An uncertain elite

Professional differences and similarities between engineers and tech workers in times of digital transformation

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ABSTRACT

The digital transformation of industries has given rise to new categories of tech workers, such as software engineers and UX/UI designers, who now work alongside traditional engineers. This study explores the evolving relationship between these groups, focusing on work processes, status perceptions and professional interactions. The research questions addressed include: how has

digitalisation affected these two groups' work processes? what strategies do they use to maintain or improve their career paths? and how do their roles converge or diverge? Using qualitative data from interviews and workshops in a German automotive company undergoing a digital and electric mobility transformation, the study finds both competition and cooperation between engineers and IT professionals, with the former adopting some IT work methods and the latter adjusting to the highly structured processes of the industrial sector. Despite growing overlaps, distinct professional identities nevertheless remain.

KEY WORDS
digitalisation; sociology of professions; automotive industry; engineers; data science
DOI: 10.13169/workorgalaboglob.19.1.0084

Introduction

The digitalisation of products and processes is increasing the importance of 'new' tech workers: software engineers and developers, UX/UI designers and other IT professionals (Dorschel, 2022; Sheehan & Williams, 2023). We refer to them as 'new' because the demand for these occupational groups has increased rapidly in recent times, though the corresponding occupational fields are not new (Marks & Scholarios, 2007). This group has at times been described as embodying the entrepreneurial spirit of the tech industry (Neff, 2012) and as being driven by an orientation towards social responsibility (Dorschel, 2022). What these descriptions emphasise is the difference between the group of new tech workers and 'traditional' tech workers – i.e. engineers.

These characterisations of tech workers as entrepreneurial and socially oriented refer primarily to tech workers who work in the tech industry itself. Yet the majority of tech workers are employed in the manufacturing sector. They join companies whose culture and career paths have long been shaped by engineers. Although software and data are increasingly important, they are not at the core of the product. Engineers create working methods in these companies, and tech workers find themselves in a service role. While the introduction of agile forms of work organisation initially promised tech workers a large degree of autonomy, companies are now striving to rationalise them (Porschen-Hueck & Sauer, 2021). Such developments could trigger this new group to adopt the self-understanding and working methods of the traditional tech workers, namely engineers.

At the same time, however, the world is also changing for engineers. They enjoy a strong reputation, but their once dominant status in companies is increasingly being called into question. The standardisation of work processes and the outsourcing of engineering tasks have led to discussions about the 'demise of engineers' for some time (Torstendahl, 2022). The increasing digitalisation of products in the manufacturing sector means that skill requirements are changing. This is having an indelible impact on career paths. Traditionally, engineers have been seen as the model of the 'company man', but their employment security is being

challenged. This is evident in industries such as the automotive sector, where the digitalisation of the automobile and its production is leading to an increasing mix of software-related occupations and engineers (Krzywdzinski, 2021). We thus also expect engineers to at least partially adapt to practices and ideas that the tech workers are introducing.

In our study, we compare tech workers and engineers, focusing on three main questions. First, how are work processes changing in the context of digitalisation? In particular, which rationalisation processes can we observe? Second, how do the two groups perceive their work and their status in the occupational hierarchy? What strategies do they use to try to influence their career paths in the company? And third, which forms of convergence and divergence do we observe between both groups?

Our analysis focuses on the case of a German automotive company in the middle of a radical transformation. The company is trying to digitalise its products and processes more quickly and expand employment in the IT area. At the same time, it is in the middle of a transition to electromobility, which is challenging traditional engineers. This group has to deal with digitalisation and reckon with the likely end of the combustion engine – which the company's engineers were centrally involved in developing. A key result of our analysis is the concept of the 'uncertain elite', which we use to characterise the situation of the two groups.

We build on two strands of research. First, we draw on previous studies of engineers' work identities and roles (Gispen, 1996; Meiksins & Smith, 1996) and integrate them with recent scholarship on tech workers (Dorschel, 2022; Marks & Scholarios, 2007). In doing so, we seek to make a comprehensive contribution to the literature on the development of tech workers in contemporary digital capitalism. We reconstruct the rationalisation processes of work with a specific focus on tech workers' demands for job security and a voice in the company. Second, we refer to Abbott's (1988) concept of professions, which focuses on competition and the interaction of professions.

In the next section, we review the state of the research and our conceptual framework before presenting our data and methods and the empirical analysis. The article concludes with a discussion of our findings and conclusions.

Current research and heuristic framework

The rise of 'new' tech workers

Since the 2000s, the term 'tech workers' has increasingly been used to refer to employees in IT-related occupations such as software development, software engineering, UX/UI design and others. Marks and Scholarios (2007) cite the prediction that tech workers will be the future 'aristocrats of the labour market'. Agile working methods originating in software development and typical among tech workers are seen as a role model for companies (Rigby, Sutherland & Takeuchi, 2016).

