New New Technologies: The Future and the Present of Work in Information and Communication Technologies

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Invited Commentary

New new technologies: the future and the present of work in information and communication technology[1]

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This paper outlines a selection of technological and organisational developments in the information and communication technology (ICT) sector and analyses their likely challenges for workers and trade unions around the globe. It addresses the convergence of telecommunications and information technology, the related developments of ubiquitous computing, 'clouds' and 'big data', and the possibilities of crowdsourcing and relates these technologies to the last decades' patterns of value chain restructuring. The paper is based on desk research of European and international sources, on sector analyses and technology forecasts by, for instance, the European Union and Organisation for Economic Co-operation and Development, and some national actors. These prognoses are analysed through the lens of recent research into ICT working environments and ICT value chains, identifying upcoming and ongoing challenges for both workers and unions, and outlining possible research perspectives.

Keywords: ICT, virtual work, restructuring, globalisation, technology, unions.

Introduction

The information and communication technology (ICT) sector is probably the sector that is most emblematic of society-wide progress and innovation, both technologically and economically. Indeed, practices of technology use, employment and work organisation in the sector often pioneer developments in other sectors. The obvious reason is that this sector develops a large proportion of the technologies that visibly change work and life throughout societies and economies. It builds its practices on the self-applications of its own inventions. Simultaneously, these technologies diffuse into other sectors and spheres of society, both changing these contexts and being adapted to them.

For these reasons of sheer pervasiveness, dynamism and impact, ICT, like space travel in the 1960s, has come to comprehensively represent images and expectations of 'the future', and in particular, the 'future of work'. Hopes of ongoing progress, economic

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growth, skill upgrading and possibly also democratisation are attached to new ICTs as well as fears of totalitarian control, alienation, job loss and insecurity. Often, hopes and fears are interrelated: the hopes imply an underlying fear of getting disconnected and being left behind, and the fears carry a bleak relish of submission to overwhelming external forces. Either way, in many policy-oriented or more general accounts of the 'future of work', with either a critical or an affirmative outlook, this future appears to be determined by technology-driven trends that converge upon a blueprint designed by the advanced actors of the ICT industry. The implication is that other parts of society are lagging behind and needing to adapt to that future.

This paper aims to go beyond an overly linear view of 'the future'. It provides a commentary on a selection of technological, economic and organisational developments in the ICT sector and analyses their opportunities and challenges for workers and trade unions around the globe. To do this, it combines a range of different research perspectives and levels of analysis: the basis is desk research of European and international sources, on sector analyses and technology forecasts by, for instance, the European Union (EU) and Organisation for Economic Co-operation and Development (OECD) (European Commission 2012a; 2012b, OECD, 2012), and some national actors that take technology developments, business and innovation activity into account. These prognoses have a somewhat descriptive angle and a tendency to extrapolate current developments into the near future, emphasising labour markets, skill levels and competitiveness. In contrast, accounts in a more popular genre of literature that accentuate the 'newness' of new technologies (e.g. Mayer-Schönberger and Cukier, 2013) reach farther into the future and focus on dramatic change and new qualities of either innovation or surveillance. The commentary provided here considers both genres through the lens of recent research into ICT working environments, which increasingly takes transnational restructuring of ICT value chains and production networks into account. Two theoretical angles provide insight: recent labour process theory addresses the adaptability and ever-changing capacities of contemporary, financialised capitalism to both access new sources of value and externalise cost (e.g. Boreham *et al*., 2007; Taylor, 2010; Thompson, 2013), and more relational approaches investigate the organisational and societal contextuality of new technology use (Tuomi, 2002; Garsten and Wulff, 2003; Orlikowski, 2007; Holtgrewe, 2008) with a focus on its ironies, obstacles and limitations. This admittedly eclectic exploration aims to do both: on the one hand, recognise the speed and impact of ICTs and the power of particular actors in the field (namely the large ICT multinationals) to shape large parts of societies' technology use according to their needs and strategies. On the other hand, assess the ways in which technologies are shaped through their uses and also the ways in which stakeholders and collective actors, labour market, education and training institutions, social and cultural life and workers' and consumers' experiences, and occupational identities shape the context in which ICT actors operate. Unions and civil society actors can and need to influence their use in the interest of workers, citizens and society at large. The paper thus does not present first-hand research results as such—which in many new and dynamic areas do not exist yet. It uses existing research and knowledge of these mechanisms to identify current and upcoming challenges and generate hypotheses on likely developments. The overall assumption is that new technologies and developments that converge in ICT and expand its possibilities into further reaches of work and society are likely to unfold their impacts along similar lines as previous developments and that from current research into work and restructuring, we can risk some forecasts.

