access to relevant health data, expert information, and knowhow. The use of ICT enables doctors to work faster and handle more patients, in particular because ICT has relieved the doctors of paperwork and made the handling of information and communication faster.

> *'30 years ago, patient summaries were written on cards. Stuff like that is much easier today. The communication between doctors is so much easier to day – and the communication between doctor and patient is becoming easier as well.' (Interview with representative of medical trade organisation.)*

However, some of the interviewed organisations warn about the risks of working fast and using ICT without time for careful reflection. The use of ICT has increased the speed of decision-making. This is a risk, in particular in relation to the development of diagnosis and treatment, because it may be important to have more time to consider alternative interpretations and perspectives. The quote below explains this risk:

'It (ICT) also has some negative aspects: The speed of decisions has increased a lot. It can be a good thing, but sometimes it is important to take a step back and see the issue from another perspective. The use of ICT means that you are expected to react really fast – that is not always good for a doctor. (Interview with representative of medical trade organisation.)

The use of ICT provides tools that can make the work of doctors quicker and easier when carrying out all their main work tasks. However, at the same time, the interviews highlight that use of ICT does not in itself guarantee the quality of the doctors' professional medical assessment and decision-making. The use of ICT, even advanced expert systems, cannot automate or replace the very complex medical interpretation of health data and symptoms, which requires deep medical knowledge and long clinical experience.

Digital skills

Basic user skills to apply transcription and translation software

The doctor need basic user skills to handle voice recognition software that enables the doctor to transcript dictation. Similarly, basic user skills are needed for computer based dialogue translation systems that help the doctor to translate and transcript interviews with foreign language patients without the personal presence of an interpreter.

Advanced user skills to apply digital patient administration systems

Digital patient administration systems are key tools that the doctors and other health personnel use for keeping track of waiting list, appointments, coding of procedures and diagnoses, and patient billing.

Advanced user skills for patient monitoring systems

Digital patient monitoring systems enable the doctor on distance to monitor the patient's pulse, temperature, breathing rate, blood pressure and other parameters. The doctor must also be able to analyse the data and feedback information on the computer, which processes the data to check for problems. In case of problems, an alarm can notify the doctor or other health personnel.

Other complementary skills

Using ICT with careful reflection based on medical expertise and clinical experience

As mentioned above, the use of ICT makes the handling of information and communication easier and may increase the speed of decision-making. However, even advanced expert systems cannot automate or replace the very complex medical interpretation of health data and symptoms, which requires deep medical knowledge and long clinical experience. Consequently, the doctor has to draw on his or hers medical knowledge and clinical experience to question and validate the output of expert systems and consider alternative perspectives and interpretations. In other words, the doctor has to combine the use of ICT with personal professional knowledge.

In general, the interviews and desk research indicate that medical professional knowledge is regarded as a much more important prerequisite for doctors using ICT for health in a reasonable way than digital skills in themselves.

One of the interviewed organisations stressed that if ICT-software programs are difficult to use and require advanced digital skills, then they will not be successful in the health system, because they will be too time-consuming for the doctors, who will then have less time for their patients.

To be very aware of data protection and privacy legislation

The use of ICT and EMR-systems implies that the handling of personal and private digital health data becomes more transparent and all encompassing. Therefore, access to and exchange of personal health data are restricted by legislation. The doctor must be familiar with this legislation and know what information may be exchanged with other institutions or professionals in the health system. The quote below describes the risks of ICT:

> *'I need to say there are some huge advantages with the rise of ICT but there also are some risks! Especially of data protection and privacy rules. We are moving in to a situation where it does not seem important, but the easier it gets to access private data the more important it is to be aware of the risks!' (Interview with representative of medical trade organisation.)*

The doctor also has to be careful to inform the patient about the exchange of his or hers personal health data. Depending on national legislation, the doctor may be obliged to ask for the patient's consent to exchange health data.

Cooperation with general practitioners and other parts of the health system

The increasing use of ICT in hospitals is taking place concurrent with another general trend. Patients are typically discharged from hospital earlier than before and are transferred to medical follow-up in the primary health care system or community services. This trend requires that doctors in hospitals can cooperate appropriately with partners in the health care system and ensure that the patient experience continuity and coherence in their treatment. The quote below from a general practitioner explains this:

> *'The care of the complex ill patient is increasingly being transferred to community services. To deliver this care we work closely with community and hospital colleagues and are currently exploring ways to increase the integration with secondary care and expand what primary care can appropriately deliver.' (Interview with general practitioner)*

To be continuously updated on new ICT-systems

The interviews indicate that the adoption of ICT in the health sector to some extent is a problem for older doctors who are not as familiar with ICT as the younger generation. However, this problem is regarded as diminishing. The quote below explains why:

> *'Older doctors are not used to it (ICT). However, that is rapidly becoming a non-problem. No doctor today goes through medical school and becomes a doctor without being exposed to ICT-systems, it's bred into them.' (Interview with regional health authority.)*

To cooperate constructively with management on the implementation use of ICT

The adoption and implementation of ICT-tools in hospitals is the hospital management's responsibility. However, in order to optimise the use of ICT-tools, doctors should have a systematic and good introduction to new ICT-systems. In addition, they should

continuously cooperate with the management on improvements of the ICT-tools and their use. As the management may be non-medical generalists, they are very dependent on the doctors' constructive feedback.

The future

The interviewed organisations expect that the use of ICT will continue to increase. In particular, they expect that clinical routine tasks will gradually be taken over by ICT systems. The organisations also expect that ICT will provide more advanced tools and systems, which can do new analytical tasks that can support the doctor's medical analysis. For example, it will be possible to let ICT systems analyse pictures and scan them for tumours and warn the doctor to take a second look. The interviewed organisations also expect that part of what the doctors do today will be taken over by others, e.g., civil engineers.

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Interviewees

Per Meinich, Norge Helse Sør-Øst RHF, (Regional Health Authority) (organisation)

James Robinnson, Medical Director, East Cheshire NHS Trust (organisation)

Alex Jaekel, Policy Adviser for international department, Bundesärztekammer (organisation)

Dr Bernard Maillet, Vice Chair of the CPME eHealth WG (organisation)

Eirik Arnesen, Norwegian Medical Association (organisation)

Emma Spak, Swedish Association of Hospital Physicians (organisation)

7. Industrial designer

The context: the use of ICT in design

Industrial design can be defined as a process of design applied to products that are to be manufactured through techniques of mass production. Its key characteristic is that design is separated from manufacture, i.e. the creative act of determining and defining a product's form takes place in advance of the physical act of making a product, which consists purely of repeated, often automated, replication (Heskett, 1980). This distinguishes industrial design from craft-based design, where the product's creator determines the form of the product at the time of its creation (Noblet, 1993).

The use of ICT in industrial design, also called computer-aided design (CAD) has increased significantly over the last decades and is now common in industry. Most often, ICT is used in mass production, as computer control makes it possible to produce many identical items very quickly. However, ICT is also useful in small batches and even one-off work, as computer control enables complicated shapes to be produced more accurately than by hand.

ICT can help with designing products in many ways. For example, drawings, graphics and diagrams can be produced and edited using graphics or design software. Writing and drawings can also be combined using desktop publishing (DTP) software. Furthermore, pictures of existing products can be scanned and used in graphics, photo editing, or DTP software.

During the last decade, a new technology '3D printing', making it possible to 'print ' a 3-dimensional object, has matured and entered the field of industrial design. This technology may revolutionise industrial design as 3D printing makes it possible, fully or partly, to bypass the traditional production line assembly. In addition, the technology makes it possible to send a blueprint of any product to any place in the world to be replicated by a 3D printer.[6]

This job profile focuses on the job of industrial designers working in manufacturing where ICT use affects their work. Industrial designers are involved in key tasks throughout the design process.

[6] Rifkin, Jerry 2015. 'The Third Industrial Revolution. ' http://www.thethirdindustrialrevolution.com/

 Main work tasks	 Main use of ICT
Customer contact about design specifications • Contact with customer to clarify design specifications of the product • Present initial sketches of ideas using traditional drawing tools or computer-aided design.	**Computer aided design software (CAD)** is the use of computer systems to aid in the creation, modification, analysis, or optimisation of a design. CAD software can be used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and create a database for manufacturing. **Desktop publishing software** The industrial designer can use the software to create posters, publications or print media, which present the product. **Presentation software** to present graphical drafts to the customer **Graphics or photo imaging software** The industrial designer can use the software to manipulate visual images on a computer.
Exploration, calculation, test and approval of design specifications • Analyse and calculate model and simulation of design • Research production specifications, costs, production materials and manufacturing methods and provide cost estimates and itemized production requirements • Evaluate feasibility of design ideas based on factors such as appearance, safety, function, serviceability, budget, production costs/methods, and market characteristics • Present draft designs and information on production costs and requirements to customers or for approval and discuss need for modification • Prepare detailed drawings and blueprints using computer-aided design equipment	
Production • Investigate product characteristics such as the product's safety and handling qualities, its market appeal, how efficiently it can be produced, and ways of distributing, using and maintaining it • Develop manufacturing procedures and monitor the manufacture of their designs in a factory to improve operations and product quality	**Analytical software** to do calculations and simulations and model-based design related to graphic programming and the design process. **Digital cameras** which can be used to monitor internal functions in the production

 Main work tasks	 Main use of ICT
• Direct and coordinate the production of first models or samples • Produce models or samples in paper, wood, glass, fabric, plastic, metal, or other materials, using hand or power tools. • Coordinate product lines	**Video creation and editing software** The industrial designer can use the software to develop 3-D animation to visualise the product and its functions. **3D printing** Also known as additive manufacturing (AM), which refers to various processes used to synthesize a three-dimensional object.
Delivery of production • Delivery of production to the customer • Evaluation of production and follow-up on quality assurance and product improvement	

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

The above table shows that the industrial designer can use ICT tools in relation to most main tasks of the design and production process. In the initial contact with the customer, the industrial designer can apply traditional, manual drawing tools to sketch and clarify the dimensions, functions and specifications of the product, or alternatively, a computer-aided design program (CAD). The advantage of CAD is that the product can be drafted and presented in 3D and colours. In addition, various qualities about the size, dimensions, material and strength of the product can be presented to the customer and modified in a collaborative, creative process.

