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Gendering the digitalized metal industry

Janet Johansson PhD, Senior Lecturer[1] |
Ildikó Asztalos Morell PhD, Associate professor[2] |
Eva Lindell PhD, Senior Lecturer[3]

[1]Department of Management and Engineering, Business Administration, Linköping University, Sweden

[2]Department of Urban and Rural Development, Swedish University of Agricultural Sciences, Sweden

[3]School of Business, Society and Engineering, Mälardalen University, Sweden

Correspondence

Janet Johansson, PhD. Senior Lecturer and Researcher, Department of Management and Engineering, Business Administration, Linköping University, 581 83 Linköping, Sweden.
Email: janet.johansson@liu.se

With an empirical investigation of the Swedish metal industry, this study explores the gendering of metalwork in the context of digitalization. Adopting Butler's notions of gender performativity, and taking a broad feminist perspective, our analysis renders the following findings: first, inequality in the workplace between normative masculine and feminine characteristics is still present in the metal industry. The dominant exploitative expectations of masculine physical strength are gradually being replaced by the persistent masculine association with technology. Both men and women contribute to the confirmation and strengthening of this new masculine attribute. Second, women, through the construction of their sense of self as competent digital steelworkers, take on a vital role in re-formulating the gender script of the digitalized metal industry. By enacting stereotypical feminine aesthetic gestures, using 'housewifely' metaphors parodying masculine discourses, and through deliberately connecting feminine attributes with competences and strengths in technology, female operators subvert the ideal image of a metalworker and disrupt the persistent myth of femininity as being incompatible with technology.

KEYWORDS

digitalization, gender performativity, metal industry, technology

1 | INTRODUCTION

Digitalization is bringing about revolutionary changes in the steel industry in many regards. As the industry has traditionally been a domain of men, the question of whether digitalization has led to changes in gender coding has gained new currency. While acknowledging that technology has enabled women to participate in previously male-dominated work (Balsamo, 1996), we view gendering of work as relying on interactions between actors, technology, and the cultural conventions of gender and work in daily practices (Balkmar & Lykke, 2015).

We place our study in the category of feminist theorizing, which problematizes the technology and gender nexus as a 'seamless web', emphasizing 'multiple, decentered agencies with no singular lines of causation' (Faulkner, 2001, p. 83), without losing sight of power as a dominant discursive framework of gender scripts. Inspired by Butler's (2007) notion of gender performativity, by focusing on doing and undoing gender in mundane work practices such as the use of language, metaphors and individuals' embodied performances in the highly masculinized metal workplace, we try to understand how gender scripts in metalwork are produced, reproduced or modified in the context of digitalization, with the increasing participation of women in this field. In addition, we aim to highlight individual agency. In particular, we focus on recognizing the advantages and strengths of women as well as the attributes and performances associated with femininity (Billing & Alvesson, 2000; Holmes & Schnurr, 2006; Tronto, 1993) as forces in changing the gender norms in male-dominated, technology-dense workplaces. Theoretically, this effort may also contribute to clarifying women's positions and add to the understanding of the role of femininity in technology, gender and work studies.

There are several milestones that mark revolutionary progress in terms of technology. The use of steam and the use of electricity enabled great leaps in industrial production, and they are regarded as being key to the first and the second industrial revolutions. Industry 3.0, that is, automation, the third industrial revolution, took place near the end of the 20th century and is characterized by the use of computers to drive the manufacturing processes. We are arguably now in the fourth industrial revolution, which enables flexible control of production through Cyber-Physical Systems, which are networked in real time and by which products are uniquely identifiable at all times (Kagermann, Wahlster, & Helbig, 2014).

In Sweden, the metal industry has followed the global trend by taking a step towards the 'digital leap' (Kagermann et al., 2014; Markus & Loebbecke, 2013). In contrast to automation, digitalization of factories not only alters the way in which people work, but also vertically connects the operational ends to operational processes within factories while horizontally linking value networks that stretch across the world, incorporating everything from ordering to delivery. As a result, changes that accompany digitalization in traditional metal workplaces are multifaceted and include modifications in work environments, requirements for new competences and skills, and demands for new ways of organizing work and people (Asztalos Morell, 2017; Johansson, 2017; Lindell, 2017).

