Future of manufacturing

Inspection engineers: Occupational report

New tasks in old jobs: drivers of change and implications for job quality

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Authors: Martin Eggert Hansen (Danish Technological Institute)
Research manager: Enrique Fernández-Macías (Eurofound)
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Related reports: This occupational report is one of the five occupational reports (Car assemblers, Chemical products plant and machine operators, Hand packers, Inspection engineers, Meat processing workers) conducted in the framework of the project Future of Manufacturing in Europe and produced by Martin Eggert Hansen (Danish Technological Institute) and Simone Rosini (Fondazione Giacomo Brodolini).

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European Foundation for the Improvement of Living and Working Conditions
Telephone: (+353 1) 204 31 00
Email: information@eurofound.europa.eu
Web: www.eurofound.europa.eu

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http://eurofound.link/fome

Contact details
Donald Storrie (Project Manager) Donald.Storrie@eurofound.europa.eu
Alessandra Massaro (Project Administrator) Alessandra.Massaro@eurofound.europa.eu

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Introduction

About the study

The overall purpose of the study is to provide a comparative, qualitative, contextualised and detailed analysis of five specific manufacturing occupations, listed below with their International Standard Classification of Occupations (ISCO-08) code:

- meat processing worker (ISCO 8160);
- chemical products plant and machine operator (ISCO 8131);
- hand packer (ISCO 9321);
- car assembler (ISCO 8211);
- inspection engineer (ISCO 2141);

The study is based on a comparative, qualitative analysis of five key occupations in four countries (Germany, Italy, Sweden and the UK), each covering different European regions (continental Europe, the Mediterranean, Scandinavia, and Ireland and the UK). The study focuses on how job content, tasks, applied technologies and working conditions are changing the jobs and their content.

The five occupations were selected as case examples of classical occupations in manufacturing, and how the occupations and their content are changing due to many different factors at contextual and company level. Many other occupations in manufacturing could have been chosen. Hence, the main purpose of these comparative occupational studies is not to analyse these occupations as an end in themselves, but rather to use them to illustrate how manufacturing in Europe is changing and how this affects European jobs.

Each case study combines a contextual level (for example, industry developments) and a company level. Each case study thus analyses the occupation in a specific country (for example, inspection engineer Germany) and how industry developments, company strategies and other contextual factors affect the work tasks and job content of the occupation. In each country, the case study is based on desk research and interviews with employees in the occupation and employers in a case company. In addition, interviews were conducted with relevant trade associations.

At company level, the main focus of the interviews was to analyse the contents and work tasks of the occupation. This analysis is based on a framework developed by Eurofound, which divides the job content and tasks of meat processors into three broad categories (Eurofound, 2016):

- physical/manual tasks;
- intellectual tasks – such as processing and transformation of information;
- social tasks – such as interaction with other people (colleagues, customers and so on).

The information gathered from the case studies suggests that the framework is robust and applicable across all the occupations of this study.

The occupation of this working paper

This working paper focuses on the occupation ‘inspection engineer’. The occupation differs from the other occupations of this study as inspection engineers are typically not blue-collar workers, but are salaried graduates who are part of the production management responsible for overseeing and optimising the organisation and quality of manufacturing processes. Inspection engineers work in many different manufacturing sectors as well as sectors beyond manufacturing, such as construction that also employs inspection engineers.

Inspection engineers – also called industrial and production engineers – handle a wide range of tasks. According to the ILO’s description of ISCO 2141:
Industrial and production engineers conduct research and design, organize and oversee the construction, operation and maintenance of process plants and installations. They establish programmes for the coordination of manufacturing activities and assess cost effectiveness and safety.

(ILO, 2008)

Inspection engineers working as quality engineers handle a wide range of tasks related to organising, controlling manufacturing processes, and overseeing quality of products, supplies, working conditions and installations/equipment. The range of tasks may vary between companies, to some extent depending on company size. At large manufacturing companies, there are typically significant differences and specialisations in the tasks that are the responsibility of inspection engineers, while inspection engineers in small companies have broader areas of responsibility.
Comparative analysis of the case studies: Contextual factors

This chapter discusses the main findings deriving from a comparative analysis of the four case studies of the occupation, one per each selected country. It analyses the contextual factors and drivers of change in the manufacturing industry and how they influence the occupation’s job content and working conditions. Contextual factors include:

- market changes;
- technological developments;
- policy and regulation changes;
- industrial relations;
- other factors that affect the industry and the occupation.