Hence, ICT will typically be used in a continuous process from the initial customer contact about design specifications and throughout the exploration, calculation, test and approval of design specifications. During these two stages, the industrial designer will explore, calculate and model the product, and maybe return to the customer with various draft proposals. When the essential specifications of the production have been clarified with the customer, the industrial designer can begin to prepare the actual production process.

Nevertheless, at this stage the developmental process will typically continue, as the industrial designer has to examine product characteristics such as the product's safety and handling qualities, its market appeal, how efficiently it can be produced, and ways of distributing, using and maintaining the product. During this process, the industrial designer may also use analytical software to do calculations and simulations and model-based design related to graphic programming and the design process. Finally, when the first pilot-product is produced, the industrial designer may use digital camera that can be used to monitor internal functions in the production.

During the last decade, 3D printing technology has become available to industrial designers. 3D printing, also known as additive manufacturing, refers to various processes used to synthesise a three-dimensional object. In 3D printing, successive layers of material are formed under computer control to create an object. These objects can be of almost any shape or geometry and are produced from a 3D model or other electronic data source. A 3D printer is a type of industrial robot.

How ICT affects the quality of the job

Overall the interviews indicate that using ICT provides tools that enable the industrial designer to enhance the *speed and efficiency* of the design process and the preparation of the production. ICT tools for CAD make it possible to draw and model products in 2D and 3D and simulate various qualities and alternative uses of materials. However, the interviewed organisations and employers warn that ICT programs should only be regarded as tools that should be *used in a balanced way*, because *ICT tools cannot replace the innovative and creative skills* of an industrial designer.

The following quote explains this balance:

> *'The designer must be able to use the various software tools and find the relevant, factual knowledge. However, when the industrial designer uses these tools the designer should be aware that the tools and their functions form his or her thoughts. Intense use of ICT in the design process can have a downside, because in many cases ICT tools lead the user towards solutions that are the most easy to draw, and do not challenge the designer to think unbounded and creatively.'* (Interview with employer)

Using ICT tools to analyse and simulate design models means that the industrial designer *has to have access to more complex information and data on multiple platforms of communication.* This means than an industrial designer needs to have presentation and communication skills to convey drafts of the products to the customers and various other professional partners. The other professional partners may contribute with relevant market information or knowledge on specific materials or production aspects. In addition, it is important that the industrial designer be able to select and present the relevant information such as production requirements and costs of alternative design solutions and materials.

Using 3D printing enables the industrial designer, fully or partly, to *automate the production and manufacturing process*. A 3D printer can develop and print complex, geometric physical forms that would be very difficult to produce in traditional manufacturing processes. 3D printing also enables the production of lightweight optimised components that are impossible to make with traditional techniques.

Digital skills

Advanced user skills for Computer Aided Design software (CAD)
The industrial designer need advanced user skills to use computer systems to aid in the creation, modification, analysis, or optimisation of a design. The use of CAD software is key to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and create a database for manufacturing.

Advanced user skills for 3D printing
The industrial designer needs advanced user skills for 3D printing, (also known as additive manufacturing), which refers to various processes used to synthesize a three-dimensional object. In 3D printing, successive layers of material are formed under computer control to create an object. 3D printing enable the industrial designer to create complex, three-dimensional forms that would be very difficult or time consuming to create by hand.

Advanced user skills for analytical software
The industrial designer uses analytical software to do calculations and simulations and model-based design related to graphic programming and the design process. The use of analytical software is important to research production specifications, costs, production materials and manufacturing methods and provide cost estimates and itemized production requirements.

Digital skills using multiple ICT tools efficiently
The industrial designer must be familiar with multiple ICT tools used in the design and production processes. In particular, the designer must be skilled at drawing in 3D and 2D. In addition, the designer must be skilled at developing a physical presentation of the model using relevant materials and tools such as moulding forms, laser cutters, or 3D printers.

Other complementary skills

Holistic thinking combining creative design with aspects of production, cost and resources.
The industrial designer must be able to relate the industrial design of a product to a broad context of various factors that influence the adequateness of a given design solution. The designer must be ready to investigate product characteristics such as the product's safety and handling qualities, its market appeal, how efficiently it can be produced and ways of distributing, using and maintaining it. The following quote describes the skill of holistic thinking:

> *'The industrial designer must be able to think as holistically as possible. Not just focus on individual objects, but the whole product and its process from 'cradle to grave'. In particular, it is important to think of resources: The more the industrial designer can combine innovative solutions with efficient and sustainable use of resources, the better. Therefore, the industrial designer must be good at working with researchers and economists'.* (Interview with employer)

In addition, the industrial designer must be interested in people, as a product is designed for people. The designer must have empathy and understand why people behave the way they do. Consumer research tools are increasingly important to designers.

To involve the customer in the design process

The industrial designer must be able to use the customer as a resource. This means that the designer should be able to facilitate a systematic dialogue with the customer about the product's specifications and desired qualities. In the early stages, the dialogue should be explorative and consider various alternative solutions.

Visualisation skills, visual language and communication skills

The industrial designer must have good visualisation skills (such as sketching, 3D modelling and rendering) and a nuanced visual language to define and communicate product concepts. In addition, the designer must be skilled at creating effective and appropriate visual languages by understanding the meaning and effect of these on the brand, audience, market and culture. It is important to be able to communicate ideas clearly and persuasively at individual and group level to team members, suppliers and business contacts. This requires that the industrial designer is skilled at developing the right communication style and influencing tools.

To balance artistic creativity and originality with functionality

Although ICT tools can increase the speed of developing complex designs, they cannot replace the creative process of developing innovative solutions for the customer. However, the interviewed employers find that it is important that the industrial designer be careful to balance new 'artistic' ideas with functionality. In addition, the industrial designer should be good at balancing artistic design with production costs and the limitations of the materials chosen.

To combine analytical and conceptual skills with teamwork

The industrial designer must be skilled at thinking analytically and creatively. However, the designer must also be able to work in a team and share the team's knowledge to create meaningful and innovative solutions. Together with their teams, industrial designers should be good at analysing information to form an understanding of the design context relevant to their specific domains, business areas, markets, and target groups.

The future

The interviewed employers think that the use of ICT in the industrial design process will continue to increase and that the interface of design programs will become more intuitive and user-friendly. They generally think that the education and training programmes for industrial designers develop the right skills. However, as regards the digital skills of

industrial designers, some of the interviewed employers find that it can differ between schools which ICT tools they teach the students to use.

The interviewed organisations think that the most important technological change currently and in the future is the 'Internet of Things' (IoT). The IoT is the network of physical objects embedded with electronics, software, sensors, and network connectivity enabling these objects to collect and exchange data. The IoT allows objects to be sensed and controlled remotely across existing network infrastructures, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.[7] The IoT affects the work of industrial designers significantly, who increasingly must be skilled at combining products with embedded ICT objects, which can connect to other products and exchange data. The IoT widens the scope of industrial designers' professional field, as they are no longer just developing a physical model or product but a solution.

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Interviewees

Henrik Jeppesen, Attention Group, Denmark (company)

Lauri Hirvesaar, Cleveron, Estonia (company)

Paul Gardien, Phillips Design, the Netherlands (company)

Paul Surridge, Technical and Professional Recruitment, UK (company)

Ronald Lewerissa, Flex.nl, the Netherlands (expert)

[7] Internet of Things Global Standards Initiative. http://www.itu.int/en/ITU-T/gsi/iot/Pages/default.aspx

8. Machine operator in metal industry

The context: the increasing use of ICT in manufacturing

Over the last decades, the use of computers in manufacturing has increased. Computer integrated manufacturing (or computer-aided manufacturing) implies that computers, robots and sensor technology are used to manage, control and automate the production process. ICT is used in manufacturing in multiple tasks such as computer-aided design (CAD), computer-aided engineering (CAE), CAPP (Computer-aided process planning) and CAQ (computer-aided quality assurance). In the metal industry, manufacturers use CNC (Computerized Numerically Controlled) production machines that are controlled by a computer to manufacture uniform metal parts with complex structures.