Trends in the ICT industry

Restructuring and relocation of work

Restructuring, outsourcing and offshoring have been characteristics of the ICT sector for years. Because ICT overall has been enhancing the integration and expansion of value chains and workflows beyond organisational boundaries, it is not surprising that

such restructuring is applied to the technology itself (Castells, 1996; Huws *et al*., 2009; Howcroft and Richardson, 2012). The digitalisation of information, its increasingly rapid transfer and the potentially global distribution of programming and ICT skills, practices and standards made outsourcing of software development and ICT services easier and more attractive for companies.

Initially, from the 1990s onwards, simple processes or pieces of the product were outsourced or offshored such as data maintenance or coding tasks. India, with its relatively cheap, qualified labour force, emerged as a prime location, followed soon by other emerging economies such as Russia, Vietnam and the Central and Eastern European countries (Huws and Flecker, 2004; Taylor and Bain, 2005; Holtgrewe and Meil, 2008). However, offshoring took on a dynamic of its own. Larger and larger parts of the software development process began to be outsourced or offshored as companies developed the expertise to manage distributed work processes and developed new functions and work roles for liaison and coordination between organisations (Marchington *et al*., 2005; Holtgrewe, 2012).

These decisions were not always economically motivated. Companies felt also pressured to 'jump on the bandwagon' and participate in offshoring even without a real strategic plan for the use of remote sites. In such decisions, pressure by financial markets, the examples of competitors and management fashions played a part. Another factor was, occasionally, the availability of expatriate engineers and managers who were interested in moving back to their home countries (Lynn and Salzman, 2007). On the other end of the emerging value chains, both independent and captive subcontractors and subsidiaries aim to expand their services, their customer base and generally to 'move up the value chain' (Dossani and Kenney, 2003)—up to the emergence of the large information technology (IT) and business process outsourcing multinationals based in India or elsewhere (Taylor and Bain, 2005). Increasingly, these subcontractors do their own offshoring and in recent years have even been backshoring work to Europe or the United States to be closer to their clients (Holtgrewe, 2009).

Nevertheless, observers and policymakers in Europe in particular apparently still focus on the familiar pattern in which manufacturing and the lower-skilled tasks and functions in software development and IT services are being relocated, whereas industrialised countries retain the higher value-added functions such as architecture and research and development (R&D) (European Commission, 2012a; 2012b). However, there is evidence that the pattern of relocating work is shifting further. The top-of-the-value chain functions of R&D, innovation and systems integration that were traditionally assumed to be core competencies remaining in the originating countries of multinationals are no longer immune to offshoring. Especially for new recruitment in these functions, companies appear to turn to the newer and cheaper locations. It is possible that the location of these functions in the traditional innovation clusters of the Americas, Europe or Eastern Asia is no longer a given.

New and evolving players

During the financial crises since 2008, the BRIC countries (Brazil, Russia, India and China) have gained some attention with their robust growth, large internal markets and increasing roles as producers of ICT goods and services. Brazil, India and China were analysed by the EU's Institute for Prospective Technology (Simon, 2011). These countries have quite distinct profiles in ICT. In Brazil, the sector is dominated by foreign companies and its main segments are telecom and IT services. In telecommunications, Mexican Telmex is prominent, owning 75.16 per cent of Embratel in the fixed market, 100 per cent of America Movil in the mobile market, and the large Southern EU companies Telefonica, Portugal Telecom, Telecom Italia have also invested (Simon, 2011: 8). China and India are the fastest-growing mobile markets in the world. China is also the largest one with its 853 million subscribers in 2011. China is the world's largest producer of ICT products, dominated by manufacturing. India is predominantly driven by software services. Both countries now have their 'own' large multinationals such as

Huawei Technologies, Lenovo, and ZTE in China and Tata, Wipro and Infosys in India. In China, large national Internet providers also are among the top Internet companies. These large companies lag somewhat behind their Western and East Asian counterparts in R&D investment, but China in particular is expanding ICT R&D activities considerably, both by national and foreign companies. The country has become the world's largest recipient of foreign direct investment in R&D in both ICT and non-ICT sectors and the third most important offshore R&D location after the United States and the UK. India ranks sixth in this list (*ibid.*, 8ff.).

For policymakers and IT professionals and companies in the United States, Europe and Japan, R&D offshoring can become a cause of some concern even though we do not yet observe massive job losses from established locations on national levels. New recruitment into the innovative and higher-value added parts of the sector may increasingly occur in lower cost locations with possible consequences for the career and employment perspectives of potential employees and for investment into nationally based innovation and educations systems. This is not to suggest a protectionist stance to unions in the developed world, but it requires them to systematically take the globalisation or transnationalisation of ICT work into account, from both the side of migration and relocation, and to explore ways of connecting with increasingly distributed and diverse workforces.