As inspection engineers work in many different industries, the analysis focuses on the manufacturing sector as a whole and how its dynamics and trends influence the occupation.

Market changes: Global competition shifts focus to quality and lean manufacturing

The manufacturing industries in all four case study countries are subject to the same general, international market forces of globalisation and technology changes. The international competition in the marketplace increasingly demands that manufacturing companies develop and manufacture complex high-performance quality products at lower prices than before to stay competitive. Product lifecycles have tended to decrease, putting greater emphasis on the ability to develop new products faster to maximise the market window. Instead of the old sequential way of doing product development to produce large series of products, companies are turning to the production of customer variants with fast adoption to changing customer needs. There is also a greater emphasis on ‘lean manufacturing’ (also known as ‘lean production’), an approach based on the core idea of continual improvement to eliminate waste from the manufacturing process without sacrificing productivity.

Competition from low-wage countries means that price competition based on lowering costs is not a sufficient competitive strategy for European manufacturing companies. The competition forces manufacturing companies in Europe to create value by focusing on advanced, knowledge-based products and the development of related services. The case companies in the four countries exemplify this trend. For example, the Italian case company in the chemical industry emphasises the importance of investment in research and development (R&D) and continuous innovation to regain its market shares of advanced biorefining to produce bioethanol from agricultural waste. It is also necessary to support research with a view to further exploiting unused production outputs (for example, agricultural waste, animal husbandry waste and forestry-related products). Another example is the Swedish case study company, which produces develops, manufactures and sells a broad selection of performance and transportation coatings around the world. The company focuses on advanced, high-quality coatings for lightweight vehicles. The products are based on a high level of R&D to provide the best corrosion protection combined with leading colour technology and design. Colours and designs are continuously improved to provide customers with new products each year.

Increasing quality demands require centralised quality control systems

Looking at the four case study companies, a general trend concerning the market forces they face is the increasing demands with regard to quality standards from their businesses customers who buy their products for distribution and sale. Increasingly, business customers demand that production process and working conditions meet specific standards related to sustainability and quality, and in some cases, business customers conduct their own control visits to the company and specify control procedures. There are several drivers of this trend. A key driver is that the ‘political consumer’ has become an important factor in the markets, meaning that manufacturing companies have to ensure that
their production and products adhere to standards of sustainability, good working conditions and other demands. The internet and social media accelerate this driver as critical ‘political consumers’ can mobilise support for boycotts against companies that do not live up to such standards. Another key driver is the increasing subcontracting in the value chain, meaning that other businesses take responsibility for sales and the distribution of products. This means that the subcontracted businesses must ensure that their manufacturing processes live up to quality standards and other criteria.

To adapt to the increasing quality demands, many of the case study companies now tend to develop more comprehensive and centralised quality control systems that involve all the company’s functions. For example, the German case study company has developed a more uniform and centralised quality control system because the company had experienced problems with fragmentation of quality control.

**Technological changes: Challenge of digitalisation and Industry 4.0**

In addition to the demands stemming from global competition, manufacturing companies in Europe are facing the opportunities and challenges of digitalisation. Digitalisation is paving the way for new business models and making others redundant. The digitalisation of manufacturing is regarded as a path to the ‘smart factory’, in which machines and components can communicate with each other. The development is moving towards self-regulating production that can be adapted to individual customer demands.

It is not only production that is becoming ‘smart’, products are as well. The Internet of things involves products equipped with sensors and inbuilt systems connected to the internet, enabling them to communicate with their surroundings. However, for many manufacturing companies, in particular small and medium enterprises, it is a challenge to adopt digital technologies and release their full potential.

The case studies show that the adoption of digitalisation and automation technologies has been most profound in manufacturing sectors such as the automotive sector, while other sectors lag behind. The UK case study shows that, despite the strong political awareness, Industry 4.0 will be a disruptive force. A recent survey found that only a modest proportion (28%) of UK manufacturers were ‘very aware’ of Industry 4.0, while 38% stated that they were ‘not at all aware’. The most widespread priority among respondents was investment in ‘smart manufacturing’—‘defined as comprising such things as increased production output, quality, safety and yield’, while only 24% of the companies had made the ‘connected supply chain’ a priority (The Manufacturer, 2016).