The advantage of computer-integrated manufacturing is that it can make manufacturing faster and less error-prone and that the number of hard, manual, repetitive and boring production tasks can be reduced. Robots are more accurate than humans are and can do the same task repeatedly at the same level of quality. Robots can work non-stop 24 hours a day, 7 days a week. Robots can also work in environments that would be too dangerous for humans. Hence, the use of computer integrated manufacturing and robots can make production processes more efficient. (ICTLounge, 2015) Furthermore, computer-integrated manufacturing can make manufacturing processes more sustainable because CAD/CAM systems enable a better use of materials and resources as well as lifetime assessments and recycling.

Manufacturing is undergoing a general trend from mass production to mass customisation, where products are differentiated according to the specific needs of the customers and different markets. In order to adapt to customers' shifting needs the production series are shorter. The increased complexity of production and the need for flexibility requires advanced automation technologies that can easily be reconfigured to address shifting production needs. However, industrial robots also represent challenges, as they can be complex and difficult to program, which can lead to high changeover times when manufacturers introduce new products. (Pedersen et. al, 2015)

Job profile in focus: machine operator in the metal industry

On this background, this job profile focuses on computer controlled machine operators working in the metal industry producing metal parts for cars. The job profile has been chosen because it is a classic manufacturing job employing many people across various industries.

The following table shows an overview of the machine operators' main work tasks and main use of ICT.

 Main work tasks	 Main use of ICT
Prepare production • Review blueprints/drawings and specifications of the metal work pieces to be produced • Measure dimensions of the metal work pieces to be produced to ensure conformance with specifications, • Determine and set machine operations and sequencing, finished work piece dimensions, or numerical control sequences • Install and secure tools, attachments, fixtures, and work pieces on machines, using hand tools and precision measuring instruments.	**Computer-aided Design Software** CAD software aids the machine operator in the creation, modification, analysis, or optimisation of a design. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. **Machinist calculating software** The machine operator uses it to calculate dimensions before production such as hole positions, chamfers, sine bar stacks (centre-to-centre distance between the cylinders), dovetail measurements, bolt circles, etc. (Examples: CNC Consulting Machinists' Calculator, EditCNC software).
Production • Enter control instructions in machine control units to start operation • Operate computer-controlled machines or robots to carry out one or more machine functions on metal work pieces • Stop machines to remove finished work pieces or to change tooling, setup, or work piece placement • Check that work pieces are properly lubricated and cooled during machine operation	**Project management software** The software is used to assist a project manager in developing a plan, assigning resources to tasks, tracking progress, managing the budget, and analysing workloads. Typically, the machine operator is not responsible for overall project management, but as member of the project team, he has to know the project plan, deadlines for assigned tasks, etc.
Quality control and program adjustment • Modify cutting programs to account for problems encountered during operation and save modified programs • Monitor machines during operation to detect problems	**Computer-aided manufacturing (CAM) software.** The machine operator uses the CAM software to control machine tools and related machinery in the manufacturing of work pieces. CAM is also used in other operations of a manufacturing plant,

 Main work tasks	 Main use of ICT
• Confer with supervisors or programmers to resolve machine malfunctions or production errors or obtain approval to continue production.	including planning, management, transportation and storage.
Preparing new production • Implement changes to machine programs and enter new specifications using computers • Clean machines, tooling, or parts, using solvents or solutions and rags	

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

As the above table shows, the machine operator can use ICT in all main work tasks in the manufacturing process. The key responsibility of a machine operator is maintaining, checking, and operating machines and equipment that are used in the manufacturing of parts or products. The machine operator is often responsible for operating machines in one production line. To keep production running, the machine operator may also be responsible for ensuring that all production materials are never short. The machine operator may also be responsible for monitoring multiple processes and production lines at the same time.

Looking across the work functions, ICT is used as a tool that enables the machine operator to *do the tasks more quickly*, and with *greater precision and quality*. In the preparation, for example, CAD (computer-aided drawing) enables the machine operator to use CAD software, which replaces manual drafting with an automated process. The machine operator can use 2D or 3D CAD programs, which help them to visualise the work piece to that they are producing and simulate how it will work. In addition, the machine operator can use machinist calculating software to calculate the dimensions before production such as hole positions, chamfers, sine bar stacks (centre-to-centre distance between the cylinders), dovetail measurements, bolt circles, etc. CAD and calculation enable the machine operator to transfer the digital drawings or calculations to

others in the production team and cooperate with them. In other words, ICT increases the *transferability of information.*

Furthermore, CAM (computer-aided manufacturing) can automate the production process fully or partly, which reduces the number of repetitive, manual tasks. While the automated machine is running, the machine operator *monitors* the machinery to detect malfunctions. The machine operator *controls the quality* of the finished products and adjusts the programming of the machines accordingly.

How does ICT affect the quality of the job?

The use of ICT affects the quality of the job of a machine operator significantly. Thus, the job involves more monitoring work and less manual work. The number of manual, repetitive and boring tasks is reduced because the production process is automated fully or partly.

Interviewed employers and experts find that the machine operator's job becomes more *independent* because CAM enables the machine operator to manage and monitor a whole production line and to manage the quality of the finished products. The interviews indicate that machine operators become better at multitasking, because increasing automation allows machine operators to be in control of multiple machines at the same time. Hence, the job of machine operators becomes more *varied.* This trend is also driven by the team-oriented 'lean' manufacturing, which requires machine operators to rotate between different machines. The more varied work also requires that machine operators have a wider range of skills.

Viewed in an overall perspective, computer-aided manufacturing increases the autonomy of machine operators because ICT empowers them by increasing their access to information and tools to maintain and monitor the production process on their own and in cooperation with others in the production team.

Digital skills

Advanced user skills for computer-aided manufacturing (CAM) software.
The machine operator needs advanced user skills to use CAM software to control machine tools and related machinery in the manufacturing of work pieces. CAM is also used in other operations of a manufacturing plant, including planning, management, transportation and storage.

Advanced user skills for calculation software
The machine operator uses calculation software to analyse dimensions of the product before production such as hole positions, chamfers, sine bar stacks (centre-to-centre distance between the cylinders), dovetail measurements, bolt circles, etc. (Examples: CNC Consulting Machinists' Calculator, EditCNC software).

Basic user skills for project management software
The machine operator may use such software to assist a project manager in developing a plan, assigning resources to tasks, tracking progress, managing the budget, and analysing workloads. Typically, the machine operator is not responsible for overall project

management, but as member of the project team, he has to know the project plan, deadlines for assigned tasks, etc.

Advanced user skills for skills for programming

Machine operators working in companies with an advanced level of ICT adoption need to have digital skills related to CAD, CAM, and CNC machines. The use of such systems, robots and other programmable devices requires that machine operators have digital skills to be able to enter the data and instructions needed for production. The Interviewed employers explain that machine operators need to be familiar with several programming languages.

The interviewed machine operators and experts find that CAD/CAM and CNC programs tend to become increasingly complex and that it takes time and practical experience to know all their operations and functions.

The interviewed employers describe that the use of ICT causes a differentiation of digital skill levels between machine operators. The most experienced and digitally skilled machine operators do the programming and enter data and specifications, while the less digitally skilled use the programs and monitor the production. In case of technical problems, the most digitally skilled may be involved in trouble shooting.

Other complementary skills

The increasing use of CAM and other forms of ICT affect the complementary skill needs of machine operators because the jobs change their role and responsibilities.

Self-directed learning and continuous update of digital skills

The increasing use of complex programs for computer-aided manufacturing requires that the machine operator proactively pursues new information and learning to update his digital skills. The update of digital skills can take place as formally arranged training and education. However, as machine operators increasingly work independently, much of the update of digital skills requires that they manage self-directed learning and review documentation, technical manuals and instructions by themselves.

> *'10-15 years ago, we would have managed the update with peer learning and on-the-job-training. Today you are just handed a thick manual and are expected to learn by yourself how to use the machine.' (Interview with employer)*

Language skills

Machine operators have to be able to read and understand complex technical manuals and instructions. According to the interviewed machine operators, this requires language skills, in particular English and to some extent also German. Furthermore, the machine operator needs good communication skills in the interaction with customers and other members of the production team. The interviewed employers find that CAM tends to make the organisation 'flatter' increasing the communication between at the production floor.

Calculating skills and accuracy

Machine operators need good maths skills to be able to prepare precise specifications of the shapes and dimensions of the work piece to be produced. It is very important that the machine operator is meticulous and can do very precise calculations and measurements as just small inaccuracies can cause defective products and production delays. Although CAD software and calculating software can do the calculations, the machine operator needs solid maths skills in order to examine the correctness of results and to solve problems.

Innovative, developmental skills optimizing production processes

In order to improve to improve ROI, efficiency and competiveness, manufacturing companies constantly pursue production optimisation by improving the organisation of production processes. As machine operators increasingly work independently, the production improvement often involves the knowhow of employees working on the production floor to find ways to optimise production processes. This can be defined as a bottom-up approach to improve production (Palmquist, 2015). In order to contribute to the continuous improvement in production, machine operators need innovative and problem-solving skills to be able to identify potential improvements.

The future

Although computer-aided manufacturing is becoming mainstream, the adoption of robotic technology is challenged by barriers and resistance. Much of this resistance seems to be related to cost, expertise and a lack of understanding of how these technologies can lead to an attractive return on investment - both up-front and ongoing - through maintenance and programming of new tasks. (PwC, 2014). Our interviews with employers and experts also indicate that there are barriers related to reluctance among older employees who need to develop digital skills. Therefore, the machine operator working with an advanced level of ICT and robotic manufacturing may currently not be representative.