Technological change

While far-reaching technological forecasting is outside of the scope of this paper, some observations of patterns of change can be made. They are the outcome of the last years' company strategies, business models, divisions of labour and modes of technology use. Technological trends of particular interest to unions and workers in the near future appear to be:

- the convergence of telecommunications and IT;
- the increasing omnipresence not just of 'chips' but of Internet connectivity and consequently, the diffusion of web-based services and functionalities into increasingly diverse spaces and spheres of activity;
- the increasing independence of computing capacity from local hardware equipment and software ('cloud computing');
- the utilisation of the resulting amounts of data and meta-data for various commercial and public purposes and business models ('big data').

All of these are obviously interrelated because ubiquitous connectivity enables remote access to data and computing capacity, and the data flows from all kinds of sources centrally feed into the large data sets of 'big data'.

The convergence of telecommunications and IT

The convergence of the historically and technologically distinct networks of computing and telecommunications has been discussed for decades and become possible with the digitalisation of all kinds of media content and the development of broadband technologies and ever-increasing processing power. Currently and in the next few years, it is happening on the network side. The Long Term Evolution (LTE) standard marks the transition of mobile telecommunications from the mixed circuit- and packet-switched Universal Mobile Telecommunications System to packet-switched, Internet Protocol-based networks.

This is likely to change the structure of the ICT sector and its industries substantially. Traditional telecommunications equipment consisted of dedicated, vendor-specific combinations of hardware and software. The Advanced Telecom Computing Architecture (ATCA) standard took some steps in taking apart network hardware and software, allowing the integration of multivendor hardware systems running software provided by network specialists. This was adopted partly upon pressure by large mobile network

providers that had an interest in a technology framework that reduced their dependency on particular vendors. However, ATCA did not yet present a truly open standard and was adapted by equipment manufacturers in different ways. However, the LTE-based separation of hardware and software layers turns network technology manufacturers increasingly into software companies and/or service providers. It also offers new (software) companies opportunities to enter telecommunications markets and compete with incumbent infrastructure vendors. The emerging business models are varied: network equipment providers may sell and service their own software applications, take over service for third-party hardware and systems and the responsibility for system integration, or host entire networks (managed services).

This transition is unlikely to be smooth: Telecommunication infrastructure vendors need to change a good part of their technological paradigm, skill and knowledge base while ensuring the smooth running of increasingly hybrid networks. Interestingly, it involves a change in the global composition of this part of the industry. The US-based network equipment manufacturers such as Motorola or Lucent have become insolvent or have been divided and sold to European competitors. These European multinationals such as Ericsson, Alcatel-Lucent or NSN are under considerable competitive pressure, cutting cost and downsizing personnel while making that transition. Meanwhile, established US hardware providers such as Cisco, IBM or HP continue to provide the hardware that telecommunication networks are running on. New Silicon Valley-based network software developers enter the competition unburdened by the legacies of telecommunications. To further complicate matters, we have seen that China does not just bring its state-backed equipment manufacturers into the mix but also has the largest and fast-growing network operators in the world with according purchase power.

The transition from the telecommunications to the Internet paradigm also entails a change in the sector's engineering traditions and technological cultures that is likely to have considerable impact on trade unions. The current generation of telecommunications engineers may still have received their initial training as technicians in the public sector or the privatised telecommunications ex-monopolists or their successors, or with equipment manufacturers that still have industrial roots. These are traditionally unionised environments in which careers from technician apprenticeships to engineering degrees and management positions were possible (Blutner *et al*., 2002; Doellgast, 2009). The subsector's moving into the more individualised world of software and the Internet may offer workers new career options and a wider range of possible jobs, but together with ongoing restructuring is likely to detach a former union stronghold in the sector further from its roots and organising traditions.

Omnipresent connectivity

With the diffusion of mobile devices and the convergence of telecommunications and IT, it is no longer just laptop computers and mobile phones (Hislop and Axtell, 2007) but data, multimedia content, social networks and computer-processing power that can be accessed from ever more places and situations. 'Pervasive computing' aims at implementing 'intelligence' into everyday devices. Gadgets such as the Google Glass for hands-free photo-taking, navigating and communicating enable users to digitally 'log' their lives. The tools, services and functionalities of this amount to fast-growing markets in which products and services may be combined in diverse ways. Mobile applications for instance may not just be sold to users directly but distributed as parts of service bundles sold by mobile providers to enhance other companies' quite different products (Schönauer *et al*., 2013). Interestingly, in a supposedly virtual world, data, information and services about the body appear to play a pioneering part as in health or fitness applications that are combined with digital magazines and medical or fitness products. Traffic- and mobility-related products and services will play another large part in the future. All of this culminates in the vision of the 'Internet of things'.

This also extends to industrial processes. Under the heading of 'Industry 4.0' (Spath, 2012), the German government pursues a high-tech strategy to accelerate the comput-

erisation of manufacturing, rendering factories 'smarter', more adaptable, resource-efficient, and ergonomic and integrating customers and business partners in the process of value creation—in effect maintaining the competitiveness of manufacturing in high-wage countries. This may contribute to another shift in the sectoral composition of ICT work: Not just electronics but Internet-connected ICT products will increasingly be embedded with other machinery, from industrial facilities to cars, and systems integration may well bridge the ICT and other manufacturing sectors. All of this will further increase the demands on ICT skills and expertise. However, the divisions of labour and configuration of value chains between the ICT sector and machine-building industries and engineering may well vary in line with countries' and regions' innovation paths.