**Policy and regulation: Increasing focus on sustainability in production**

Manufacturing industries also face growing political demands concerning environmental sustainability and energy resource efficiency. The governments in the four case study countries have launched strategies for manufacturing that focus on digitalisation and a transformation to a more sustainable, energy resource efficient, low-carbon economy. This means that sustainable production and products are increasingly becoming competitive parameters. To stay competitive, manufacturing companies need to be able to transform environmental challenges into economic opportunities and provide a better deal for consumers. The challenge is to improve the overall environmental performance of products throughout their lifecycle, boost demand for better products and production technologies, and help consumers to make informed choices.

The increasing focus on sustainability in production influences the job of inspection engineers. They have an important role in planning and optimising production processes so that they become more resource efficient. For example, inspection engineers may be involved in the development of processes that reuse waste material from production or in the reuse of heat energy in wastewater from production. Hence, inspection engineers not only manage and control sustainability in production, but

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1 A recent article in *The Financial Times* describes the ‘political consumer’ (*Financial Times*, 2017).

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are also expected to be innovative and develop new processes that enhance sustainability, quality and efficiency.

**Government strategies to boost adoption of digital technology in manufacturing**

The case studies indicate that enhancing the adoption of digital technology in manufacturing companies requires long-term government–industry partnerships and cooperation between manufacturing companies and research institutions. For example, the UK government’s industrial strategy launched in 2017 is based on creating the right framework conditions and institutions to bring together sectors and places. This strategy is based on an ‘open door’ approach that urges industry to come to the government with proposals to transform and upgrade their sectors through ‘Sector Deals’ under various strategic areas. For example, the government would welcome Sector Deals to accelerate the transition of automotive manufacturing to ultra-low emission vehicles. In parallel, Sector Deals are welcomed that involve a review of industrial digitalisation to consider how UK industry can benefit from the accelerated adoption of digital technology across advanced manufacturing.

In parallel, the Swedish government launched the strategy, *Smart industry – a strategy for new industrialisation for Sweden*, in 2016 aimed at stimulating the development, spread and use of digital technologies and encouraging new business models and organisational models to tap the potential of the new technology.

**Industrial relations: Heterogeneous affiliations of inspection engineers**

Inspection engineers are white-collar, salaried employees who have graduated from a higher education programme for engineers. However, the industrial relations, educational pathways and affiliations of inspection engineers described in the four case studies are relatively heterogeneous. Employees working as inspection engineers are not only graduates from higher education but also ‘blue-collar’ employees who have qualified for the occupation based on their workplace experience and training. Hence the grouping of inspection engineers and their affiliations to some extent depends on their actual job tasks and level of responsibility in the company.

In Sweden, for example, employees working as inspection engineers (kvalitetingenjör) include academically educated engineers with an MSc in industrial economics as well as employees who have no degree but who, based on their experience in production, work as inspection engineers. An inspection engineer in Sweden can apply for membership of four different trade unions, that is, Unionen, the Swedish Association of Graduate Engineers (Sveriges Ingeniörer), the Swedish Paper Workers’ Union (Pappers) and the Union of Metalworkers (IF Metall). For three of the trade unions (Unionen, Pappers and IF Metall), employees can opt for membership if they carry out inspection tasks. IF Metall and Pappers are only for employees in industrial production, while Unionen accepts members from all sectors in Sweden. In contrast, membership of the Swedish Association of Graduate Engineers requires the employee to have graduated from, or be a student at, an academic education programme for engineers. The union takes in inspection engineers from various sectors including construction, electricity and energy, installation and industrial production.

This heterogeneous set of trade unions reflects the complex nature of the organisational affiliations of inspection engineers and has given rise to some conflicts in industrial relations in Sweden. In some cases, the differing collective agreements and affiliations of inspection engineers give rise to conflicts between trade unions and employers. An important issue is whether agreements on working conditions and wages for inspection engineers should be covered by an agreement for workers or salaried employees.

In Germany, an inspection engineer is basically an academic profession certified at tertiary level with different levels of academic degrees. However, the actual employment conditions, wages and affiliations of the collective agreement of inspection engineers depend on their actual work tasks and level of responsibility. The grouping takes place according to their tasks and job requirements, and blue-collar and white-collar workers have been integrated into one wage scheme.