Furthermore, in studies of technology and gender, the liberating perspective holds the view that the rapid development and spread of digitalization have made a great impact on gender equality. Results from a report on G20 economies (Sorgner, Bode, & Krieger-Boden, 2017) and a report from the Swedish steel industry have both shown that the number of women working in industrial workplaces has increased in recent years (Jernkontoret, 2018). This has led to a general belief that digitalization empowers women entering the labour market and will continue to strengthen the position of women in the future (Sorgner et al., 2017).

Nonetheless, we argue that the impact of digitalization alone towards gender equality does not entirely explain the changes taking place in male-dominated industries. According to Kimmel (1990), masculinity is subject to eternal doubt. It needs constant validation, and its pursuit is relentless (Kimmel, 1990). Historically, masculine notions have varied and evolved in male-dominated industries as a response to alterations in the demands of new competencies and skills induced by technological, economic and social changes (Kimmel, 1994). A recent example shows that, although machines were broadly used for mitigating the physical demands of work as early as the late 19th century, hegemonic masculinity represented by physical strength, toughness and aggressiveness remained dominant in labour discourses, sustaining working-class manliness (Baron, 2006).

Complex changes have arisen in today's metal industry in Sweden along with digitalization. Digitalized tasks demand skilled labour with knowledge of computers, data, algorithms and processes — competencies that are strongly associated with masculinity (Lie, 1995; Wang & Degol, 2017). In the meantime, notions of the ideal worker have shifted from one who is a 'master' of specific tools to one with the ability to supervise an integrated unit and to be part of the flow, which requires the kind of attention and care that is stereotypically associated with women (e.g., Arcy, 2016; Jarrett, 2013). These changes thus raise new questions concerning the gendered notions of metalwork, which require comprehensive problematizing.

We find that several gaps remain in the existing literature in the field of gender research in heavy industries. First, there has been little research exploring the (re)gendering of masculinized work in the metal industry in the context of digitalization. Second, existing studies on gender in metalwork mainly focus on structural changes emphasizing the tenacity of the masculine connotation of the metal industry. Yet, these studies fall short in exploring individual agency as a source of change. Third, although there has been an increasing influx of women participating in digitalized metal workplaces, the position of women in the gendering of metalwork in the context of digitalization remains ambivalent. Little has been done to highlight the strengths and advantages associated with women in this field. In order to further explore the gendering of the metal industry with a timely focus on technology development, we seek to profoundly unpack these issues by grounding our discussion in the current debate on the nexus of gender, technology and work.

For this study, we have incorporated Butler's (2007, 2004) notion of gender performativity to understand how people doing and undoing gender at work casts light upon both the opportunities and challenges in the pursuit of gender equality. The performativity of gender may be seen as a certain kind of enactment and a negotiation with dominant norms and power in a particular context, and undoing or redoing the gender norm opens up the possibility of a remaking of gendered reality (e.g., Butler, 2009, p. i). Further, we have analysed empirical materials gathered from the Swedish metal industry to understand how symbols of new gender orders may emerge and how the myth of the incompatibility of technology, metalwork and women may be destabilized in the digital era. Acknowledging that the digitalization of the metal industry is an ongoing process, in this study, we focus on examining the gendering processes in the context of shop-floor units where work and the organization of work have been digitalized to a certain extent.

Moreover, as Faulkner (2001, p. 79) so eloquently put it, the relation of women to technology is inherently ambivalent, balancing 'between uncritical endorsement and outright rejection'. It is therefore crucial that we understand how people, especially women, construct and contest definitions of gendered identity while 'learning to work, in working, in struggles between workers' (Baron, 1991, p. 37). We see this as a quest of understanding femininity more profoundly in male-dominated, technology-dense workplaces, and thus we incorporate a broader perspective of feminist notions regarding the concept of femininity. In doing so, we aim to explore the strengths and advantages of women and characteristics associated with femininity as a source of agency of change (e.g., Holmes & Schnurr, 2006; McRobbie, 2009; Tronto, 1993). We focus on what women do — be it falling into the normative frame of femininity, or less so — as ways in which women actively express their identities as competent digital steelworkers to seek a possible agency of change (e.g., Holmes & Schnurr, 2006; McRobbie, 2009).