There are differing descriptions of tech workers. In an early study, Neff (2012) argued that they were characterised by high risk-acceptance and an entrepreneurial orientation. In contrast, Dorschel (2022) reported an 'ethic of mindfulness' and an

openness to collective organising. These differences may be related to developments over time. When there were job cuts in the tech industry in the early 2020s, Di (2021) found an increasing perception of job insecurity and injustice (see also Su, Lazar & Irani, 2021). Another important factor might also be differences within the broader group of tech workers. Marks and Scholarios (2007) found a polarisation of working conditions: University graduates occupied software development jobs characterised by a high degree of autonomy, while IT workers without relevant university degrees tended to take jobs with more standardised tasks and less autonomy.

Sheehan and Williams (2023) emphasised that the collective organising of tech workers can tie into the contradictions in their professional identity. Tech workers emphasise individual responsibility for performance and career, but they also see themselves as producers of a 'social good' (Sheehan & Williams, 2023:455) for society as a whole. This second side of their identity has resulted in developments such as the Tech Workers Coalition and other organising activities within the American tech community (cf. Rothstein, 2022).

Previous research has especially focused on workers in the new tech industries. The rise of tech workers, however, can be observed in all sectors, due to the growing importance of software (Helper & Kuan, 2018). The automotive industry is a good example, as production is increasingly being digitalised, and big data analytics are being used in areas such as product and process development and, sales and marketing (Krzywdzinski, 2021). A rapid digitalisation of the automobile itself is also occurring (Spirgi & Meier, 2022). As a result of these developments and, traditional manufacturing companies are increasingly becoming major employment sites for tech workers (Lechowski & Krzywdzinski, 2022; Pfeiffer, 2023). In these companies, tech workers encounter engineers, who increasingly need to master skills such as big data analytics (Heidling & Neumer, 2021). This may fuel interprofessional competition.

Engineers as challenged, 'traditional' technical workers

Until the 1990s, the term 'technical workers' primarily referred to engineers (and technicians) (Crawford, 1989; Meiksins & Smith, 1996; Smith, 1987). They were the carriers of the new forms of advanced skills, independence and creativity. Accordingly, there was limited standardisation and controllability (Kunda, 1991). These characteristics meant that engineers were not easily replaceable and gave this employee group high structural power (Wright, 2000). Kotthoff (1997) argues that this was reflected in engineers' expectations of material security (high salary, job security and career paths in companies). While this high structural power tends to go hand in hand with an individualistic orientation towards interest representation – engineers rarely organise themselves into unions – they attach high value to employment security, and (in countries like Germany), they see the works council as a useful collective institution (Bromberg, 2011).

Beginning in the 1980s, empirical research noted a polarisation between different groups of engineers (Meiksins & Smith, 1996). Highly skilled engineers, primarily employed in areas such as product development, succeeded in maintaining their high autonomy and demanding work content. However, many engineers in other corporate areas faced increasing labour market competition (Torstendahl, 2022). Engineers' work

processes became increasingly standardised and, by the 1980s, there was talk of an assembly line in offices (Perrolle, 1986). The outsourcing of engineering tasks was also associated with relocation to low-wage locations, at least in part (Bryant, 2006; Will-Zocholl, 2011).

Many engineers experienced this development as a loss of autonomy and increased uncertainty about their status (Torstendahl, 2022; Will-Zocholl, 2011). The pace of these developments differed between countries; in Germany, France and Scandinavia, the engineering profession has maintained a very high status (Gispen, 1996; Meiksins & Smith, 1996). In Germany, the engineering profession is certified, meaning it is only open to university or technical college graduates. In a technology-oriented corporate cultural context, engineers have several attractive career paths in companies (Lawrence, 1992; Lee & Smith, 1992).

Analysing 'traditional' and 'new' tech workers

Our analysis examines how encounters and cooperation between engineers and tech workers shape their work-related perceptions. Following Marks and Scholarios (2007), we assume that work-related perceptions develop through professional socialisation. Workers' experiences and understandings of how their tasks differ from those of other occupational groups are crucial in this regard. We do not see engineers and tech workers as homogeneous groups but account for the fact that they work in very diverse fields.

We build on concepts proposed by Marks and Scholarios (2007) and Kotthoff (1997) and focus on three dimensions when comparing engineers and tech workers. The first of these dimensions is their *tasks, work processes and their rationalisation*. The second is their *status in the company and perceptions of status in relation to other groups*. Finally, we look at their *expectations of the organisation regarding employment security, career paths and interest representation*.

We identify two mechanisms that could promote a partial convergence of both groups' work-related perceptions. The first mechanism is competition (Abbott, 1988). Abbott emphasises that professions compete for recognition and responsibility for a particular set of tasks, what he calls 'jurisdiction' (1988:20). Social groups attempt to gain jurisdiction over certain tasks through the formation of associations, development of educational programmes and government regulation – typical cases here are lawyers and doctors. Even if the struggles over professional monopolies based on governmental regulation that Abbott addresses do not play a role in our case, there is still competition between engineers and tech workers for 'jurisdiction'. Highly regulated industries, such as the automotive industry, have field-specific external norms, professional rules and even codified procedures (e.g. by the International Organization for Standardization, ISO). These norms and rules strongly influence company-internal work processes and hence organisational forms of jurisdiction. In the automotive industry, these norms and rules are set by associations dominated by engineers and reflect their culture.