Looking to the future, the technological development may provide CAD/CAM systems that become ever more advanced and can 'replace' human thinking and problem-solving. For example, CAD software incorporating information about the nature of materials such as their weight, tensile strength, flexibility and other qualities. By including this and other information, the CAD system could then 'know' what an expert engineer knows when that engineer creates a design (InC.Edu, 2015).

Additive manufacturing (AM) (3D printing) is a technology that may radically change the job of machine operators. AM refers to various processes used to synthesise a three-dimensional object. In 3D printing, successive layers of material are formed under computer control. These objects can be of almost any shape or geometry and are produced from a 3D model or other electronic data source. A 3D printer is a type of industrial robot. From an industry perspective, AM technologies have the potential to significantly affect traditional production models in terms of industrial machinery, assembly processes, and supply chains (Wei, Gao et al.2015).

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Wei, Gayo et al. 2015. 'The status, challenges, and future of additive manufacturing in engineering'. Computer-Aided Design, Volume 69, December 2015, Pages 65–89.

Interviewees

Søren Kromann Hansen, Denmark (company)

Marco Taisch, Italy (expert)

Torben Andresen Lindhardt, Danish Metal Workers' Union, Denmark (organisation)

Niels Chr. Nielsen, Confederation of Danish Industry (Organisation)

9. Police detective

The context: the use of ICT in police work

The rapid developments in ICT have had major influence on police work. In terms of the police, ICT plays a dual role where new technologies can support police work but they also provide new opportunities for offenders to commit crimes, such as online fraud, cyberterrorism, financial crimes and other forms of cybercrimes. In addition, globalisation, open borders, the free flow of people, goods, information and capital also facilitate the planning and committing of crimes. Politicians and police forces need to address these problems. Consequently, police work is a highly complex, challenging and information-led activity that requires the integration of multiple data sources, often in short periods. ICT systems present solutions to this challenge enabling police forces to increase their capabilities.

New technology in communication, data analysis and mobile computing has huge potential for policing. For example, the advent of always-connected smartphones and tablets backed by access to large amounts of public and police-specific data mean officers can potentially be better informed and make better use of their time than before. In addition to systems that are specifically designed for the police, the public's ICT use may offer the police new means of dealing with their tasks (COMPOSITE, 2011).

However, adoption of ICT raises new challenges as the legislation regulating police work is regulated, which is also reflected in the organisation of police work. The division of policing into separate law enforcement units can cause ICT fragmentation and reduce interoperability. The introduction and implementation of ICT tools and systems is challenging, and, at the same time, there is frustration with old technology used in policing and the slow pace of change. There is a need to share data efficiently with partner agencies, and this requires an agile organisation and flexible contracts with ICT providers (Anderson, 2013).

This job profile focuses on the work of police detectives. Police detectives conduct general, classical police work including investigating crime scenes, gathering and analysing information, and developing evidence. These generic tasks were key activities of police work long before the advent of ICT. Hence, selecting police detectives as a case enables us to analyse how the dual role of ICT mentioned above affects police work, i.e. how ICT has changed society and the crime forms, and how police detectives use ICT tools and systems in their work.

The table below shows the main work tasks of a police detective related to the use of various ICT tools and systems.

 Main work tasks	 Main use of ICT
Investigation and gathering information • Organise scene searches, assigning specific tasks and areas of search to individual officers and obtaining sufficient lighting if necessary. • Examine crime scenes to obtain clues and evidence, such as loose hairs, fibres, clothing, or weapons • Obtain evidence from suspects • Organise photographs to be taken from all angles of relevant parts of a crime scene • Obtain facts or statements from complainants, witnesses and defendants, and record interviews, using recording devices. • Examine records and governmental agency files to find identifying data about suspects • Maintain surveillance to obtain identifying information on suspects. • Monitor and record progress of investigation, maintain informational files on suspects, and submit reports to commanding officer to authorise warrants.	**Graphics or photo imaging software** Digital Image Management Solutions Crime Scene; The CAD Zone, The Crime Zone, etc. **Digitally controlled surveillance systems** Digital Vision Security, etc. **Automatic number plate recognition systems** to monitor and spot vehicles **Digital biometric information** Fingerprint technologies and DNA-profiling, etc. **Systems for recording and storing interviews and videos** digitally to make them accessible to other police officers involved in the case.
Processing and analysing information • Organise the preservation, processing, and analysis of items of evidence obtained from crime scenes and suspects, placing them in proper containers and destroying evidence no longer needed. • Note, mark, and photograph location of objects found, such as footprints, tire tracks, bullets and bloodstains, and take measurements of the scene.	**Digital biometric information** Fingerprint technologies and DNA-profiling, etc. **Map creation software, using digitally geo-referenced information supports** Crime mapping software, Geographic Information System GIS software, etc. **National networked databases and information systems**

 Main work tasks	 Main use of ICT
	Allowing the police to share information throughout the country making it easier for them to collaborate and piece together evidence.
Prepare case and charges based on evidence • Prepare charges or responses to charges, based on evidence. • Provide testimony as a witness in court • Present relevant evidence in court	**Case management system** to prepare cases in the police system and exchange data with prosecution authorities.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

The above table shows the main work tasks of a police detective ordered as a sequence starting from the investigation of the crime scene to the processing of information and preparation of the case and charges based on the evidence. Some of the tasks, such as collection and processing of forensic evidence, may be carried out by assisting staff and forensic specialists in laboratories and not by the police detective himself. However, it is the police detective who is responsible for coordinating the investigation and who is responsible for interpreting the evidence. In the investigation of the crime scene, the police detective may use data from various ICT tools to support the gathering of information and evidence in ways that are more *efficient and reliable* than personal observations. For example, the police detective can gather various types of information based on graphics or photo imaging software, digitally controlled surveillance systems and automatic number plate-recognition systems. Such systems also enable the police to gather and filter information automatically and save many man-hours of police patrolling and observation.

After the gathering of information and data, the police detective can apply various ICT-tools to *process and analyse data* in the search of evidence. The police detective can apply digital biometric information technologies such as fingerprint and DNA-profiling technologies. Using national networked databases and information systems enables the police detective to match fingerprints or DNA profiles from thousands of individuals efficiently. ICT can also be used to display and analyse data very quickly to get an

overview and search for patterns. For example, map creation software and digitally geo-referenced information supports can be used to identify patterns in locations of incidents and transport behaviour of individuals. Moreover, digitally geo-referenced information supports statistics that can be accumulated and made accessible to decision makers.

National networked databases and information systems allow police detectives to access and share information all over the country, making it easier for police detectives to cooperate and piece together evidence. The system enables them to link electronic data sources and criminal intelligence information to increase efficiency, because data only have to be registered or accessed once.

During the preparation of charges, the police detective can use a case management system to prepare cases in the police system and exchange data with prosecution authorities. Such systems enable more *effective information management*, which can increase continuity and ensure that cases move quicker through the court system.

How ICT affects the quality of work

Overall, the interviews with organisations and police detectives indicate that using ICT increases the *speed and efficiency* in the gathering, exchanging and analysing of information and data. In addition, use of ICT also increases the reliability of data gathered and processed, because ICT tools make it possible to gather and *analyse data reliably*, and much quicker and better than the human brain. Use of ICT tools implies that the amount of available data, in particular digital evidence, tends to increase in most cases, which means that the police detective must be able to understand and *analyse multiple forms of data*.

Using national ICT systems to record and store information digitally instead of paper-based filing enables police detectives to *access and share relevant information much more efficiently* with colleagues and other police units, who can be engaged in the case when relevant, irrespective of time and place. For example, by using iPads, patrol cars can look up and check number plates instead of having to call the police station or operation centre.

The following quote exemplifies this quality:

> *'By using the intelligence system for spreading out secret national information within the police, for example, if there is a drug dealer in a special area, we can enter information into the system and all investigators that are working with this particular drug dealer can read about it.'* (Interview with police detective)

This tends to make the work of a police detective more transparent to others and involve more online communication with colleagues and other police departments/units. However, the interviews also indicate that the exchange of information between police departments may differ due to different ICT systems.

The following quote exemplifies this challenge:

> *'If an officer needs a case from another district, he or she needs to import the case from that particular district. One officer can send the case number to another officer within the district who can then look up the case in the system. However, if the officer who is receiving the case does not work in the district, the case has to be exported instead.'* (Interview with police detective)

The quote shows that the division of policing into separate law enforcement units can cause ICT fragmentation and reduce efficiency and interoperability.

Digital skills

The increasing availability and use of ICT in police work implies that police detectives must be familiar with relevant ICT tools to support their investigation tasks. However, the interviews indicate that police detectives' exposure to ICT varies from field to field. Some police detectives only need basic digital skills at user level.

> *'You need to be at a certain level when you come here. It also depends on which kind of work you do. If you work in the IT department then you need high skills for that. We have internal computer courses to help people get better.'* (Interview with police detective)

In contrast, police detectives working in specific units such as cybercrime are required to have advanced digital skills. Similarly, police detectives working with financial crimes are also require to have advanced digital skills since these crime forms increasingly take place online.