2 | LITERATURE REVIEW AND THEORETICAL FRAME

2.1 | Masculinity and femininity at work

Masculinity and femininity are categories defined within culture, not by biological necessity (Butler, 2007). At the same time, the meaning attached to categories of masculinity and femininity is an ever-present influence on our judgement and evaluations of the intelligibility and appropriateness of the behaviours of ourselves and others (Butler, 2007). Hence, the performativity of gender, according to Butler (2007), resides in the invisible forces

whereby people use societal gender stereotypes to conduct norms in a particular context in which women and men are expected to conform.

Workplaces are important sites where societal gender orders are produced, reproduced or modified (Connell, 1987). Although the binary classification of performances involves the simplification and dichotomization of qualities and characters associated with men and women, these distinguishing features capture components that typically refer to 'masculine' and 'feminine' workplaces. As Gherardi (1994, p. 592) once stated, gender in the workplace is 'one of the most powerful symbols' and attributes signifying power distribution between sexes in professional settings. Thus, this 'simplification' of gender categories may facilitate the understanding of the types of symbols that are central to work performances, that is, the ways in which they are enacted and constantly influence our views of the nature and quality of performances (Gherardi, 1994).

Masculine values have persistently dominated labour discourses (Baron, 2006). Kimmel (1994) traced various historical challenges to masculinity and concluded that men confront challenges to their manhood through constant validation. When social, technological, economic and political forces have altered men's and women's social roles and have challenged the structure of patriarchy (Freeman, 1993), men have responded by actively demonstrating or 'renewing' masculinity to secure their positions.

As the rise of new technologies in the late 19th century altered the criteria for determining worker competence, male industry workers made attempts to 're-masculinize' work and identities by emphasizing the hegemonic masculinity characterized by toughness, physical strength, aggressiveness and risk-taking (Baron, 2006). The masculine values that have influenced criteria for jobs in male-dominated industries have therefore been sustained. This can be seen as the collective efforts of men, organized through trade unions, responding to mechanization, time-management and other management practices that have largely challenged working-class manliness (Baron, 2006). Thus, this historical view of masculinity in labour discourse also explains the tenacity of masculine exploitative expectations, such as physical strength and masculine embodiment, in male-dominated workplaces.

Unlike masculinity, femininity has not been positioned as a desirable construct in many industrial workplaces or male-dominated professional occupations. Stereotypical feminine characteristics have been described as being caring, gentle, kind and passive (Huddy & Terkildsen, 1993), as well as being inclined to emphasize beauty and appearance (Rhode, 2016). Organizational studies have revealed the paradoxical condition of femininity at work (Billing & Alvesson, 2000; Kelan, 2007; Kerfoot & Knights, 1998). In workplaces, women who aim to advance their careers in occupations dominated by male and masculine values are often said to intentionally engage in 'femininity management', that is, mimic their male peers and adapt more masculine result-oriented, competitive and aggressive behaviours (Billing & Alvesson, 2000; Kerfoot & Knights, 1998). Consequently, women face contradictory pressure to be 'one of the lads' while maintaining normative feminine attributes out of fear of being judged (Faulkner, 2009b, p. 169; see also Billing & Alvesson, 2000). On the contrary, it seems that it is less problematic when men enact femininity at work (Holmes & Schnurr, 2006; Kelan, 2007; McDonald, 2013). In a study of both male and female nursing students, McDonald (2013) found that in female-dominated work contexts, men are able to employ work-related feminine characteristics to pursue professionality without challenging their male identity.

Moreover, when normative masculine embodiment, such as large muscles and physical strength, are incorporated in labour discourses as not only a positive attribute of work but also an important criterion for work in industrial workplaces, feminine bodies have long been 'trouble' and are subject to 'gender management' (Trethewey, 1999). Women entering male-dominated professions are typically advised to adopt a presentational style that mimics their male counterparts (Trethewey, 1999). Doing gender in workplaces dominated by masculine values thus often requires women to control their femininity to comply with both gendered behavioural and embodiment scripts.

These findings show that there is an unequal level of tenacity in gender scripts between workplaces inscribed mainly with masculinity and those with femininity. Feminist organizational scholars have therefore committed to the struggle against patriarchy and sexism in workplaces by focusing on revealing and confronting the inferior positions

of women. Pioneers of feminist critique of work segregation thus tend to associate normative feminine characteristics with lack of power, as they appear to be subordinate to patriarchal control while seeking approval from men (Lakoff, 2004).