Technological change has led to increased competition between engineers and tech workers as it alters work content and working methods. As the product (the car) is becoming increasingly digital, engineers are having to adapt to tech workers' working methods. This means that their knowledge and status are being called into question.

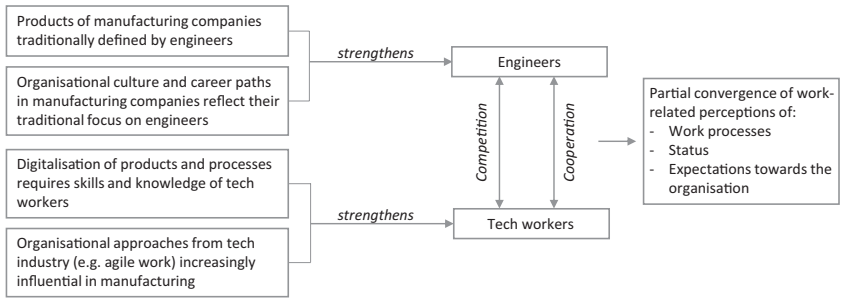

Figure 1: Explanatory model

At the same time, manufacturing companies remain different from tech companies: their product still has a clear engineering core, which requires tech workers to adapt to engineers' working methods and knowledge. It remains to be seen what this competition will mean for career paths within companies.

Besides competition, cooperation is the second mechanism potentially leading to partial convergence. Here, we follow Adams (2007), who argued that Abbott (1988) over-emphasised interprofessional conflict and overlooked interprofessional cooperation. The necessity to cooperate could lead to learning processes and convergence between engineers and tech workers. At the same time, the interplay of competition and cooperation implies that convergence would likely not be complete, as both groups retain the specifics of their educational backgrounds, working methods and tasks.

Figure 1 above summarises our analysis scheme. The factors that strengthen the organisational position of engineers and tech workers are listed on the left-hand side. The relationships of competition and cooperation between the two groups lead to a partial convergence of work-related perceptions.

Data and methods

The data and analyses used in this article originate from the authors' joint research project on perceptions of the dual transformation of digitalisation and electromobility in the automotive industry. The project centred on a case study of a large German car manufacturer. In 2021 and 2022, the research team conducted 13 interviews with tech workers and 21 with engineers. These were complemented by six workshops with managers, HR employees, works councils and training experts from the departments employing the interviewed workers.

We selected the following four groups for this analysis.

The first of these groups was made up of *engineers in product development* with a focus on the combustion engine. These have long been the most prestigious group of engineers in the company, but they are now hugely affected by the transformation.

Process engineers made up the second group. They are a less prestigious group but one whose work is significantly less dependent on specific technologies.

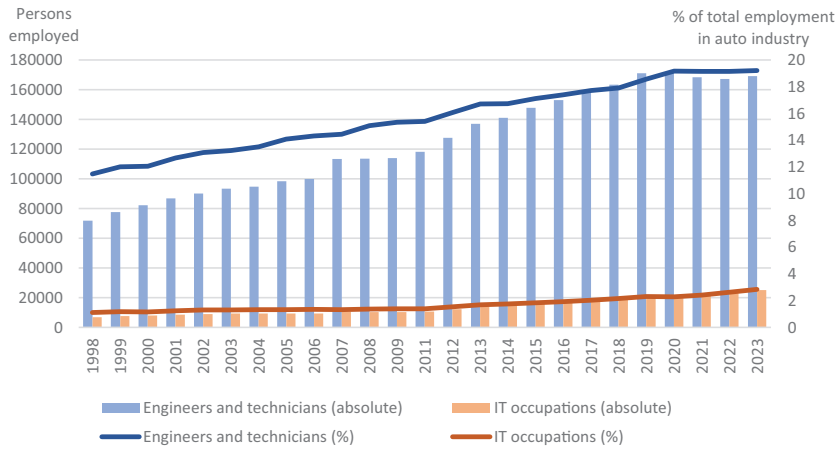

Figure 2: Engineers & technicians and IT professionals in the German automotive industry, 1998–2023
Source: Authors, based on Federal Employment Agency (BA) data.

The third group comprised *data scientists*. This is a particularly sought-after and prestigious group, as the company places great importance on using big data and technologies such as machine learning in product and process development.

Finally, we studied *UX/UI designers* – a less prestigious group that works much less with cutting-edge technologies.

At the time of the study, engineering jobs in the company we studied were under considerable rationalisation pressure while tech-worker jobs were being massively increased. The situation in the company was typical of the entire German automotive industry. Exact data for the numbers of product and process engineers, data scientists and UX/UI designers are not available, but we can use statistical data to analyse employment trends for engineers and tech workers.

Figure 2 shows that engineers continued to be the dominant group in the German automotive industry. According to data from the Federal Employment Agency, the number of engineers and technicians more than doubled from 71,800 in 1998 to 169,200 in 2023. In 2021 and 2022 (i.e. at the time of our study), employment fell by around 4,000 jobs for the first time in over two decades, although it increased again slightly in 2023. The job cuts were linked to a slump in production that began in 2021. Overall, the share of engineers and technicians employed in the German automotive industry rose from 11.5% in 1998 to 19.2% in 2023.