Cloud computing

With the ever-expanding availability of broadband Internet access, data storage and processing capacity become independent of location and ownership as well. 'Cloud computing' means the use of distributed, network-connected facilities for both storage and data-processing tasks. The advantages are that 'infrastructure replaces the purchase of hardware like servers or storage' (OECD, 2012: 78) for companies; capacities can thus be more flexibly tailored to actual demand, with users 'renting' (additional) capacities that are not needed continuously. Cloud service providers improve their own utilisation of capacities and technological know-how of running large, distributed systems and may further commercialise the data generated by the usage of the cloud. In effect, business models develop towards service or infrastructure provision, promising savings in capital, improved resource utilisation and also environmental friendliness.

However, not all data processing and storage can be rendered independent from their location or ownership. There is also a demand for 'private clouds' in different arrangements of owned or hosted services. Issues of security, reliability, availability and migration in the cloud are not always clearly defined. Although service providers' capacities to address these issues may well be higher than those of their clients, the consequences of problems may also reach farther beyond individual companies. A concentration of IT expertise and also physical maintenance jobs and functions in large, shared data centres is possible, but as with more traditional forms of IT service outsourcing, it is unlikely that cloud users will be able (or would be well advised to) to comprehensively outsource this expertise (cf. Flecker and Meil, 2010). They still need to integrate their needs and technology with the cloud infrastructure and to monitor service providers' performance. Workers using cloud services will need to arrange their workspaces, devices, materials, social relationships and boundaries from a wider set of choices which, extrapolating from Hislop and Axtell's (2007) framework, may result in increasingly unpredictable remote working environments or increased and increasingly pressurised needs for coordination and negotiation.

Big data

Of course, data run both ways. Users and their machinery and all kinds of infrastructures generate vast amounts of data, voluntarily or by default. The collection and combination of these data with other sources and analytics are becoming a large business, a resource for society, policy, public authorities and the public, and a political issue around privacy and security. A key point of 'big data' technologies is their expected predictive capacity (Mayer-Schönberger and Cukier, 2013). Technologies involved come from artificial intelligence areas such as natural-language processing, pattern recognition or machine learning. Patterns of activities discovered through combining various data sources and using sophisticated statistical and network analysis and artificial intelligence applications may be used for conclusions about the future behaviour of individuals and groups (or of machines), from people's buying decisions

to the risks of machine breakdowns, diseases or accidents to illegal behaviour. This is not entirely new but departs from traditional market research, epidemiology, actuarial theory or intelligence gathering—disciplines that have contributed to the standardisation and target-setting of customer service work in financial services or tele-mediated health services for decades. By its technological enhancement and the attached belief system that shifts from causation to statistical evidence, the impact will be considerable. On top of that, the development may well be self-enhancing: '*Machine-learning algorithms, for example, learn on data, and the more data, the more the machines learn*', explains Steve Lohr (2012) in *The New York Times*. The provision of data by governments or other public bodies ('open data') is likely to provide not just 'more and bigger' data for commercial purposes but also new opportunities for research, public planning and societal participation.

For trade unions, new forms of control and surveillance in the workplace remain key issues. Global Positioning System already plays a part in monitoring logistics and postal deliveries, effectively limiting drivers' and postal workers' discretion over routes or breaks (Grampp *et al*., 2009; Haidinger, 2012). Using natural-language recognition on email communications to identify clusters of undesired activity in companies is a distinct possibility—if such activities are distinguishable from regular work. Union organising and interest representation activities in virtualised workplaces may well be affected by increased surveillance or by just the possibility of increased surveillance (Sewell *et al*., 2012). Combining data on behaviour at work with other information on employees, searching for patterns and drawing conclusions on likely future behaviour may affect recruitment and careers and lead to new forms of statistical discrimination well beyond the current use of signalling to predict work behaviour. When currently young people are warned that future human resources (HR) managers might draw unfavourable conclusions from careless use of social media, they can still control that use to a certain extent by not posting this or that party photograph or off-colour joke. If the conclusions result from patterns of statistical evidence rather than somewhat accessible perceptions of appropriate behaviour, individuals' control over their self-presentation is undermined further. Hence, unions have stakes in the issues of surveillance, infringement of civil rights and discrimination. Global privacy and civil rights issues require responses.