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Similarly, in Italy, inspection engineers are assigned to a given collective agreement, pay level and category based on their actual job content and experience. In the case study company, an inspection engineer is assigned a category and position ranging from C2 (entry level) to B1 (final level) based on their length of service and the competences gained throughout the working career. Category B is assigned to workers carrying out management tasks or equivalent specialised tasks, who hold positions requiring several years of experience and knowledge in a range of intertwined activities.

In the UK, inspection engineers are academic, salaried employees and most of them are members of Prospect, which represents engineers, managers, scientists and other specialists in the public and private sectors. Although a professional trade union focusing on enhancing individual career progression, Prospect campaigns to establish the recognition of, and collective agreements for, engineers with employers. Such recognition is based on the statutory procedure that came into effect in the UK in June 2000 through which trade unions can seek recognition from employers for collective bargaining purposes. In recent years, Prospect has intensified its campaigning strategy to enhance effective trade unions that can resolve problems in the workplace, collectively negotiate terms and conditions, and protect fundamental rights. Although not affiliated to any political party, Prospect finds the political climate hostile and believes that the past four years have seen concerted government attacks on employment rights and trade unions.
The occupation’s job content and tasks

The contextual factors discussed in the previous chapter affect the strategies, manufacturing processes and work organisation adopted at company level, and hence the content and work tasks of the occupation. Overall, the contextual analysis indicates that global competition forces manufacturing companies in Europe to focus on quality and advanced products as well as striving to be ‘lean’ and efficient in order to stay competitive. The inspection engineer plays a pivotal role in organising production to meet the demands of efficiency as well as quality.

Based on interviews in the case study companies, this chapter examines how the contextual changes are affecting the job content and tasks of the occupation. The approach taken is to look at the four case companies to deduce the main generic tasks and job content. Table 1 presents a summary of the occupation’s tasks, following the task framework developed by Eurofound researchers, which distinguishes between physical, intellectual and social tasks (Eurofound, 2016; Fernández-Macías and Bisello, 2016).

Table 1: Summary of job content and tasks performed by inspection engineers

<table>
<thead>
<tr>
<th>Category</th>
<th>Tasks content and subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical/manual tasks</td>
<td></td>
</tr>
<tr>
<td>Physical strength</td>
<td></td>
</tr>
<tr>
<td>• None</td>
<td></td>
</tr>
<tr>
<td>Dexterity</td>
<td></td>
</tr>
<tr>
<td>• Visiting and making visual inspections of various parts of the production units</td>
<td></td>
</tr>
<tr>
<td>• Performing various tests on machinery and products</td>
<td></td>
</tr>
<tr>
<td>Intellectual tasks</td>
<td></td>
</tr>
<tr>
<td>Information processing</td>
<td></td>
</tr>
<tr>
<td>• Collecting and analysing data from production processes</td>
<td></td>
</tr>
<tr>
<td>• Disseminating the analytical results from production processes to the various company departments</td>
<td></td>
</tr>
<tr>
<td>• Controlling that production processes are lean and that output fulfils production objectives</td>
<td></td>
</tr>
<tr>
<td>• Assessing that product quality adheres to customers’ standards</td>
<td></td>
</tr>
<tr>
<td>• Horizon scanning of prospects and trends</td>
<td></td>
</tr>
<tr>
<td>Problem-solving</td>
<td></td>
</tr>
<tr>
<td>• Ensuring that the organisation of production balances quality and well efficiency</td>
<td></td>
</tr>
<tr>
<td>• Reacting to customer complaints and launching corrective action</td>
<td></td>
</tr>
<tr>
<td>• Planning and developing the management system for production processes</td>
<td></td>
</tr>
<tr>
<td>• Developing and continuously improving quality management systems and procedures</td>
<td></td>
</tr>
<tr>
<td>• Project management of the implementation of quality initiatives</td>
<td></td>
</tr>
<tr>
<td>Social tasks</td>
<td></td>
</tr>
<tr>
<td>Managing/coordinating</td>
<td></td>
</tr>
<tr>
<td>• Cooperating horizontally with employees in production units and vertically with top managers</td>
<td></td>
</tr>
<tr>
<td>• Coordinating quality management involving many different stakeholders</td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Category</th>
<th>Tasks content and subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interacting with colleagues</td>
<td>• Interacting with colleagues and working in a team</td>
</tr>
<tr>
<td>Serving/attending</td>
<td>• Arranging audit inspections in collaboration with production units</td>
</tr>
<tr>
<td></td>
<td>• Organising intervention and problem-solving</td>
</tr>
<tr>
<td></td>
<td>• Informing the relevant authorities</td>
</tr>
<tr>
<td></td>
<td>• Communicating with customers on quality issues</td>
</tr>
<tr>
<td>Teaching/training/coaching</td>
<td>• Instructing employees in the collection and reporting of production</td>
</tr>
<tr>
<td></td>
<td>data</td>
</tr>
<tr>
<td></td>
<td>• Providing feedback to employees based on production and quality</td>
</tr>
<tr>
<td></td>
<td>data</td>
</tr>
</tbody>
</table>