Employment in IT occupations has grown even faster than that of engineers and technicians, albeit from a significantly lower level. Employment rose more than threefold, from 6900 persons in 1998 to 25,000 in 2023. This corresponded to 1.1% of workers in the automotive industry in 1998 and 2.8% in 2023. From 2021 to 2023, when all other employee groups in the automotive industry suffered job losses, around 5000 jobs were created in IT occupations. While engineers and technicians have remained the dominant group in the automotive industry, IT employment has developed much more dynamically.

The interviews conducted by the research team focused on previous educational and career paths, the contents of work and how they are changing due to digitalisation and electromobility, perceptions of interviewees' own status within the company and opportunities and wants with regard to further training and career paths. The workshops with managers, HR experts, works council members and training experts were used to reconstruct how the company's transformation was affecting different departments and validate the interview findings. All interviews and workshops were recorded and transcribed. The transcripts were analysed using qualitative content analysis methods (Mayring, 2021). We developed codes deductively, based on our research questions, and inductively from the material to capture different perceptions, career paths and strategies.

Empirical findings

Engineers in product development

Biographies: passion for the automobile

Our analysis begins with the department responsible for developing the engine. The engineers working here have traditionally been the elite of the company. Typical career paths start with an engineering degree focusing on engine development. After graduating, the engineers pass through several positions, such as assembly, process engineering or prototype construction. All of our interviewees have worked in the company since graduating and strongly identify with it. This close bond is also based on a passion for combustion engines.

Tasks and work processes: electromobility as a threat

Digitalisation has changed the work content. Test procedures are now mainly carried out using digital simulations of engine and driving behaviour. This has eliminated some of the engineers' tasks. However, the product demands are becoming ever greater and more complex. This requires more intensive collaboration and more overview knowledge.

Despite its advantages, digitalisation is perceived to have intensified work, because many processes run in parallel and informal exchanges are becoming more difficult. Engineers complain that they do not have time 'to look left and right' (AE-IV01) and deal with new ideas. Our interviewees also report a lack of a clear corporate strategy for introducing digital tools into the company. The 'heavy tanker' (AE-IV02) is sluggish, and structures are 'old-fashioned' (AE-IV02). It remains unclear which data should be migrated to new systems and how it should be structured. Central management decisions are delegated to employees, who feel overwhelmed without guidelines.

Our interviewees reported that the lack of informal exchange in digital work environments is having a negative impact on innovation. According to the engineers, digital images cannot replace the direct experience of the material properties of an object – 'Developing a car is a bit more than just software' (AE-IV02). Engineers fear that experience and specialist knowledge will erode, as their major task is now managing data. They argue that simulations of extreme conditions (heat, cold, altitude)

are inadequate and that a combination of physical testing and digital calculation remains central to making the right decisions.

The major consequence of the transformation to electromobility is that employees are being assigned to develop the electric powertrain, and positions in the development of combustion engines are no longer being filled. As ongoing projects must be completed with fewer members of staff, work intensity is increasing.

Career strategies: transformers, observers, traditionalists and worriers

The engineers can be divided into four groups with regard to their strategies for dealing with the transformations of digitalisation and electromobility: first, 'transformers' who have quickly gained further skills and applied for interesting jobs; second, 'observers' who are exploring the possibilities and see good opportunities; third, 'traditionalists' who identify strongly with the combustion engine and do not want to change; and finally, 'worriers' who are mainly older employees who plan to remain in their current position until they retire, but, nevertheless, if they remain in their current job, face uncertainty regarding their own future prospects.

The managers emphasise that this mix is quite functional. There have to be 'transformers' who drive the change but also 'traditionalists' who remain loyal to the combustion engine:

> *We need a few 'observers', we need … a few people to stay on. But we also need … young people with the personality and methodological process knowledge who have the speed to help us with electromobility… So we need a certain mix. If we only had 'transformers', we would have a huge problem as a company. (AE-GD1)*

There are different options for 'transformers' and 'observers'. One strategy is to focus on a management career. One problem often lamented by our interviewees is the lack of support for this path. Candidates need to gain experience in different departments and through placements abroad to move into a management position, but these opportunities are not open to everyone. Moving into management positions is also sometimes viewed critically, particularly because of the additional demands and burdens associated with working in management.

Another strategy is to look for jobs in other areas, using the internal job market and personal contacts. The company offers many opportunities to network and exchange information about job opportunities. Nevertheless, considerable uncertainties remain, because employees want to avoid accidentally manoeuvring themselves into a professional dead end. For such employees, the central challenge of the transformation is the inability to assess future developments well, making career orientation and planning much more difficult.

Changing status: lack of recognition

Engineers do not generally see their company's future as being at risk. Nevertheless, massive changes are taking place. The company is no longer investing in the development of combustion engines, it is cutting budgets and it is implementing restructuring measures.