In the last few decades, the feminist agenda has grown increasingly fragmented. It has shifted from radically rejecting stereotypical feminine norms and encouraging constant critical self-reflexivity that militantly subverts the enduring world's judgement of women (Probyn, 1993) to contemporary approaches that have begun to focus attention on agencies of women's personal choices (McRobbie, 2009; Rhode, 2016). Tronto (1993), in her theorizing on ethics, contended that scholars need to highlight a care ethic that includes the values traditionally associated with women. McRobbie (1993, p. 409) argued that 'the old binary opposition which put femininity at one end of the political spectrum and feminism at the other is no longer an accurate way of conceptualizing young female experience'.

The emerging stream of feminist thought considers 'all women do' — including pursuits of feminine features such as beauty, sexual desirability and use of make-up, as well as 'housewifeliness' — to be possible sources of pleasure and potential individualized agencies of change (Holmes & Schnurr, 2006; McRobbie, 2009, p. 13; Rhode, 2016). It has been argued that women, especially professional women, should not see the enactment of normative femininity as demureness, lack of power or a cause of embarrassment, but as a positive attribute in workplace discourse (Holmes & Schnurr, 2006). These notions have opened up a broader perspective in understanding the gendering process of work and women's role in this process. That is, a feminist approach to change may not always play out in a unified form, but opportunities of change may also reside in individualized gender performances of women, whether normatively feminine or less so (McRobbie, 1993, 2009; Trethewey, 1999).

Indeed, labour discourses have been infused with 'gender anxiety' (Baron, 2006, p. 145). Whereas masculine notions aim to sustain domination and power, women strive to establish a legitimate identity at work. This historical view entails the relevance of our study, which explores whether the implementation of digital technology in metal workplaces might be generating new forms of masculine power that continue to marginalize women and femininity. Or will it lead to women's emancipation?

2.2 | The technology, gender and work nexus

To explore gendering of the metal industry in the context of digitalization, it is necessary to understand the persistent association between technology and masculinity and the gender implications of such in the workplace.

Technology plays a paradoxical role in constructing gender norms at work. The technology determinist view contends that technology creates opportunities for labour. Following this reasoning, digital technology has been regarded as an emancipatory force that helps women gain access to and participate in previously male-dominated industries (Sorgner et al., 2017). However, we challenge this determinist view and consider the gendering of work as a more complex phenomenon. Historically, men have validated masculine superiority over women through a monopolization of the use and knowledge of technology (Cockburn, 1983a; Lie, 1995). Previous research shows that men have maintained a dominant status in the printing industry through controlling the use of technology in processes related to mechanization (Wikander, Kessler-Harris, & Lewis, 1995). Moreover, in times of dire labour shortages, women were recruited to male-dominated industries, but were placed in technologically low-rated jobs (Rylander, 2002) and were dismissed once the labour shortage eased. These industries remained masculine workplaces.

Wajcman (2010) goes further by arguing that the problem was not only men's monopoly of technology and work, but also the way gender was embedded in them. Indeed, the long-time association between technological skills and power and white, middle-class men has left the perception of femininity incompatible with technological pursuits (Oldenziel, 1999). Research following along the lines of socialist feminist notions therefore considers technology to be something captured by the social relations of patriarchy and capital (Bradley, 1989). In line with this logic, Arnold and Faulkner (1985) see the women and technology nexus as being determined by patriarchal

dominance. Other influential studies in this stream have also revealed that male trade unions actively sought to exclude women from advancing professions (Cockburn, 1983a) or nightwork (Wikander et al., 1995) throughout the industrialized world. Seeing the modernistic technological quest as 'being hopelessly bound up with a masculine world view that is detached from nature and from people' (Faulkner, 2001, p. 80), the structural perspective renders a great deal of insight into how technology is deeply implicated in masculine domination over women in the workplace but leaves little room for individuals to pursue change.

Hence, both the technology determinist view and the structural perspective tend to simplify the role of technology in influencing gender norms in workplaces by either self-evidently taking technology as a liberating instrument or viewing it as being hopelessly hijacked by patriarchal notions. These approaches fall short in highlighting individuals and their actions as the agency of change in the gendering process. This oversight thus continues to conceptualize individuals, particularly women, as docile in workplaces. We argue, along with other scholars (e.g., Harding, 1986; Lie, 1995), that possibility for change comes not only from structural alterations but also from symbols, identities and behaviours in the daily efforts of individuals at work. We therefore seek a comprehensive understanding of the gendering process and turn to a third scholarly perspective that allows for a complex problematization of the gender, technology and work nexus that focuses on the mundane practices of individuals at work (e.g., Cockburn, 1983a, 1985; Harding, 1986; Lie, 1995).