Advanced user skills for national databases and information systems

The police detective needs advanced user skills for national databases and information systems. The use of such databases linking information and evidence/findings are key to efficient detective research. For example, using national networked databases and information systems enables the police detective to match fingerprints or DNA profiles from thousands of individuals efficiently.

Advanced user skills for crime mapping software

The police detective need advanced user skills to apply map creation software and digitally geo-referenced information to identify patterns in locations of incidents and transport behaviour of individuals.

Advanced user skills for case management systems

The police detective must be skilled in using a case management system to prepare cases in the police system and exchange data with prosecution authorities. Such systems enable more *effective information management*, which can increase continuity and ensure that cases move quicker through the court system.

Other complementary skills

Analytic skills for interpreting multiple data

Although ICT tools, such as surveillance cameras and digital biometric information programs for processing forensic evidence, can provide quick and reliable results, they can never replace the classical analytical reflections of the police detective. The police detective is responsible for analysing evidence and other relevant data to deduce facts and consider alternative theories or explanations. Using ICT has increased the amount of available data, which means that the police detective must be able to combine and analyse multiple forms of data and evidence.

> *'The police also have a forensic centre that uses computers to analyse evidence but the police detectives are responsible for the analysis.'* (Interview with expert from police technology centre)

Continuously update digital skills and experience

ICT tools for police work are developing fast, and this means that police detectives must be open to new technology and get practical experience using them.

> *'Important to be a fast learner. Find it easy to corporate with other people. Curious and want to learn more. It is necessary to want to learn throughout your whole career as it is to be able handle all the systems that are required.*' (Interview with police detective)

The interviews indicate that young police officers are quite familiar with ICT tools, while older police officers typically need extra training.

Handle digital information carefully in accordance with law regulations

The use of ICT means that police detectives increasingly access, analyse, and exchange digital information with other police authorities and the court system. The activities of the police and the formal procedures of the court system are regulated by law, and the information they exchange is often is sensitive and confidential.

This makes it increasingly important that police detectives are very familiar with the regulations and formal procedures in connection with exchanging confidential information with the police system and the prosecution authorities. In particular, they have to know what information at can be distributed to whom and when. If sensitive data are leaked or distributed incorrectly, it may have damaging consequences for the legality of court proceedings.

The future

Looking to the future, the interviewed experts and police detectives expect that the adoption and use of ICT in the police will continue. However, they also highlight that the most important future challenge is that the police must become better at understanding and following society to be updated in connection with the many new crime forms that ICT and the internet enable.

> *'We lost ten years on the internet because we did not understand it. We thought that fraud would disappear. Instead, fraud is now one of the most common crimes.* If we *had understood the internet correctly, we would now have had another situation. To read the future is an important future skill.'* (Interview with expert from police technology centre)

The interviewed experts and police detectives also envisage that the police must be better at understanding and using the social media. For example, the social media can be used when the police need help or information from the public. Similarly, social media can be used to research online activities and interactions between persons involved in a case.

The interviewed experts and police detectives also think that the police may need to have technological procedures and tools that match the contemporary digital activities of people better. The following quote exemplifies this need:

> *'I hope that the systems will improve in the future. For example, when people are filming a stabbing in the streets with their smartphone, the police have to collect the smartphone and import the data. It would be easier if we had a system with which people could just send the data to us. It would be easier and more efficient for us.'* (Interview with police technology centre)

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Interviewees

Aija Kalnaja, CEPOL European Police College, Hungary (expert)
Kjell Erik Eriksen, Norwegian Police Service – Investigation, Norway (organisation)

Robert Karlsson, Swedish Police, Police Technology Department, Sweden (organisation)

10. Property caretaker (or manager)

The context: the increasing need for property management software

Management of commercial or corporate real estate involves very large financial values and considerate environmental impact in terms of energy consumption and use of resources. The increasing need for portfolio transparency, compliance and business continuity creates a need for technologies such as property management (van Dijk, 2015). Property management software, which receives information from sensors, placed at key points in buildings, enables much more comprehensive and efficient building management than traditional, human inspection and maintenance. The use of ICT in property management is also called 'smart buildings' or building automation. It enables automatic centralised management of a building's heating, ventilation and air conditioning, lighting and other systems through a building automation system. Such systems can improve occupant comfort, efficient operation of building systems, and reduction in energy consumption and operating costs (*Dragoicea, M & Patrascu, M. 2013).*

Another important driver is the environmental and climate agenda, which has increased the importance of efficient energy consumption. Being green has become increasingly popular and building corporations can brand themselves as environmental stewards by investing in technology that save water and energy (James, E. 2007).

The job profile in focus: property caretaker/manager

On this background, the present job profile focuses on a property manager working in commercial real estate building with an advanced level of ICT use. A property caretaker (or manager) is typically in charge of a range of responsibilities depending on the specific type of property being managed and the requirements of the employer. A property manager may be in charge of building maintenance, administration and finance, security and numerous other tasks, such as collecting rent, enforcing community living standards, and addressing tenant complaints. A property manager can also be responsible for directing staff and contract personnel carrying out service and maintenance tasks

 Main work tasks	 Main use of ICT
Planning and staff management • Plan, schedule, and coordinate general maintenance and major repairs • Market vacant space to prospective tenants through leasing agents, advertising, or other methods • Direct and coordinate the activities of staff and contract personnel.	**Property management software (PMS)** PMS is computerised systems that facilitate the day-to-day **management** of properties including maintenance, legalities and personnel. Such systems enable the property manager to oversee occupancy levels, budgets for repair and maintenance and payroll for staff and contract personnel and many other functions.
Contact with tenants • Meet with prospective tenants to show properties, explain terms of occupancy, and provide information about local areas • Regular contact with tenants to ensure their needs are being met • Investigate complaints, disturbances and violations and resolve problems following management rules and regulations	
Administration and finance • Maintain records of sales, rental or usage activity, special permits issued, maintenance and operating costs, or property availability • Contact with authorities to ensure that renting and advertising practices are not discriminatory and that properties comply with state and federal regulations • Prepare budgets and financial reports for properties. • Negotiate loans to finance construction and ownership of buildings	**Rental Property Software** Rental property software (also called rental management software) enables the property manager to monitor and analyse financial aspects of rental activities such as utilisation and vacancy levels, rental levels, contract duration, maintenance costs, etc.
Inspection and maintenance • Inspect buildings, facilities, and equipment routinely to determine necessity of repairs or maintenance • Purchase building and maintenance supplies, equipment, or furniture • Checking alarm systems, key and security systems	**Building automation software** Building automation systems enable the property manager to conduct centralised management of a building's heating, ventilation and air conditioning, lighting as well as other systems such as security systems, alarm response time. Building

 Main work tasks	 Main use of ICT
• Monitor the building's consumption of energy, heat, water and other functions with building automation systems • Set up contracts and conduct tender procedures for provision of property services such as cleaning, maintenance, and security services • Analyse bids and confer with winning subcontractors to negotiate management and service contracts	automation systems enable the property manager to optimise energy efficiency, safety and security. **Key management software** Using key cards instead of keys eliminates the problems of lost keys. In addition, key card technology enables easier tracking of persons entering or leaving buildings – and better security.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

As the above table shows, the property manager can use software to support all main tasks related to property management. Looking across the functions, ICT is used as a tool that supports *monitoring* and *analysing* many different kinds of data from the buildings. A building automation system can be defined as an electrical control system that is used to manage a building's heating, ventilation and air conditioning (HVAC) system. Based on sensors placed in the buildings, building automation software can monitor much more comprehensively and efficiently a building's energy use, heat levels, etc., than the property manager would be able to do by personal inspection. Building automation software can monitor the energy use and environmental impact of the building 24 hours a day and it can be pre-programmed to optimise energy use according the activity level.

Building automation systems for monitoring energy consumption are based on smart grid systems. A smart grid is a system with a variety of operational and energy measures, including smart meters, smart appliances, renewable energy resources, and energy efficiency resources (IET, 2015). For example, smart grid technology may be used for:

- optimised cooling and ventilation equipment that allows the system to spend the minimum amount of money to provide the comfort level desired;
- matching occupancy patterns to energy use; and
- dynamic power consumption.

By taking signals from the electricity market and altering usage in response, a smart building ensures the lowest possible energy costs and often generates revenue by selling load reductions back to the grid.

Property management software and rental property software enable the property manager to do a better financial analysis of the numerous and complex data related to the economics of the property. By using such systems for analytic support, the property manager can carry out complex calculations and assessments more efficiently and prepare financial reports.

As the above table shows, property management systems can cover planning and staff management as well as contact with tenants. This shows that there is a wealth of different property management programs. Some programmes are very comprehensive, offering total solutions managing everything from leasing to renewals, scheduling, etc., while other programs are more specific and only cover rental or staff management.

How ICT affects the quality of the job

The use of building automation systems has significantly changed the job and daily work life of property managers. Traditionally, property managers handled the inspection of buildings and facilities by themselves. With the advent of building-automation systems and advanced software programs, today's building caretaker spends more time analysing and acting on data generated by the building automation system.