The following sections analyse the different task categories in more detail.

**Physical/manual tasks**

The work of inspection engineers mainly involves intellectual and social tasks, and the case studies found only found a few physical/manual tasks. Physical tasks involve visiting and carrying out visual inspections of various parts of the production units. Typically, an inspection visit includes a walk round the production plant together with the production management to discuss improvements. During the visits and inspection of production units, the inspection engineer often performs various tests of production equipment, for instance, switching machines off and on and checking their performance. In addition, the inspection engineer may takes samples of products to be sent to the laboratory for analysis.

**Intellectual tasks**

Overall, the inspection engineer is faced with the challenging task of organising production in a way that balances quality and well efficiency (for example, lean manufacturing). The various approaches designed to focus on quality and lean manufacturing can give rise to conflicting demands for inspection engineers. The Six Sigma approach focuses on quality, while lean manufacturing means that activities that do not directly create value, such as inspection and quality control processes, should be minimised. This means that inspection engineers are increasingly required to balance quality control and lean manufacturing. The inspection engineers interviewed in the case study companies and trade associations confirmed this. They find that the simultaneous focus on quality and lean manufacturing means that inspection tasks must be carefully prioritised and organised to be both effective and efficient. In particular, inspection engineers are required to organise collection of inspection data efficiently and involve workers in production to collect regular data on product quality and processes. Increasingly, also digital collection of data from sensors and scanners in production is used for management of quality of production processes.

Inspection engineers play a key role in planning and optimising production processes, and this involves many intellectual tasks related to information processing. Quality management systems require the regular collection and analysis of many data by the inspection engineer. Hence, a key task for the inspection engineer is to organise systematic collection and analyses of data on the company’s production processes. The systematic collection of data must be planned in detail and involves numerous employees in production, who may also collect and submit samples of products/ingredients to be sent to the quality department or laboratory for analysis and feedback.

Increasingly, data from the production processes are reported digitally by sensors and scanners in the production equipment. In the analysis, the inspection engineer assesses the quality of products and

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production processes and checks that they adhere to quality standards and customer standards. For example, the assessment may be of how many product deliveries are on time in connection with customer orders. In addition, the inspection engineer ensures that production processes are lean and that the output fulfils input/output and production objectives. For example, the inspection engineer may develop calculation principles that measure the volume of the output to calculate productivity per man hour of production.

Based on the analysis of production and quality data, it is also the responsibility of the inspection engineer to transfer the analytical results of production processes to the various company departments as feedback. Feedback information is an important tool for the continuous improvement of production processes.

The frequent market changes and increasing digitalisation of manufacturing mean that many production technologies may be relevant for the company to adopt to stay competitive. Therefore, the inspection engineer continuously performs a ‘horizon scanning’ of changes in markets, new technologies, policy changes and new regulation that may affect the company.

Inspection engineers are continuously involved in problem-solving related to the planning, management and optimisation of production processes. A key part of this problem-solving is the planning and development of the quality management system for the monitoring and assessment of the company’s production processes and quality. One of the main tasks is to develop and continuously improve the company’s quality management systems and procedures. A quality management system such as ISO9001 includes functional statements, organisational charts and information that determine quality and output standards, and the functions and responsibilities of workers and work units. Typically, the inspection engineer oversees the procedures designed to ensure that production processes, and their inputs and outputs, fulfil the standards specified in the system. Inspection engineers also handle the regular updating and certification of the quality system.

In case of customer complaints concerning product quality, it may be the responsibility of the inspection engineer to follow up on the complaints and launch corrective action(s) in the production process. The trend is that customers increasingly set detailed standards for product quality, their packing and delivery.