We're told in the middle of the year that we can't spend any more money, but the deadlines all remain unchanged. It's no fun then either. (AE-IV06)

Our interviewees agree that the role of the combustion engine will decline significantly. Accordingly, younger engineers rate their chances of working in this area in the future as low. Some see themselves as well-prepared, while others perceive the transformation requirements as a 'threat' (AE-IV09). They do not generally fear becoming unemployed, but worry about being unable to find a suitable position in the organisation.

The lack of appreciation for the work is a major issue. Engineers are constantly being told that they should look for something else. Innovation in the combustion engine has also become much less important for the company. Engine development is still innovative, but nothing is being published, and engineers cannot attend conferences. The company simply no longer talks about the combustion engine.

The interviewees unanimously believe that their specialist knowledge of the development of combustion engines is of very limited relevance to new, electromobility-related tasks. Yet they emphasise that they have knowledge that remains relevant in at least three respects.:

First, they insist that they have specialist knowledge about organising development work. In complex development processes, it is important to know 'who to tell what and when [and] what not to miss under any circumstances' (AE-IV09). This knowledge can lead to a management career.

Second, they see their experiential knowledge as an important asset for development tasks in the field of electromobility. For example, subjective physical feeling plays a central role in assessing the driving experience; does an engine feel 'inharmonious', 'sluggish' or 'sporty' (AE-IV05), does the driver notice jerking sensations and how do these sensations feel? Even when the driving experience is measured digitally, subjective experience is required to interpret the data.

Third, the engineers' methodological knowledge, such as their expertise in coordinating and combining digital simulations and physical test arrangements of engine and driving behaviour, remains important.

Engineers in process planning

Biographies: once a process engineer, always a process engineer

Process engineering is not as prestigious as product development. Most of the process engineers we interviewed began their careers in the company straight after graduating from university (typically in industrial engineering or mechanical engineering). Some had also completed vocational training (e.g. as an industrial mechanic) before or parallel to their studies. The interviewees have mainly pursued their careers in process engineering; only a few have switched from other areas, such as procurement. They share a great interest in technology but also enjoy the highly collaborative work environment in process engineering.

Tasks and work processes: embracing digitalisation

Process engineering is structured like a matrix. Engineers specialise in different technologies and production areas (e.g. welding, electrics, painting, assembly) while

also working on projects that are linked to a specific vehicle model. This structure means that the work content is varied. Process engineers are an important interface with product development, production, procurement and personnel planning, which means they do a considerable amount of communication and coordination work. Coping with uncertainties – for example, in coordinating suppliers – plays a major role, and social skills are very important.

Process engineers have been working with various digital tools for some time. These range from classic CAD applications to systems such as Human Work Design and modern process planning applications (e.g. Teamcenter Process Designer), which can be used to simulate the function of production lines in 3D. The variety of programs and data formats used by the company and its suppliers represents a big challenge. As a result, applications such as Microsoft Excel still play a major role and are used to merge data from suppliers, equipment suppliers and internal processes.

Increasing digitalisation has boosted the demand for new IT knowledge and created an additional short-term burden. Existing digital tools must be maintained, and data entry and data transfer in these tools take up much of the engineers' working time. On the other hand, new tools have to be introduced, which requires additional work. Process engineers have noted that they receive too little support from company headquarters.

Process engineers expect advancing digitalisation to eliminate manual data entry and transfer activities, which they see as a very positive development. This could free up time for communication tasks, which will not be changed by digitalisation. The increasing use of simulations and digital process monitoring will also reduce work content but will not eliminate the need for communication.

Process engineers do not expect the transformation to electromobility to jeopardise their jobs either. Although individual production processes are changing, this does not devalue process engineers' knowledge.

Career strategies: stability prevails

There are clear differences between the career strategies of process engineers and those of engineers in engine development. Since process engineers perceive their area of work as stable, they have little desire to move to other areas. With regard to further training, they frequently mention an interest in artificial intelligence and project management. However, several engineers criticise the company's focus on formal training and certificates, which they feel quickly become outdated in relation to IT topics; in this regard, there is a parallel with tech workers. They emphasise the necessity of learning by doing and maintaining communication about new topics in communities of practice.

Changing status: combining new and traditional ways of organising work

In the interviews with process engineers we found no evidence of any perception of a devaluation of the engineers' position in the company. Engineers perceive their own department as very successful in implementing technological change. Agile working methods have been promoted in some areas, and new roles, such as agile facilitators and moderators, have been introduced. Process engineers also confidently emphasise the

differences between their work organisation and the way IT works – agile organisation is the right approach in some cases, but not everywhere and always. Planning a new production hall requires precisely timed cooperation between different areas and functions and reduces the scope for agile forms of teamwork. Tech workers perceive this as bureaucratic and complicated, but the process engineers emphasise that production's requirements for security sometimes clash with ideas of an agile work organisation:

> *When you're in production, you want everything to be 100% safe … And this means that sometimes you can't innovate as much. (PP-IV05)*

Many engineers express concerns that the company could collapse if the digital and ecological transformation were to fail. This reveals parallels with the sustainability and ecological orientations of the 'new' tech workers, which are more pronounced than those of engineers involved in combustion engine technology development.