Viewed as a whole, the building or property manager's work spends less time on routines, personal on-site inspection of buildings and more time in front of a computer monitoring building automation systems and conducting analyses. Moreover, the property manager’s administrative tasks can be supported by property management software enabling interaction between accounting systems, billing systems for work orders, the rent roll and many other functions. Overall, such systems enable the property manager to do complex calculations and assessments more efficiently, which allows the building caretaker to focus more on management based on the data.

Digital skills

Advanced user skills for property management software (PMS)
The property caretaker need advanced skills for PMS that facilitate the day-to-day management of properties including maintenance, legalities and personnel. Such systems enable the property manager to oversee occupancy levels, budgets for repair and maintenance and payroll for staff and contract personnel and many other functions.

Advanced user skills for rental property software
The property caretaker needs advanced user skills for rental property software, which enables the property manager to monitor and analyse financial aspects of rental activities such as utilisation and vacancy levels, rental levels, contract duration, maintenance costs, etc.

Advanced user skills for building automation software
Building automation systems enable the property manager to conduct centralised management of a building's heating, ventilation and air conditioning, lighting as well as

other systems such as security systems, alarm response time. Building automation systems enable the property manager to optimise energy efficiency, safety and security. The property caretaker need advanced user skills to apply building automation software. However, such systems are complex, and property managers may often need assistance and instruction from external consultants with expertise in programming the systems.

Other complementary skills

Skills for long-term strategic planning

Before the advent of property management systems and building automation, the property manager was more engaged in routine inspection and short-term problem solving. Our interviews indicate that ICT systems enable the property manager to spend less time on such tasks. Moreover, these ICT systems generate many data that the property manager can use to optimise maintenance, finances, staffing, energy consumption and many other parameters. Our interviews indicate that property management systems can be used to detect and register building deficiencies and repair requirements. Hence, registration of repair requirements makes it easier to categorise and tender them in bundles. Similarly, service contracts and their duration can also be entered into a property management system, which automatically reminds the property manager when to renew service contracts. Consequently, the property manager needs strategic, long-term planning skills to make the best use of all these data and optimise the efficiency and economy of the buildings.

Data interpretations skills and ability to develop knowledge

The interviews indicate that property management systems generate a multitude of data. Consequently, it is important that the property manager has analytic skills and is able to interpret quantitative and qualitative data to be able to convert data into knowledge. In addition, the property manager must be able to describe and communicate this knowledge to the management/ownership and other stakeholders.

Cooperating with external experts on how to use building automation systems

The property manager needs solid ICT skills and technical understanding to be able to handle programming and use of building automation systems. These systems are complex, and often they require special expertise, which the property manager may not have. Our interviews and research of job advertisements indicate that property managers may often need assistance and instruction from external consultants with expertise in programming the systems. Hence, the increasing use of building automation systems has developed other new job profiles such as building 'automation engineers', 'building automation technicians' and 'building automation consultants'. As the property management systems can cover many different functions, separate external consultants may be needed in different fields of expertise, such as energy management and finance management. Consequently, the property manager needs to have a clear awareness of what problems he can solve on his own and when to draw on external expertise and in what field.

Organisational skills to create an efficient decentralised service structure

Property management systems not only support centralised decision-making by the property manager. It is also important that the property manager is able to oversee and link the property management system to facilitate the decentralised completion of

various work tasks and functions. For example, our interview persons explain that the invoice/billing function can be linked to the overall financial management system. When employees purchase or order delivery of materials, an electronic bill appears in the system to be approved by the property manager. Over time, data on all electronic bills/invoices are registered in the system to be used for financial reports and budgeting. It is also important that the property manager be able to develop and share relevant information gathered by the property management system. Another example is that if a lamp is broken on the tenth floor, then the building automation system can transmit the data as a work order directly to the engineer who is subcontracted to do the maintenance. Then the engineer can purchase and install a new lamp, and he can submit the electronic invoice for approval and registration simultaneously. Similarly, when a tenant calls the maintenance service with a specific problem, for example complaining about the temperature level, n the engineer can log on to the building-control system and adjust the temperature.

Consequently, the advantage of such property management systems is they can ensure that problems are dealt with faster, when the system has a decentralised service structure. This requires that relevant personnel have access to the system and its information when needed. In order to ensure such a decentralised service structure, the property manager needs organisational skills and a good understanding of the needs of various groups of employees' work tasks.

Service minded and multi-tasking

The increasing use of ICT in property management has increased the expectations of tenants and stakeholders to the speed and quality of service. Our interviews indicate that compared to before, when the property manager could be more engaged in his or her own routine tasks, the ICT systems now enable the property manager to have more external communication and cooperation with tenants, subcontractors and other stakeholders. Furthermore, the use of smartphones and wireless technology enables the property manager to leave his desk and access the systems from many other locations. In other words, the property manager does not need to be 'tethered at his desk.' (James, E. 2007). These framework conditions require that the property manager be service minded, outgoing and able to handle multiple relations. At the same time, he or she must be able to prioritise and complete sudden urgent tasks while still performing their normal duties.

The future

Looking to the future, the interviews indicate that the use of ICT in property management and building automation is only in its infancy and will continue to develop. A factor contributing to this is that the price of property management software is falling and that some software programs are accessible as freeware on the internet. In addition to the core property management software options, a fast-growing number of closely related software products are being introduced to the industry. The interviews also indicate that the biggest challenge to the adoption of ICT in this job field is that many property managers are not used to working with ICT and exploiting its potentials for strategic long-term planning. They need expert assistance and advice to prepare for the investments in such systems. It is also a challenge to integrate the various components and systems.

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Interviewees

Synne Remvig, DTU, Building Maintenance Department, Denmark (organisation)

Valentin Buob, VINCI Facilities Schweiz AG, Switzerland (company)

Raoul Eggen, TOPdesk Nederland BV, the Netherlands (company)

Eystein C. Husebye, Norwegian Building and Property Association, Norway (Organisation)

11. Transport clerk

The context: the use of ICT in freight transport and logistics

The use of ICT in multimodal freight transport and logistics has increased significantly over the last decades and is regarded a key enabler to improve efficiency, quality and service. In addition, using ICT to optimise transport is also driven by sustainability issues because it can contribute to reduction in CO2 emissions in connection with road freight transport and identify opportunities for further improvements (Wang, Yingly et al. 2015).

Consequently, growing environmental problems, increasing fuel prices and congestion on many road networks require new solutions to freight transport operations. An integrated multimodal transport network is a critical factor for companies to be able to execute their supply chain processes successfully home and abroad. However, the complex nature of multimodal integration, such as the involvement of a wide variety of operators, can limit the growth of multimodality. One of the major constraints is the lack of effective and efficient information connectivity among and between the different transport modes (i.e., water, air, road and rail). Therefore, it is well recognised that information and communication technology (ICT) functions as the nerve system of a multimodal transport chain and brings multiple benefits to organisations by providing real-time visibility, efficient data exchange, and better flexibility to react to unexpected changes during shipment (Harris et al. 2015).

On this background, this job profile focuses on transport clerks (also called logistics clerks) because they play a key role in managing logistics and transport processes. Typically, their role is to verify and maintain records of incoming and outgoing goods, prepare goods for dispatch, arrange clearance and collection of imported cargo from customs and bond stores, and arrange shipment of cargo for export.

The table below presents the main work tasks of a transport clerk and the use of ICT related to each main work task.

 Main work tasks	 Main use of ICT
Contact with the client • Reply to requests for quotations and orders from customers • Receive and confirm orders for transportation • Find optimal solutions for transport and communicate solutions to the clients	**Analytical software for optimising transport and logistics** The transport clerk can use the software to find transport solutions that optimise the decided route, the use of energy resources and ensure the best possible utilisation of

 Main work tasks	 Main use of ICT
Preparing and planning transport • Plan schedules and optimise traffic route and transport costs • Anticipate any problems and plan for the supply and cost-effective solutions and legal enforcement**.**	transport vehicles, reducing empty mileage costs (e.g., Freight Rail Crew Optimisation Scheduling FRCOS software, Integrated Decision Support Match Advice).
Manage staff implementing the transport • Direct workers in connection with loading and unloading consignments, goods and means of transport • Organise and manage activities related to transportation in relation to the company's timekeeping and quality standards	**Databases for managing locations** The transport clerk can use location databases to provide location-based services based on GPS positions for mobile platforms, such as information on the nearest storage facility or transport centre (e.g., Bentley Transportation Data Manager; Labelmaster Software REG-Trieve).
Information to client during shipment • Send information to client on where the freight/package is during shipment • Confirm delivery • Contact client in case of delay of shipment.	**Shipment tracking software** (or package logging) is the process of localising shipping containers, mail and parcel post at different points of time during the transport process. The client receives a tracking number/reference and can track where the shipment is.
Administrative tasks • Arrange transport in accordance with regulation and authorities • Obtain licenses for transport and follow-up on due dates for renewal of licenses, permits, etc. • Arrange transport in line with legislation on road traffic, public, domestic and international transport of goods • Coordinate team that prepares all documents and obtain all documents necessary for legal circulation on public roads • Manage the economy of the transportation process and allocated budget	**Management system organising all the activities of the transport company** The management system is a comprehensive tool that organises inventory, remote warehouses, activity billing, client contracts/agreements, orders, shipments, workflow for distributors and the involvement of third party logistics companies. Typically, the management system is linked to the ERP/accounting system of the company.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

The above table shows that the transport clerk can use ICT throughout all the steps of logistics and transport processes. In the introductory contact with the client, the transport clerk can use *analytical* software to find transport solutions that optimise the route taken and then discuss them with the client. When the client has decided on the route, the transport clerk can use analytical software *to plan* the transport process and manage the staff involved. In the planning and implementation of the transport process, the transport clerk can also use databases for managing the locations involved. During the implementation of the shipment, the transport clerk can use route navigation software to *optimise* and outline route options for the transport. In addition, the route navigation software can be an important tool to tell the transport staff what route to take. During the transport process, the transport clerk can use data tracking software *to monitor* the shipment and enable the client to track information on the location of the shipment and its expected delivery. Such information can be an important service for the client's supply chain.