Digital simulation tools are increasingly allowing inspection engineers to try out new ways of organising production processes and estimate costs. The advantage of digital simulation is that it makes it less costly and risky to experiment with alternative production processes.

When solving problems, inspection engineers often have to handle conflicting objectives related to lean and quality. On the one hand, the inspection engineer must develop efficient production processes that reduce activities that do not contribute to value creation. On the other hand, the inspection engineer must give priority to processes that enhance quality and provide a high level of service to customers. These objectives may be conflicting, and the inspection engineer must develop solutions that balance both objectives. For example, the implementation of a barcode system that provides traceability of the company’s products may be regarded as a cost that does not contribute directly to value creation. However, traceability may be very important to quality control and to customers.

The work of inspection engineers does not only include repetitive, regular data collection and quality control. The technologies and work organisation of production change continuously, and the implementation of new technologies is often trialled in pilot projects. Inspection engineers are typically involved in their project management in cooperation with the production managers.

Social tasks

The inspection engineer’s job involves horizontal collaboration with managers and workers in production: vertically, the inspection engineer is an important link between the production at operative level and the top management of the company. Consequently, the job involves many social tasks.

Inspection engineers play a key role in the continuous planning, implementation and controlling of production processes. The implementation of the continuous optimisation of production processes and
quality control systems is not a simple top-down process. Rather, it involves intense, horizontal cooperation with blue-collar production workers. This demands good social and communication skills. The workers in production are typically involved in the daily collection of production and quality control data. They also provide feedback and ideas in relation to the continuous improvement of production processes. Inspection engineers typically work with technicians in maintenance departments, IT specialists and white-collar and blue-collar colleagues when it comes to monitoring the production process.

The overall role of the inspection engineer is the continual improvement of the optimisation of floor schedules, production planning, quality control systems and decision-making tools. This makes the inspection engineer an important vertical link between production and management, though the position can involve conflicting demands. One of the main tasks of the production engineer is to calculate the budget and observe the cost targets and budgets as defined at company level. In some cases, inspection engineers are also responsible for budget, and must implement corrective actions and budget reductions ordered by top management. That can lead to conflict with other technical or organisational goals set by technical workers or technicians on the production line.

In terms of serving and attending tasks, the inspection engineer is typically responsible for arranging audit inspections in collaboration with the production units. Audit inspections may involve external inspection engineers and, in some cases, customers may send in inspection engineers, sometimes on unannounced visits. Inspection engineers also cooperate with external stakeholders and regulatory authorities on environmental issues and permissions related to the emission and control of wastes such as effluent from the production plant. They may also be responsible for communicating with customers on quality issues and production standards. The coordination of quality management also involves cooperating with many different stakeholders both inside and outside the company.

Another of the inspection engineer’s important role is the teaching and coaching of workers on the production line and in departments involved in the collection of production and quality data. The task involves instructing them on how to collect the data and how to follow up on deviations and problems detected in the production.

Inspection engineers handle many tasks in a team with other professionals in the company. The continuous development of production processes and the adoption of different technologies often require the inspection engineer to collaborate with technical experts, ICT professionals, mechanical engineers, human resource (HR) managers and other professionals. For example, staff members and the HR manager in the Italian case study company described how the successful application of new technology depends on the ability to establish a good research team with different competences. Implementation of new technology requires technical expertise as well as the involvement of people with practical experience from production processes.

Methods and tools of the work
The previous sections analyse the content of the work in terms of the occupation’s physical, intellectual and social tasks. This section focuses on the methods such as the forms of work organisation used in performing the tasks. The framework developed by Eurofound differentiates between three dimensions:

- autonomy – extent to which a worker is free to carry out the task as they want;
- teamwork – extent to which the task is carried out in direct cooperation with a small group of co-workers;
- routine – extent to which the task is repetitive and standardised.

The case studies indicate that the work of inspection engineers has a high level of autonomy as they are free to decide how to organise their work during the day to perform their overall role of organising, optimising and evaluating production processes. Some of the work tasks, such as collecting production data and providing feedback to employees, are routine in the sense that they are carried out regularly and must be consistent. Although inspection engineers work autonomously, many work tasks are
social ones as they involve horizontal collaboration with employees in the production units and maintenance and quality departments. The inspection engineer also has an important role as a link between top management and production operatives.