Even less is known about the impact of 'big data' analyses on workers' skills and the demands of work in the sectors using these technologies. Mayer-Schönberger and Cukier give a hint:

> Salespeople in all sectors have long been told that they need to understand what makes customers tick, to grasp the reasons behind their decisions. Professional skills and years of experience have been highly valued. Big data shows that there is another, in some ways more pragmatic approach. Amazon's innovative recommendation systems teased out valuable correlations without knowing the underlying causes. Knowing what, not why, is good enough (2013: 52).

From a skills perspective, this opens up the entire spectrum of deskilling or skill change scenarios. The interactive and analytical skills and the knowledge of sales-workers, health professionals, bank tellers (and social scientists) might be devalued or replaced by artificial intelligence-based recommendation systems. Even more likely, their jobs may increasingly be governed by targets and recommendations based on 'big data' without an understanding of the reasoning behind the recommendation. This will add new demands to the interaction with clients, patients or customers or exacerbate current pressures: the task to translate correlations into sales or medical decisions without being able to explain the 'why' of a particular recommendation to clients. Less technologically sophisticated examples of this kind of mechanical execution of sales targets have been observed in banking or call centre interactions for years (Frenkel *et al*., 1999; Regini *et al*., 1999; Bain *et al*., 2002; Smith *et al*., 2008).

However, focusing exclusively on the surveillance potential of ICTs may be a too narrow view to take for unions. Big data also have the potential to contribute to societies' self-awareness and capacity to make decisions and address societal challenges. Unions and social scientists taking an interest here, connecting with initiatives

to 'democratise' data analysis and utilisation, can be a promising perspective—not just for political reasons but also as a way of re-establishing contact with the professional and normative orientations of many younger ICT and knowledge workers. These constituencies often are interested in public goods and spaces, knowledge sharing and open source. Indeed, such normative dispositions are a part of ICT-specific engineering cultures (Tuomi, 2002; Holtgrewe, 2004)—and appear quite compatible with wider-ranging, community-oriented and innovative union strategies.

Employment and skills in the ICT sector

Employment growth

Worldwide, in 2011, some 14 million people are reported to work in ICT, holding approximately 6 per cent of all jobs in the OECD countries. From 1995–2011, employment on average grew by 0.8 per cent per year in the OECD countries (OECD, 2012: 36). The EU expects the number of ICT professionals' jobs to grow from 1.9 million in 2010 to 2.2 million in 2020, a growth of some 13 per cent (European Commission, 2012b). According to the OECD data on the top 250 ICT companies, from 2000 to 2010, employment expanded most in Internet companies, followed by IT equipment manufacturers and the software industry. IT services have slow increases, and telecommunications and the other hardware subsectors have stagnating employment. Obviously, not all ICT specialists by profession are employed in the ICT sector. In Europe, some 45 per cent of ICT professionals (i.e. people developing, selling, maintaining or supporting ICT systems) work in other sectors (public, private and non-profit) that use ICTs. Nor does the ICT sector consist only of multinationals.

Skills and (perceptions of) skill shortages

Generally, work in ICT is comparatively highly skilled, and many regions expect skill shortages. With the sector's dynamics and focus on speed, innovation and time-to-market, both skill obsolescence and skill shortages are two sides of a coin. Apart from the technical skills (such as knowledge of programming languages and tools, server, network, and cloud technologies and structures), ICT workers increasingly need non-technical skills and competencies such as English, project management and organisational skills, teamworking and communication skills, and both creativity and systematic ways of working. Also, 'assessment of the market environment' and attention to client demands are counted under general non-technical skills (EU Skills Panorama, 2012, cf. Marks and Scholarios, 2007). This implies that employers do not just rely on marketing and sales specialists or management to be aware of the market environment, but 'customer focus' or a 'profit mindset' are demanded from ICT professionals at large, regardless of their decision-making powers in these areas.

In Europe in particular, but also in Australia or Canada, there is some concern that with increasing demands on skills and rapid technological advances, the supply of graduates may not be sufficient. In the EU-27, the numbers of graduates have declined from a peak in 2005–2006, especially at the levels of vocational and pre-vocational programmes and first-stage tertiary education (*ibid.*). This decrease concentrates in countries as diverse as the UK, Belgium, Romania and Italy, whereas some Eastern European countries and Austria have seen an increase by 50 per cent. Employers across Europe complain about both technical and non-technical skill gaps and training needs of graduates. In addition, there is the age structure of the workforce to consider. In 2010, some 80,000 ICT professionals retired per year, a figure that will increase to approximately 120,000 in 2015.

Indeed, a projection of a shortage of 700,000 (Cattaneo *et al.*, 2009) or even up to 900,000 ICT professionals in Europe by 2015 (http://www.filling-the-gaps.eu) caused the European Commission to establish a multi-stakeholder partnership under the heading of the 'Grand Coalition for Digital Jobs' to increase the supply of ICT experts

and improve the matching of supply and demand of digital skills. This initiative involves '*representatives of ICT companies, non-ICT companies, schools and universities, governments as well as public and private employment services*' (European Commission, 2013: 5). Actions involved aim to improve the image and attractiveness of ICT careers to offer training packages co-designed with the ICT industry and align vocational training and university curricula better with the needs of the industry and of students, improve recognition of qualifications across countries and stimulate mobility and digital entrepreneurship.