None of our interviewees articulated a wish for collective representation by the works council or a trade union. The engineers emphasised the high degree of autonomy and independence they have in their work; the works council or the trade union are not seen as channels for asserting individual or collective interests.

Data scientists

Biographies: high diversity of paths

Data scientists are one of the youngest groups among the tech workers and the antithesis of engineers – they work solely with data, and their approach to working is strongly rooted in IT culture. The employees we surveyed are organisationally part of corporate IT and work remotely at different locations. On average, they are younger and more international than other groups of employees in the company. Most of them have completed university education and have only been with the company for a short time.

The paths into data science are very diverse. While a degree in computer science is considered helpful, candidates from other fields can acquire the necessary experience and knowledge (understanding of theoretical concepts and mathematical models, programming skills). For example, there are many lateral entrants among data scientists who hold degrees in mathematics.

Data scientists predominantly cite two motives as crucial for the decision to work in an automotive company: personal enthusiasm for electromobility; and fascination with the variety of data. The bond with the company is predominantly professional.

Task and work processes: far-reaching autonomy

The data scientists work according to agile principles and consistently use pair programming (two people working together on the same code). Our interviewees particularly appreciated this way of working, with some making their remaining in the company dependent on how long they are allowed to continue working in this way (the cost of this approach has been questioned).

The work is very holistically organised because there are still few standardised workflows. The interviewees also rate this as particularly positive. The projects usually centre on applying existing machine learning algorithms and frameworks to company

data. The data scientists act as service providers for various departments and production plants in the company, which place orders for analyses. Projects are predominantly developed up to the proof of concept (POC) stage; in some cases, the tasks also include maintaining ongoing machine learning projects.

The projects cover extremely diverse challenges, including the automation of legal or commercial processes using robotic process automation (RPA), the application of machine learning (in areas such as robot control), logistics, quality assurance, the resource-saving use of production materials and, in some cases, projects in the field of autonomous driving or charging technology.

Career strategies: an unstructured field

The data scientists we interviewed barely mentioned the need for formal training. They emphasise the need to acquire new knowledge *ad hoc*, for instance, by exchanging information in specialist web communities. They also valued trial and error and mutual learning in pair programming.

A career in the company is not a priority and was not described as a decisive motivating factor in the interviews. Data scientists are largely intrinsically motivated and fascinated by technical possibilities – the brilliance of a technical solution, the leanness of code, and the specifics of new data sets. This is precisely why they chose an industrial company as an employer: the variety of different data and applications provides many opportunities for technical development.

Data scientists particularly criticise the failure to allocate enough money for their projects. They understand this as a lack of recognition of their own performance.

Changing status: innovation identity

The interviewees consistently express appreciation for what they see as the unique mix of advantages of a large company and a start-up. Working in a large company offers them a huge field of action and an enormous amount of data. It also provides job security and – until now – relatively low rationalisation pressure. At the same time, data scientists see their working conditions as comparable to those in start-ups, as they have very few standardised workflows. The only negative experience is the need to market their own services within the company, which data scientists dislike and see as inhibiting them from a technical perspective.

This could lead to tensions in the future. In interviews, managers noted that pair programming is considered expensive. In future, pressure will increase to rationalise data science personnel and standardise work processes. Data scientists report approvingly that their managers have so far resisted this rationalisation pressure and are trying to maintain the best of both worlds for their employees.

Data scientists see themselves as pioneers and innovators of cutting-edge digitalisation, distinguishing themselves from other IT roles (such as IT security, system administration). They also see little reason to compare themselves with engineers. They simply regard the engineering areas as customers of their work.

Some interviewees also explicitly and positively address the advantages of co-determination and the role of the works council. For most of them, however, this topic plays no role.

UX/UI designers

Biographies: high diversity

The UX/UI designers are also part of the IT department but are not organised in the same way as the data scientists. They work as service providers on specific development projects for other departments in the company's software development centres.

The designers' educational and professional biographies are very diverse. In our interview sample, their educational backgrounds ranged from architecture to technical studies, innovation management, media design and software design. There are three types of career path. 'Pioneers' have come from larger companies and already gained relevant professional experience in UX/UI. 'Creatives' have typically worked in small design or advertising agencies for several years before joining the automotive company. They cite better and more regulated working conditions, better resources and more professional work as reasons for switching employers. Finally, there are 'internal creatives', most of whom joined the company with commercial or technical degrees but then sought creative challenges and moved to UX/UI design.

No standardised educational and career paths have yet been established in the UX/UI field. The major reference points for employees are specific methodological concepts such as design thinking.

Task and work processes: creativity rules

The UX/UI designers work on projects according to the principles of agile project work. Typically, project teams consist of 1 to 2 UX/UI designers, several data scientists and representatives of the departments that commission the work.

The work itself is extremely diverse, ranging from exploratory analyses (focus groups, interviews, observations) to innovation work in the narrower sense (generating new ideas), concrete design tasks (prototypes, user interfaces) and project management and moderation tasks. This allows for considerable creative freedom, includes cooperation with various other expert groups, and differs in its methods and culture from the more technical ('planning') approach of engineers.