In terms of tools, the Eurofound framework differentiates between two main types: machines (excluding ICT) and ICT. Although the inspection engineer’s job does not involve machines as tools for carrying out the work, it does involve inspection tasks where machines and production equipment are regularly checked and improved in collaboration with production managers and the company’s maintenance department. However, the work of inspection engineers involves a high level of ICT use.

Inspection engineers are typically responsible for:

- organising the collection of production data and test samples for quality control;
- ensuring all data are inputted correctly into the appropriate ICT system for processing.

Inspection engineers use software programs to analyse production data (for example, to perform calculations on the status of production such as production yield). In addition, they are responsible for making presentations of the information obtained to aid decision-making by management and determining any corrective actions.
Job quality of the occupation

The concept of job quality refers to the potential impact of the characteristics of jobs on the well-being of workers. Based on information from the case studies, this chapter discusses the job quality of the work of inspection engineers. The discussion uses a Eurofound model, which has the following four main dimensions of job quality (Eurofound, 2013):

- intrinsic quality of work (autonomy, skills and social support);
- employment quality (development opportunities and contractual stability);
- workplace risks;
- working time and work–life balance (duration, scheduling, flexibility and intensity).

A further dimension, pay/wages, was added for this study to enrich the analysis.

Intrinsic quality of work

Intrinsic job quality has three main components:

- skills – how varied and stimulating the skills required in the job are;
- autonomy – to what degree the worker work on their own and can decide the pace of the work and how to carry out work tasks;
- social support – how stimulating and enriching the social environment of the job is.

Taken as a whole, intrinsic job quality can be understood as a measure of the richness of work as creative human activity, which is what skills, autonomy and social support are all about.

The case studies show that the intrinsic quality of the work inspection engineers is good as it involves an enriching variety of intellectual and social tasks that are solved autonomously and in collaboration with employees, maintenance departments and management.

In contrast to the other occupations covered in this study, inspection engineers do not take a direct part in production/manufacturing processes; their role is to organise and optimise them. Therefore, the intrinsic job quality of inspection engineers does not involve the same problems of monotonous and repetitive work as workers in production. As the job tasks are mainly intellectual, the intrinsic job quality may be more related to the psychological, intellectual and social challenges of working as an inspection engineer.

The case studies also show that inspection engineers have a key role in the continuous optimisation of production, which requires close collaboration with all production units as well as with top management. This may be both challenging and enriching. However, inspection engineers are often faced with conflicting demands when seeking to organise production in a way that balances quality with efficiency, such as the adoption of lean manufacturing. This can be a stressful element of the job. Inspection engineers are often required to handle the difficult double role of being both controllers and advisers. They are expected to help and advise production units on how to improve their production and quality, while working as controllers who report problems and faults to the management to launch corrective action. Employee interviews as part of this study indicate that some inspection engineers find this role stressful, as they often have to implement solutions that may cause discontent among production units.

Employment quality

Inspection engineers have wide areas of responsibility and typically work as salaried employees. They have stable employment relationships and contracts that specify a long notice period. The employment quality and contractual stability of inspection engineers are typically higher than for blue-collar production workers.

Inspection engineers have good career prospects and development opportunities. Typically, they start as a member of a team of engineers in the company and gradually move upwards to become a team
coordinator or project manager with responsibility for small, incremental projects and the implementation of new technologies and production processes.

Although inspection engineers are salaried employees in stable contractual employment relationships, they face some of the same risks of outsourcing as workers in production. Inspection engineering and quality control of production are service activities that the company may choose to outsource fully or partly to external consultants. As many of the inspection and quality control tasks are increasingly based on production data obtained through digital technologies such as sensors, the work tasks of analysing the data could be transferred to low-wage countries as ‘web work’. Hence, outsourcing may in the future be a threat to inspection engineers as well as to workers in production.

**Workplace risks**

The work of inspection engineers mainly consists of intellectual deskwork carried out in front of a computer. The job therefore does not typically involve the same health and safety risks as the job of production workers. The job of inspection engineers involves regular inspection of production equipment and taking samples. The increasing use of sensors to collect production data means that inspection tasks are becoming safer as they involve less direct contact with machines. Digital technologies also enable virtual simulation of production processes, meaning that test procedures become less risky and much cheaper.

**Working time and work–life balance**

Inspection engineers are salaried employees whose working time and duration are typically regulated by collective agreements. Their work typically involves a high degree of autonomy and flexibility, allowing them to decide how to organise their work tasks during the day. However, the high level of autonomy and flexibility may constitute an inherent risk of damaging their work–life balance.