Besides these main steps in the transport process, the transport clerk typically has to manage various administrative tasks such as obtaining licences, permits, etc., and arrange the transport in line with domestic as well as international regulations on freight transport. The transport clerk can use a management system for organising and documenting all the activities of the transport company to carry out such administrative tasks. In addition to such tasks related to external relations, the transport clerk typically also uses the management system for organising and documenting all the internal workflow activities of the transport company.

How does the use of ICT influence on the quality of the job

Overall, the interviewed organisations and employers think that using ICT to optimise route planning has made the work of transport clerks *easier and more efficient*. With analytical software for optimising transport and logistics, the transport clerk is relieved of difficult and time-consuming routine planning tasks. The interviews also highlight that ICT reduces the amount of paperwork and manual work. At the same time, the analytical software for route planning enables the transport clerk to work out more options that can be presented to the client as well as manage a large number of shipments within a given period. Consequently, the transport clerk must to be good at multi-tasking and managing many clients and shipments simultaneously.

Using software for tracking shipments and managing locations increases the communication and cooperation between the transport and the drivers transporting the shipment. The quotes from interviewed employers below exemplify how the transport clerk can monitor and cooperate with the drivers:

> *'The drivers cannot use the system to contact. Instead, they use email or smartphone to send messages directly to us. The system is also has a GPS-function which means that we can always see the location of the drivers. We also use the system to report vehicle breakdowns, i.e. the driver calls us concerning a breakdown and we report into the system.'* (Interview with employer – transport and logistics company)

The next quote from the interview of another employer shows that transport clerks can use tracking systems based on satellites and GPS-technology to track units and drivers during transit.

> *'We also use satellite tracking of the units. The person at the planning desk uses the satellite to track the whereabouts of the truck. The drivers have on-board scanners. The communication works by email or by a login. We use a black box to communicate with the drivers in their trucks.'* (Interview with employer – transport and logistics company)

The examples show that the transport enabled by ICT can communicate with the drivers regarding safety and where the driver is going next for loading or unloading. The transport clerk can also intervene and help in case of unforeseen problems.

Digital skills

Advanced digital skills for analytical software

The transport clerk needs advanced user skills to find transport solutions that optimise the decided route, the use of energy resources and ensure the best possible utilisation of transport vehicles, reducing empty mileage costs (e.g., Freight Rail Crew Optimisation Scheduling FRCOS software, Integrated Decision Support Match Advice). Furthermore, the transport clerk must be able to present solutions and various options to the client.

Advanced user skills for shipment tracking software (or package logging)

The transport clerk needs advanced user skills to apply **shipment tracking software in t**he process of localising shipping containers, mail and parcel post at different points of time during the transport process. Furthermore, the transport clerk must provide a tracking number/reference to the client, who then can track where the shipment is.

Basic user skills in management system organising all the activities of the transport company

The overall management of the transport company is not the responsibility of the transport clerk. However, in order to work and cooperate efficiently in the company, the transport clerk must have at least basic user skills to use the management system, which is a comprehensive tool that organises inventory, remote warehouses, activity billing, client contracts/agreements, orders, shipments, workflow for distributors and the involvement of third party logistics companies. Typically, the management system is linked to the ERP/accounting system of the company.

The interviewed organisations and employers generally think that transport clerks have sufficient training in using ICT. The transport clerks must also be prepared to participate in regular further training to update their digital skills. Especially older transport clerks

participate in further ICT-training because it can sometimes be difficult for them to learn how to use new systems on their own.

Other complementary skills

Ability to adapt and update the use of software critically
Analytical software for route optimisation has made route planning easier, but the transport clerk cannot just use the software programs automatically without critical thinking. Some routes may only be temporary, while others are permanent. Hence, the transport clerk must continuously check the route patterns and options that are available to the client.

Planning abilities –optimising transport route and volume
Although the analytical software can outline optimal routes, the overall planning of all aspects of a transport cannot be fully automated by software programs. Therefore, the transport clerk may have to do to the overall planning manually. The transport clerk must organise and time the despatch of the transport in a way that optimises the volume sent. The quote below by an employer exemplifies this:

> *'The combination of the routes is made based on the volume we have per day, and then the planners try to make the best of the combination. However, the planning is done manually, not with a system, as there are too many parameters. We have not found a system that covers all the commodities that we provide to the costumers.'* (Interview with employer – transport and logistics company)

Language skills
Transport clerks must have good English skills for two main reasons: 1) the manuals for the software programs are usually in English, and 2) the transport clerk typically has to communicate internationally with staff and locations involved in the transport process as well as clients from many different countries.

Personal skills to be open minded, learning and cooperative
Interviewed employers find that it is important that transport clerks are open-minded and like to learn because the technology is developing fast. Communication and cooperation skills are also regarded as important as the transport clerk engages with many different kinds of clients and partners during the transportation processes.

The future

The interviewed organisations and employers expect that the use of ICT, in particular GPS-technology, will increase and become even more important in the future. They think that the general trend is that the transport and logistics is driven by the attempt

They believe that ICT systems will become more transparent and automated. An important driver for this trend is the demands from clients who increasingly ask for transparency, tracking information and a high level of information and service.

The interviewed organisations and employers also expect that language skills will become more important since transport clerks increasingly communicate with drivers, partners and clients in many different countries.

Environmental issues are expected to become more important as well, making it important that transport clerks can optimise transport volumes and routes to reduce the amount of fuel used.

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Interviewees

Myriam Chaffart, European Transport Workers' Federation, Belgium (organisation)

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12. VET teacher

The context: the use of ICT in VET education

Over the last decades, e-learning or digital learning has become an important educational tool in learning, comprising an extensive array of digitisation approaches, components and delivery methods (Richie, 2008; Selwyn, N. 2011).

The introduction and adoption of ICT in education has not been easy, and not all teachers have embraced the new technologies without some scepticism as regards whether they can improve teaching and learning. However, there are a number of ways that digital learning and traditional teaching can complement each other rather than be seen as opposite sides of a spectrum (Pullen & Winter, 2014 p.6). If used appropriately, new technologies provide teachers with an opportunity to be innovative in their approaches and use greater creativity within their lessons. For example, ICT can enable personalisation and coaching, particularly to differentiate learning, which is particularly difficult when a teacher is responsible for large groups of learners. Technology enables learners to be more self-directed, as they can review material themselves. This helps the teacher to intervene and coach in a more productive way by not having to demonstrate the same task repeatedly. In addition, simulations using digital technologies can be an important part of enabling access to practical experience in a safer environment. Other types of technology, such as filming and collaborative software, can support self and peer assessment. In some cases, online collaboration can support the development of communities of learning (Pullen & Winter ibid.).

On this background, this job profile focuses on vocational education and training teachers (VET-teachers) who use ICT in education. A VET-teacher teaches and instructs vocational subjects that prepare students or workers for a specific trade. The vocational education and training develops expertise related to technology, skills and scientific techniques to span all aspects of the trade.

This job profile does not focus on a particular vocational trade, but presents a generic job profile describing the main tasks and uses of ICT that VET teachers can have in general. The table below presents a VET-teacher's main work tasks when preparing, conducting and evaluating learning processes related to the use of ICT.

 Main work tasks	 Main use of ICT
Planning the learning process • Assess the needs of the trade and companies and determine training needs of students or workers accordingly • Select and collect books, materials, supplies, and equipment for training, courses or projects. • Develop curricula and plan course content and methods of instruction. • Prepare outlines of instructional programmes and training schedules and establish course goals. • Develop teaching aids such as instructional software, multimedia visual aids, or study materials.	**Calendar and scheduling software** The teacher and the students can use this software for **planning** and appointments. Typically, using the school's local intranet, the teacher can upload plans, exercises and literature references for the upcoming lessons for the students. **Presentation software** to produce teaching materials for the students, using general ICT tools such as PowerPoint, etc. **Learning management system** to create assignments, prepare reports, maintain records, obtain the students' grades and attendance rolls, track progress of the students, and uploading assignments.
Conduct education and training • Present lectures and conduct discussions to increase students' knowledge and competences using visual aids, such as graphs, charts, videotapes and slides • Conduct training sessions to teach and demonstrate principles, techniques, procedures, or methods of designated subjects • Supervise independent or group projects, field placements, laboratory work, or other training	**Digital simulation technologies** to train students in doing practical work task in a safe environment. For example, serious games, modelling tools, and scenario simulations. **Computer/web-based training software** providing a platform for communication and sharing content between teachers and students. For example e-portfolios. **Interactive whiteboard.** An interactive whiteboard uses touch detection for user input (for example scrolling and mouse click) in the same way as normal PC input devices. The interactive whiteboard works when connected to a computer, a projector and white boarding software.