However, online documents of the initiative's conferences show that the involvement of trade unions in this initiative is peripheral at best. Consequently, the emphasis is on the supply side of labour: skill generation, motivating young people to enter the sector, developing certification frameworks and encouraging the European industry to use them. However, women's persistently low involvement in education (at 22 per cent of computer science graduates) and employment in ICT professions is only mentioned in passing. The same applies to other groups of the population that might benefit from ICT skills in the labour market such as migrants, minorities or older workers (Warhurst *et al*., 2006). The demand side, apart from the recognition of certifications, is hardly included. Working conditions in the ICT sector and/or ICT professions are rarely mentioned as factors, although it is quite likely that increasing job insecurity, persistently excessive working times and negative work–life balance are disincentives to pursue careers in the sector (Legault and Chasserio, 2012).

Australian technical writer Chris Duckett[2], commenting on the Australian ICT Workforce Study (AWPA, 2013), points to another neglected aspect of presumed skill shortages: employers in Australia appear to be reluctant to hire recent graduates and invest in some on-the-job training. The AWPA report finds that some 70.2 per cent of recent computer science graduates in Australia find jobs shortly after graduation but work in jobs where their qualifications are not directly relevant (a considerable increase from 58.7 per cent in 2009). ICT employers on the other hand require workers with between 2 and 10 years' previous experience. They prefer to externalise the initial training necessities, relying on immigrants on work visas instead, but in effect contributing to an outflow of skills from the sector.

It would thus require further research to evaluate the notion of skill shortages in different regions. Skill shortages may be a consequence of the related strategies of both employers and workers: employers may prefer to access lower cost or less demanding workforces to the idea of offering better working conditions and training opportunities in the sector. Skilled employees may find more favourable work opportunities in other sectors and jobs.

Work and employment conditions

Work in the ICT sector takes place in various environments. There are factories, hierarchical multinational companies, start-ups with more or less far-reaching aims for growth and small specialists, cutting-edge R&D-intensive small companies spun off from universities and research institutes, and freelancers that work individually or in networks of colleagues. Older and newer regional networks continue to play their part, from Silicon Valley and both Cambridge, Massachusetts and Cambridge, UK to Swedish Robotdalen (Forge *et al*., 2013) or the specialised local reputation economies of computer game designers in Montreal (Legault, 2013). On the other hand, there are the 'born globals' (Eurofound, 2012): high-tech start-ups, often from small countries that from their inception address a potentially global market because they need to attract more business than they can get in their domestic markets. All of these actors may contract with one another, assigning or taking over delimited tasks and modules or collaborating on complex open-ended developments and innovations (Howcroft and Richardson, 2012; Schönauer *et al*., 2013).

'Crowdsourcing' has been a much-discussed issue in recent years (Lehdonvirta and Ernkvist, 2011; Barnes *et al*., 2013; IG Metall-Vorstand, 2013), but in this author's view, needs to be regarded as an extreme and in itself possibly overestimated instance of the

basic subject: employers searching for new workforces that are cheaper, more flexible, more adequately skilled and preferably all of these things. Crowdsourcing thus fits into the continuum of relocation (see above and Bergvall-Kåreborn and Howcroft, 2013), virtualisation and the implementation of internal markets and tendering systems that have been observed in recent years and are likely to continue. It takes different shapes ranging from tendering for professional services with different contractual arrangements to the virtual distribution of Taylorised microtasks. In all these strategies, the familiar labour process theory subjects of control, cost-cutting, industrialisation and knowledge management continue to be played out.

Liquidising employment?

In February 2012 in Germany, IBM announced the cutting of 8,000 jobs and showed German unions and the public the 'instruments of torture' of flexibilisation in the shape of the 'liquid' programme of restructuring. This programme basically takes the old vision of the 'flexible firm' (Atkinson, 1984) into web 2.0 dimensions. It is first an internal crowdsourcing platform enabled by globally standardised skill databases, project descriptions, project management tools and accounting standards. With this and the tools of virtual collaboration, project teams can be put together regardless of location. The vision behind it, widely reported by German news media, is to replace large parts of regular employment with a 'talent cloud'. Except for managers and sales workers, actual and potential employees would offer their services on a global platform and be hired for particular projects. This would be supported by a certification system that compiles skill and qualification profiles and project-related performance appraisals into a network of digital reputation. German IG Metall and ver.di, journalists and management researchers agreed that this would form a somewhat logical 'further step in the global competition for work' (IG Metall-Vorstand, 2013: 3). Risk would be shifted further onto workers, and companies would escape legal regulations, social partnership relations and collective agreements. In addition, technical writers and management consultants wonder what would happen to the knowledge base of the companies. While digital crowds might bring new and more varied expertise to the job, there are concerns over the leaking of company-specific knowledge and workers' commitment. Business commentator Haydn Shaughnessy makes an additional point:

> The reality is that the crowd is not necessarily cheaper. It is more flexible and often provides access to a more appropriate skillset. [. . .] You can see the temptation when revenues are down to attack your cost base through crowd-like options and by forcing output based pricing onto labor. On the other hand clients could quickly learn from IBM and force output based pricing onto Big Blue.[3]

Indeed, it may not be just clients but, horrible to say, workers themselves. Early in 2013, a Verizon programmer was reported to have had the same bright idea, offshoring his job to a Chinese company for a third of his salary while spending his time at the office browsing the web. Further investigation by Verizon security showed that he was not the only one:

> It turns out this seems to be something of a trend and lots of people are doing it. It's especially common with contract workers and freelancers who sign up for jobs and then farm out that work in parts of the world where coders are cheap.[4]

This points at a downside of 'liquidising' employment and changing psychological contracts: if freelance or outsourced workers or disgruntled employees lose a sense of reciprocity in their relationship with the firm (and have been encouraged to develop a 'profit mindset', etc.), perceiving increasing pressure and ongoing restructuring and lacking employment security, they may as well give up on commitment and professionalism and become entrepreneurial in their own interest rather than the firm's. However, in some segments of software development, large companies base their business models on integrating entrepreneurs: Apple and Google are relying on individual or small-business developers to create smartphone applications

(Bergvall-Kåreborn and Howcroft, 2013) and large providers of enterprise resource planning software leave the adaptation to their clients' needs to consultants (Holtgrewe and Meil, 2008).

Still, like other virtual work arrangements (see below), crowdsourcing is likely to be more complex than it looks or vice versa; the obvious application fields may be more limited than expected. In the more Taylorised arrangements of 'microtasks' distributed to a crowd of casual workers, both the organising of tasks and the management of such workforces require specialised tools, technologies and know-how (Lehdonvirta and Ernkvist, 2011). Users may find themselves underrating the transaction cost and management headaches. For example, it does not take much research, but everyday observations on 'digital reputation' already suggest that IBM's notion of merging skill databases and performance appraisals may not be as effective as it appears. In LinkedIn, for example, it is quite common for friends and (former) colleagues to swap euphoric endorsements of one another's performance, skills and general qualities as a human being—reminiscent of the overly friendly pseudo-reviews by colleagues found on English-language academic books or in Amazon's book reviews. This does not mean that reputation does not play a central part in networked and project-based industries. It does, and indeed, individualised entrepreneurs spend considerable time on reputation management (Bergvall-Kåreborn and Howcroft, 2013), but the real-life mechanisms of reputation and appraisal are embedded with personal acquaintance and longer term relationships. These may not easily translate into virtuality without any inflationary effects.

Virtual collaboration and its limitations

Support for this view comes from existing studies of virtual collaboration. In general, virtual work and project-shaped collaboration are not trivial to manage and organise. The tools enabling virtual collaboration and knowledge management need to be complemented by socially established modes of collaboration, and both aspects need to enable one another (Dubé and Robey, 2009). Virtual collaboration becomes ineffective in unstructured situations and without clear divisions of labour, and vice versa, the structures and tools need to be utilised through intelligent and circumspect labour (Holtgrewe, 2012; Schönauer *et al*., 2013).

This does not mean that these challenges are always adequately addressed by companies or managers. Often enough, it is workers or subcontractors themselves who make sense of tools and tasks, establish workable collaborative relationships and compensate for management deficiencies. Under conditions of intensified work and increased competition between locations and workers, this may be an inherently contradictory endeavour. Internal collaboration between locations can be undermined by internal tendering, which shifts the balancing of collaboration and competition onto project managers at the expense of a company's internal knowledge circulation (Holtgrewe, 2008).

Another pitfall is the specification of interfaces and task modules in cases of remote collaboration. A case study of a start-up company investigated by Schönauer *et al*. (2013) showed how product development with a spatially distributed team failed in spite of developers' previous collaborations in an open-source context. The company eventually returned to localised working. It still employs freelancers—upon the condition that they work from the company's office for at least three days a week. This case confirms that the crucial issue in geographically distributed virtual cooperation appears to be less the standardisation of work in an industrial sense but a precise delineation of modules and definition of the interfaces between them.

Even companies aiming to cultivate employee commitment for these very reasons have been found to have limited success with these efforts as the same companies are increasingly driven by financialisation, short-term performance and shareholder value or actual shareholder intervention (Thompson, 2013). These dynamics put pressure on

employment and working conditions, downsizing staffing levels, intensifying work, cutting cost and reducing employment security, in particular in higher wage countries. HR efforts to cultivate commitment and strong organisational cultures in these contexts are perceived as hypocritical at least and in places, downright insulting (Cushen and Thompson, 2012).