Inspection engineers often have to solve unforeseen problems and implement improvement projects within a deadline. To do this they are expected to be flexible and, if necessary, work overtime. So compared with workers in production, the work of inspection engineers is much more ‘limitless’. In employee interviews, some inspection engineers complained about working overtime and the scheduling of meetings outside normal working hours. A global customer base can also mean that an inspection engineer may need to attend a meeting or contact a customer outside regular working hours.

**Pay/wages**

Inspection engineers are typically well-paid salaried employees as most of them are members of professional trade associations and covered by collective agreements that regulate minimum starting pay. However, the case studies show that the industrial relations, educational pathways and affiliations of inspection engineers are relatively heterogeneous. Employees working as inspection engineers include not only graduates from higher education but also former blue-collar workers who have qualified for the occupation on the basis of their workplace experience and training. In some cases, the collective agreements and affiliations of inspection engineers give rise to conflicts between trade unions and employers. A key issue is whether agreements on working conditions and wages for inspection engineers should be covered by an agreement for blue-collar workers or salaried employees.

The wage levels of inspection engineers vary considerably depending on the level of experience of the employee and their educational pathway. In Sweden, for example, the average monthly salary for newly graduated engineers in the private sector in 2014 was about €3,310 (SEK 32,490 as of 5 January 2018). With 10 years of professional experience, the median salary of engineers not in a managerial position was €5,600 and after 20 years, €6,800 per month (AllasStudier, 2017). The wide range of salary levels reflects the fact that inspection engineers in Sweden include members of blue-collar trade unions as well as members of the Swedish Association of Graduate Engineers. For example, the starting salary today for young inspection engineers (aged 20–24) who are members of Unionen is €2,512 per month under a collective agreement (Unionen, 2017).
Conclusions
In contrast to the other occupations covered by this study, inspection engineers are not directly involved in manufacturing processes but are salaried employees who have the role of organising and optimising the processes.

Global competition is forcing manufacturing companies to focus on quality and advanced products as well as lean and efficient production in order to stay competitive. The inspection engineer has a key role in organising and optimising production processes to meet the demands of efficiency and quality, which often conflict. Inspection engineers also have to handle the difficult double role of being both controllers and advisers; they are expected to help and advise production units on how to improve their production and quality, while also working as controllers who report problems and faults to management leading to the launch of corrective action.

European manufacturing companies face increasing demands from their business customers on quality standards. One of the basic drivers of this development is that manufacturing companies increasingly operate in politicised markets, where they need to demonstrate a commitment to sustainability, the climate change agenda and ethical standards of good working conditions. The increasing use of subcontracting in the value chain adds to this development, as subcontractors must ensure that the manufacturing processes meet the same quality standards and other criteria.

Increasingly, customers are demanding that production processes and working conditions meet specific standards related to sustainability and quality, and in some cases, they make their own control visits in the company and specify control procedures. To adapt to these increasing quality demands, many companies are developing more comprehensive and centralised quality control systems that involve all functions of the company. In response to this shift, inspection engineers tasked with optimising their company’s production processes have to cooperate with many different departments and functions in the company. This cooperation requires inspection engineers to have broad competences not only in technical fields (such as engineering, agronomics, biotechnology and chemistry) but also in organisational, economic and social fields (such as teamwork, HR management, team leading and project management).

The job of an inspection engineer includes many intellectual and social tasks, including cooperating with many stakeholders, both inside and outside the company. One of the inspection engineer’s main responsibilities is to organise the systematic collection and analysis of data from the company’s production processes. Increasingly, production data are collected digitally by sensors and scanners within the production equipment. Based on an analysis of production and quality data, it is also the responsibility of the inspection engineer to feedback information on the results to various company departments – an important tool for the continuous improvement of production processes. The inspection engineer’s job also involves cooperating with different departments in the company in relation to planning and quality control.

Inspection engineers have an enriching and stimulating job, with a high degree of autonomy and freedom to organise their working day. At the same time, the responsibilities of the job are broadening and inspection engineers increasingly have to handle conflicting demands and objectives related to lean manufacturing and quality. Furthermore, the broad areas of responsibility and the flexibility necessary to deal with unforeseen problems entails a greater risk of having to work outside normal hours and, in consequence, suffering from a poor work–life balance.
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