As with the data scientists, the work is organised holistically, and there are no standardised workflows yet. There are, however, specific challenges. UX/UI designers have to cooperate with many different actors and adapt their workflows accordingly:

> *For me, this is like winning the lottery. I come from the agency world. In terms of salary, yes, it's a doubling. But it's also about self-realisation. And I have to say that this is not a company where you can stand up and say: 'I'm going to do everything the way I want'. There are many processes, and you also have to have fun convincing people that this is the right way. (IU-IV04)*

UX/UI designers see themselves as pioneers of digitalisation in the company and work with a variety of digital tools. However, the core of their work has not been digitalised. They don't see AI as a threat but as another interesting tool.

> *So there are already steps in the direction of AI, where design is seen as a kind of construction kit … That an AI will take over a lot of this work at some point is actually likely … and will also be a help for us, so that people who don't know so*

much about design in the visual sense can still participate … But our real job is to question things, to look individually at how we can help people, how we can improve things, how we can create things. (IU-IV07)

Career strategies: learning by doing

The level of formalisation of professional expertise in UX/UI design is comparatively low. The interviewees report constantly gaining new experiences and familiarising themselves with new methods. They are sceptical about structured, formalised programmes; sufficient time and opportunities to use less formalised learning opportunities are much more important. Interviewees do not understand why the company obliges employees to use the offerings of its own Corporate Academy, which they do not consider the best and most up-to-date. By contrast, UX/UI designers greatly appreciate the company allowing them to work on their own ideas outside of ongoing projects every second Friday ('innovation and improvement day').

Though UX/UI designers do not focus on the 'brilliance of a technical solution' – as with data scientists – but on creativity, their understanding of a career is very similar. They do not aspire to advancement in the company hierarchy:

I've heard that I'm not bad as a leader, but I don't want that at all. I don't want to move away from professionalism and what my work is all about: teaching people, developing ideas with people, applying methods, learning new things, getting to know new people. I would rather intensify that. (IU-IV07)

Changing status: creatives in a traditional company

UX/UI designers see themselves as innovators and creatives (with a 'mission'). They appreciate the benefits of a large company (pay, security, resources, professionalism) combined with the start-up mentality of their own department. They display awareness of a substantial work-cultural difference compared with the 'car builders', though they do not pair this with a devaluation of others or an exaggeration of their own role, as is sometimes described in the 'Silicon Valley mentality' (Neff, 2012).

Most respondents perceive a high level of recognition. They feel that their way of working is accepted, and they also accept that technical planning processes in an automotive company must be more stringent and standardised. They highly value the expertise of engineers as the 'traditional' tech workers; this presumably results from the close cooperation of both groups within project work.

However, our respondents repeatedly note that UX/UI is an 'alien body' in the company and has no representation in the management hierarchy. Individual designers also complain that the UX/UI department is not an independent organisational unit and that they lack their own professional home and thus a power base within the company.

They have similarities with data scientists regarding interest representation. They do not see the need for interest representation by the works council and have hardly any contact with it. However, most UX/UI designers are aware of the power of the works council in the automotive company and see this as positive.

Discussion

Changing tasks and work processes

Table 1 provides an overview of our findings on the role of engineers and tech workers in manufacturing companies.

In the field of tasks and work processes, tech workers and engineers remain quite different, even though their situations are interdependent. Unlike tech workers, product engineers are under considerable rationalisation pressure – digitalisation is eliminating certain tasks, and the development of the combustion engine is becoming less important. Product development engineers are severely affected by these developments and are aware of the declining importance of their domain-specific expertise and their recognition within the company. By contrast, process engineers see their role and recognition within the company as largely unchanged. Although they complain about a lack of resources and work overload, they do not believe that their position is threatened by the digital transformation or electromobility.

Tech workers are experiencing a different working situation. As the focus on software is still relatively new to the company in our study, there are few standardised processes and substantial scope remains for autonomy and creativity. Rationalisation pressure has so far been limited, so approaches such as pair programming or the 'innovation and improvement days' can be applied. This means that their experience not only differs from that of engineers but also from tech workers in software companies, who have had much more experience in the control of work processes in IT-related jobs (Schmidt & Rosenberg, 2014). However, we can expect these conditions to change in the long term. Tensions between the expectations of tech workers and the reality of working in an industrial company are ultimately likely to arise.

Partial convergence in work organisation

Tech workers' work organisation is considered important for the company (Rigby, Sutherland & Takeuchi, 2016) and is implemented in many areas, but engineers' work is only gradually changing. Engineers emphasise that they are implementing agile forms of work, but only where it makes sense. In many areas, opportunities for agile working are limited by the highly structured and long-term planning of product development and by the need to coordinate a very large number of players. Work processes remain strongly based on industry standards developed by engineering associations over decades.

Careers

While product development engineers are being severely affected by the transformation of manufacturing and note declines in the importance of their domain-specific expertise and recognition within the company, they are not experiencing precarisation and have few concerns about job security. Engineers expect to be able to transfer their knowledge (e.g. about vehicle dynamics, materials and the organisation of development processes) to other areas within the company.