Conclusions: connecting with 21st-century knowledge workers

Considering company and industry restructuring, from Chinese manufacturing (Lüthje *et al*., 2013) to the innovative but sometimes precarious networks and clusters or the 'liquidisation' of employment envisioned by IBM, the picture is contradictory. Markets, employment opportunities and technological possibilities appear ever expanding still, and certainly, the sector in many segments continues to offer above-average pay, interesting work and favourable working conditions. Yet there is some discontents and also disillusionment with the promises of knowledge-intensive work. (Not only) in the higher wages regions of Europe and the United States, announcements of downsizing and relocation of companies abound, work is intensified and continuous restructuring, which is supposed to improve efficiency, in effect adds to employees' workloads. In particular, excessive working times have been shown to remain an issue persisting through booms and crises, especially in the segments of the sector shaped by project organisation and/or self-employment (Perlow, 1999; Shih, 2004; Bergvall-Kåreborn and Howcroft, 2013; Gold and Mustafa, 2013; Legault, 2013).

Some observers of company restructuring emphasise industrialisation and the continuous moves to render workers' knowledge explicit within the company (Taylor, 2010; Howcroft and Richardson, 2012). In other parts, the use of freelancers, crowds and output-based or success-based pay systems looks less 'industrial' than neocolonial, with companies exploiting social exchange, smallest modules of working or leisure time, and marginal work (Scholz and Liu, 2011). On the other hand, the visions of vast globally competitive crowds should not be overrated (cf. Thompson, 2013). Management strategies will not be able to 'solve' the challenges of knowledge management anytime soon, turning highly skilled experts into exchangeable applicants of well-documented modules of knowledge. Codification of workers' knowledge of necessity requires the circulation of uncodified knowledge through formal and informal interaction, through workers' mobility and worker retention (Holtgrewe, 2008; Mayer-Ahuja, 2011; Ramioul, 2012; Schönauer *et al*., 2013).

Nevertheless, all of this certainly puts pressure on existing workforces and their unions. The competition for work is becoming more intransparent and erratic for workers. Existing regulations and partnerships are at continuous risk to be undermined or exited by employers. Workers themselves are facing multiple tensions. The customer and the market are coming closer. Competitive pressures undermine professional identities and engineering cultures based on sharing and collaborating. Yet these cultures and dispositions are still necessary to fulfil work tasks and solve problems. Such professionalism even increases in importance, as colleagues are becoming more unknown, diverse and remote.

Not least, younger and older ICT workers still have stakes in the ICT-specific norms and values of collaboration, problem-solving and use-value of what they are doing. These engineering cultures are multifaceted and range from telecommunications engineers' valuation of 'Connecting People' (Nokia) to 'open source'-style norms of collaboration and technical excellence (Tuomi, 2002) to notions of user participation. Some elements of these cultures point into a direction worth exploring by unions. As we have seen, companies may try to mobilise commitment and enthusiasm as well, but in combination with downsizing, cost-cutting, intensifying work and competition risk disillusionment. Connecting interest representation to the wider picture of democratic technological futures, public goods, and spaces and platforms for participation may diversify unions' ways of relating to increasingly diverse and individualised workforces.

If further research aims to engage with possible users such as unions and policymakers rather than just confirming its underlying theories, it will do well to overcome the boundaries of existing research domains. The focus of policy-oriented research on skill development or competitiveness in the next few years appears overly reliant on the continuation of current trends rather than the interplay of different and contradictory drivers of changes and actor strategies. However, labour process theorists and analysts of value chains, connecting workplace and local situations and developments to the wider reaching mechanisms of restructuring may overgeneralise the understanding of these mechanisms from the more or less exemplary cases they have investigated. Business process outsourcing from the UK or United States to India, for example, may only tell us so much about other regional patterns or subsectors. Keeping a comparative eye out on the institutional contexts of the ICT sector, from varieties of capitalism to innovation or skill and training regimes, may render insights more precise and policy relevant. The various debates on intellectual property, privacy or surveillance might also be usefully connected to professional identities, habitus and practices that permeate the boundaries of work, consumption and play. It is probably mutual awareness of different research genres, academic, disciplinary and professional contexts, of the possibilities and limitations of generalisation and contextuality, and of comparative and theoretical angles that will help to project current analyses further into the future with any relevance. Not an easy feat, considering that as social scientists, we share a fair proportion of the risks, pressures and joys of competitive, reputation- and market-driven, project-based work with our research subjects.

Notes

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2. http://www.zdnet.com/short-term-thinking-led-australia-into-an-it-skills-shortage-7000017866/
3. http://www.forbes.com/sites/haydnshaughnessy/2012/10/22/how-far-can-ibm-push-its-bet-on-a-realigned-jobs-market/2/
4. http://www.theregister.co.uk/2013/02/27/outsourcing_job_common/

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