 Main work tasks	 Main use of ICT
	Multimedia projector, i.e., a compact, high-resolution, full-colour projector capable of projecting text, images, video and audio content. **Videoconferencing.** Videoconferencing can connect the teacher in a classroom with classes of students in other classrooms – and with students sitting at home connected via their PC.
Evaluation and counselling of students • Contact with in-company trainers on the status and progress of apprentices' work-based learning • Evaluation and feedback on the students' learning and performances at examinations • Advise students on course selection, career decisions, and other academic and vocational concerns	**Virtual platform for linking** vocational school, training company and student, for example the Danish 'Elevplan ' (Student Plan). **Search** software **for checking the originality of texts** The software enables the VET teacher to make a quick search on the internet, and test the students' texts for inappropriate copying of existing texts.

Sources: Interviews and desk research of job advertisements and information databases such as Skills Panorama (http://skillspanorama.cedefop.europa.eu/en), O* Net (https://www.onetonline.org), ICT/Clayton Wallis www.ictcw.com, Career planner (www.careerplanner.com), Duties,com (www.dutiesjob.com).

Use of ICT in the job

The above table shows that VET teachers can use ICT throughout all their main work tasks related to the three stages: preparation, teaching and evaluation of the learning process. Overall, ICT is mainly used as a tool to *support the communication* between the teacher and the students in relation to the three stages of the learning process. During the preparation, the teacher can inform the students about the content of the coming lessons and what homework to do. Some use calendar and scheduling software, while others use more advanced learning management systems. The quote below exemplifies such systems:

'We have a new system for mapping and a learning management system that we use for creating assignments, preparing reports, maintaining records, obtaining the students grades and attendance rolls, tracking the progress of the students and uploading assignments. It is a communication system between students and teachers. It is new, so we have not used it for many things yet, and we do not know all the features. We also use Word and Outlook, and we use an internet portal for sending administrative messages.' (Interview with VET-teacher)

The quote exemplifies that that teachers and students communicate via multiple web-platforms that complement each other. In addition, the interviews indicate that some teachers increasingly use common social media, such as Facebook, to communicate with their students.

When conducting lessons, the teacher can use multiple digital tools to support the learning process. In workshops, the students can practice relevant vocational skills in a safe environment by using digital simulation technologies. To support the learning process, the teacher and students can also use computer/web-based training software, which provides a platform for communication and sharing content between teachers and students. An example is e-portfolios that can be seen as a type of learning record providing actual *evidence and documentation* of achievement. Such software systems enable the teacher to keep in touch with the learner online and answer queries or make personalised suggestions. The assessor or trainer is also able to monitor the work the learner is given through their submissions for assessment and through contact with the learner. By using these tools, VET-teachers are able to *organise, monitor and assess the learning process* of each individual student.

The interactive electronic whiteboard is a *presentation* device that interfaces with a computer. The computer images are displayed on the board by a digital projector where they can be seen and manipulated. The advantage is that the presenter can run the application from the board, using his fingers like a mouse making it easy to show the important features of a particular software. Our interviews also indicate that although interactive whiteboards are still used, touch screen TV's and monitors are now becoming more common and are often used with wireless keyboards and tablets so that students do not have to come to the front of the class. In some cases, students have mobile devices that they connect automatically to the projector and share the work from their own device. Multimedia facilities also include the use of videoconferencing and shared desktops to allow remote students to share their work. However, some of the interviewed VET-teachers caution that videoconferencing should be restricted to theoretical lessons, as vocational training and practice typically require personal instruction and the presence of the teacher.

In the evaluation and feedback on students' performances or apprentices' going through work-based learning, the VET-teacher can use web-based tools that link the vocational school, training company and student. Like all teachers in all other parts of the education system, the VET-teacher can use search software for checking the originality of texts.

How ICT affects the quality of the job

Overall, the interviews with organisations and VET-schools indicate that use of ICT enhances the *communication* between teachers and students. VET-teachers must be able to communicate with their students via multiple media platforms before, under and after the lessons. In addition, the teachers also increasingly have to *cooperate and communicate with their colleagues* electronically. Increasingly teachers are required to use web-based blogging tools to reflect on their own practice and to share their experiences.

The use of ICT tools means that teachers are able to have a *supportive function*, where they counsel and coach the students in their learning processes. The supportive function tends to replace the 'instruction' part of a teacher's role. Instead of instruction, the teacher can prepare video/audio content or presentations either explaining or demonstrating how to do something. Replacing this 'instruction' element of the role of the teacher means that the teacher has more time to be the 'expert in the room', as well as providing guidance on evaluating and being more critical about the amount of information learners are faced with Gilbert, I. (2011).

The use of ICT means that VET-teachers' personal presence in front of the students only represents a fraction of the communication with the students that increasingly takes place online. Hence, the students tend work more independently during the learning process and gather information and data via the internet. In addition, the VET-teacher is able to *support the individual student* in his or her learning process and organise individualised curriculum and teaching materials. The following quote below describes this tendency:

> *'We may in the long term need fewer front line teaching staff as ICT is likely to make it possible to teach more students and provide a more individualised curriculum, particularly if the idea of student presence online rather than physical attendance grows. However, other roles are likely to increase.' (Interview with VET-teacher)*

This development means that VET-teachers increasingly will be needed to support the creation of rich online content, respond to student queries, possibly at any time of day, facilitate online discussions, tutor students through their online course material, and provide face-to-face support sessions in labs, workshops, salons and other specialist vocational environments.

Digital skills

Overall, the VET teacher must have digital skills to apply ICT a tool to *support the communication* between the teacher and the students in relation to the three stages (preparation, teaching and evaluation) of the learning process. During the preparation, the teacher can inform the students about the content of the coming lessons and what homework to do. Some use calendar and scheduling software, while others use more advanced learning management systems.

Advanced user skills in learning management systems
Learning management system are used to create assignments, prepare reports, maintain records, obtain the students' grades and attendance rolls, track progress of the students, and uploading assignments. Similarly, the VET teacher needs advanced user skills in calendar and scheduling software used for planning and appointments. Typically, using the school's local intranet, the teacher can upload plans, exercises and literature references for the upcoming lessons for the students.

Advanced user skills in web-based training software and digital simulation technologies
The VET teacher must be skilled at using web-based training software providing a platform for communication and sharing content between teachers and students. For example e-portfolios. Similarly, the VET teacher must be skilled at using digital simulation technologies to train students in doing practical work task in a safe environment. For example, serious games, modelling tools, and scenario simulations.

Other complementary skills

Openness to new technology and self-learning
The interviewed organisations and VET-schools all emphasise that VET-teachers must be open to new technology and willing to familiarise themselves with ICT-tools by self-learning and sharing experiences with their colleagues. Teachers need to be innovative and recognise the potential of new developments and apply them to their own practice. They need to be open minded about technology and be prepared to learn from others including their own students. VET-teachers should not just see ICT technology as an objective in itself. Instead, it is important that VET-teachers can use relevant ICT tools in a personal and innovative way where they practice and find out how the ICT tools can support their delivery of teaching and their students' learning processes.

To be updated with specific digital technology related to their vocational field
The interviews indicate that VET-teachers do not only have to be familiar with ICT tools to support learning processes. As ICT increasingly penetrates many vocational occupations, VET-teachers also need to have extensive knowledge of the ICT systems of their specific trades. For example, the trades related to industry, technology, construction and logistics rely heavily on advanced hardware and software, which a skilled worker must be able to operate, programme and control. In trades related to administration, tourism, hospitality, leisure and foodservice, ICT systems for communication and marketing are key for modern businesses.

Creative communication and presentation skills for multiple media platforms
As described above, the use of ICT increases the communication between teachers and students via multiple media platforms. This requires that VET-teachers have good communication and presentation skills enabling them to present educational content written, orally, in images and other relevant forms. The interviews indicate that VET-teachers must be able to present educational content in a creative way to support their students' learning. The delivery of educational content needs to add to the student's experience, providing flexibility of access, allowing for repetition, and being more engaging than traditional methods of delivery. In other words, provide a tailored experience that meets the students' needs.

The future

The interviews indicate that the adoption of ICT in vocational education and training will continue. However, the adoption of ICT tools varies considerably among teachers. The interviewed organisations and VET-schools think that young teachers find it easier to adopt ICT tools than older teachers do. Similarly, many students are experienced with using ICT-tools.

Looking to the future, it is expected that the use of digital simulation technologies will increase as the software programs become better and less expensive. Research indicates that evidence of better retention of students with simulation tools for learning has been happening over the last decade. In addition, there is also an economic rationale. Most of our interview persons think simulations can reduce the cost of training because they simulate dangerous environments and extreme operating issues, such as equipment failure and emergencies, without risk. (London Knowledge Lab, 2013).

It is also expected that VET-teachers will be required to have more focus on problem solving and willingness to change. Teachers are envisaged to be using technology a lot more in the future, e.g., to collect data and more complex systems for simulations. In addition, communication and foreign language skills will also become important, as VET-schools are becoming more global, exchanging students.

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Interviewees

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