The situation is different for tech workers. The lack of structured career paths is a source of uncertainty regarding their role in the company. Tech workers come from a variety of educational backgrounds and do not yet have a clear professional profile.

Table 1: Comparing engineers and tech workers

	Product engineers	Process engineers	Data scientists	UX/UI designers	Relations between the groups
Tasks	Demise of the combustion engine and the digitalisation of the car are changing tasks	Tasks remain unchanged, but increasing importance of digital skills	High autonomy, but service role: supporting engineering projects	High autonomy, but service and facilitator role: supporting engineering projects	Diverging, but interdependent
Work organisation	Industrial product development methods increasingly linked with agile work	Industrial process development methods increasingly linked with agile work	Agile work forms need to be linked with industrial product development methods	Agile work forms need to be linked with industrial product development methods	Converging
Careers	Engineers need to reorient themselves on the internal labour market	Engineers can continue careers within their area	No structured career paths	No structured career paths	Diverging
Status in the organisation	Status challenged due to product transformation	Status not changed, self-perception as pioneers of digitalisation in engineering	High status, but self-perception as elite does not correspond to the service role in company	Service role in companies corresponds well to the self-perception of own occupation	Converging
Interest representation	Individual	Individual	Individual	Individual	Converging

They have also only recently gained importance in the company, and there is still no experience in developing career paths.

Perceptions of status and relations between new and traditional tech workers

The divergences and convergences described above mean that we can describe both groups as an 'uncertain elite' in terms of their status within the company. Among the product development engineers, many feel abandoned by the company, emphasising their loss of status. Though most engineers are not afraid for their jobs, they express disappointment with the way the company is changing. Tech workers can also be regarded as an uncertain elite because their role is also unclear. While they see themselves as innovators, they are perceived in other areas of the company as service providers, sometimes conveying a lack of appreciation.

While individual studies on engineers have already highlighted uncertainty about changes in their work processes and status (Torstendahl, 2022), they have described tech workers as the labour market winners. Only since the COVID-19 pandemic have some studies pointed to a change in tech workers' perceptions of their own social position (Di, 2021; Su, Lazar & Irani, 2021). Our concept of the 'uncertain elite' follows from this literature.

Convergence and divergence

Engineers and tech workers experience uncertainty for different reasons. At the same time, the insecurity of both groups leads to a convergence in organisational ideas. Data scientists and UX/UI designers clearly appreciate the advantages of a large industrial company in terms of job security and regulation of working conditions, for example, with regard to working times. Like Dorschel (2022), we do not find any entrepreneurial orientations. Tech workers have adopted engineers' ideas, and there are also similarities in attitudes towards the collective representation of interests. Neither group actively participates in trade union organising, but both consider representation by works councils based on the German model to be useful.

Despite the latent competition for status in the company between engineers and tech workers, interprofessional cooperation and a convergence of both professional fields dominate overall. This interprofessional cooperation is facilitated by engineers and IT workers retaining their specific domain knowledge. Their jurisdictions overlap, but they do not merge. Engineers adopt the working methods of tech workers in some fields, but they must also adapt to the prevailing forms of organisation in an industrial company and accept a service provider role. The tech workers see themselves as pioneers in the most innovative forms of the latest wave of digitalisation but compare themselves only to a limited extent with the traditional engineers. There is a high level of appreciation of the 'car builders'.

Conclusions

Manufacturing companies are undergoing a digital transformation, becoming an important field of interaction between tech workers and engineers. We examined a

company where tech workers are being forced to deal with rules and processes that originate in traditional industrial culture and differ from those in pure software companies. Our analysis shows that tech workers appreciate working in a manufacturing company – albeit in a context in which the company in question still leaves a lot of scope for the tech workers' own work culture and does not enforce the same rationalisation and standardisation of processes that it does with engineers.

Our study shows how manufacturing companies are becoming a field for convergence between tech workers and engineers. This convergence is not all-encompassing. The tasks of both groups remain different (albeit interdependent), and their career paths continue to differ. Engineers see their role in the company as being challenged, but they continue to benefit from long-established career paths. Meanwhile, tech workers have more uncertain development paths. While both groups perform complementary tasks, there is also a certain overlap between their work domains. Their statuses and working methods are partially converging.

We describe this changed status as resulting in an 'uncertain elite' and see this as an important finding of our analysis. As their status in the companies is uncertain, we can expect the demand from these groups for interest representation to grow. In our own study, we see this in the fact that both groups show a high interest in employment security and support the institution of the works council – even though they are not unionised. Nevertheless, the demand for interest representation could also open up scope for unionisation in the future.

For future research, we see the focus on sectoral and organisational influences on the identities of professions as fruitful. We expect tech workers to develop differently depending on whether they work in software or manufacturing companies. Tech workers in US tech companies may have very different identities and work forms compared to the same professional group in German industrial companies, who are exposed to the influence of a strong engineering culture. There are also potential influences from different national regulations, for example with regard to employment security and industrial relations.

The increasing blurring of boundaries between software industries and manufacturing will lead to increasing interactions between engineers and tech workers, significantly changing both professional groups. This change will remain an important research topic.

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