A constructivist perspective highlights the importance of seeing the construction and de-construction of gender characteristics of work as deeply rooted in the gendering (and un/re-gendering) process on an individual dimension (Billing & Alvesson, 2000; Harding, 1986; Kelan, 2010; Lie, 1995; McDonald, 2013). This perspective allows for a scholarly study examining how symbols of masculinity (and femininity, if any) become integrated into processes and activities, language and images within ordinary patterns of use in a workplace where a relatively new type of technology is being implemented (Lie, 1995; Rosaldo, 1980).

Faulkner's (2009b) work on women in engineering highlights the importance of identity construction for the gendering of work. With this focus, Faulkner (2009b, p. 177) finds that women entering engineering professions face a double paradox: in order to qualify as engineers, women need to play down their femininity and 'distance themselves from feminist analyses of their situation'. The same study finds a higher level of gender diversity and complexity than the oversimplified conclusions of such situations being 'disqualifying of femininity' as have been suggested in earlier research. Similarly, Kelan's (2007) analysis highlights complexities concerning binary gender identities and changes in the context of work. Her study illustrates how the binary of rationality (masculinity) versus emotionality (femininity) is challenged in new information and communications technology (ICT) workplaces, where ICT workers are expected to possess good communication skills and emotional intelligence, traits normally considered to be feminine.

While some works emphasize the intricate ways in which symbols and identities add to complications in the gender and technology nexus, other studies have focused on how changes in organizational relations are co-constitutive in the production and reproduction of gender symbols in the workplace (Gherardi, 1994). Ely and Meyerson (2010) found that, in male-dominated workplaces, changes in managerial culture — from one that accepts risk behaviours to one that emphasizes safety, collectivism and learning — allowed for diversified gender performances. On a similar note, Faulkner (2009b) argues that organizational cultures that render new dynamics in the technology, gender and work nexus, in turn, may lead to diversified gender performances.

In short, by analysing doing and undoing gender, scholars have explored the mechanism of how the equation of masculinity and technology sustains the male dominance of some work, despite the elimination of the social prohibition of women's participation in these workplaces, and how the basis for destabilizing this equation emerges in everyday individual practices (Balsamo, 1998; Burfoot, 1997; Caputi, 1988; Faulkner, 2001). These studies serve as a source of inspiration in our attempt to explore how the gendering process in the male-dominated metal industry — with the implementation of digital technology and women's increasing participation — may underpin a (new) symbolic order of gender that 'permits differentiation and fashions a deep-lying attraction and repulsion between the sexes' (e.g., Gherardi, 1994, p. 593).

In addition, organizational scholars emphasize that the research of gender norms in the workplace ought to focus more on the recognition of the advantages and strengths of women and attributes of femininity as well as the values traditionally associated with women (Billing & Alvesson, 2000; Holmes & Schnurr, 2006; Tronto, 1993). Instead of seeing women solely as victims of men's desire to control (Berg, 1997; Cockburn, 1985) and judging femininity as subordinating to patriarchy, we embrace a broader perspective of feminist notions to interpret the meaning association of femininity. With this, we seek to pursue further theorizing on the gendering of work in a time of technological advancement in male-dominated workplaces through highlighting how femininity may be enacted as an important attribute that can induce substantial changes (e.g., Holmes & Schnurr, 2006).

2.3 | Seeking the agency of change in gender performances at work

To fulfil our research pursuits, we incorporate Butler's (2004, 2007) notions on doing and undoing gender, and we explore individuals' agency in the gendering of digitalized metal workplaces through unpacking the notion of performativity. We, however, recognize that there are diverse views of doing and undoing gender in existing research, which have differing predictions on the state of gender performances. The ethnomethodological approach underlying the work of Deutsch (2007) and West and Zimmerman (1987), and an approach with roots in Post-structuralism by Butler (2004), both conceptualize doing and undoing gender (Kelan, 2010; McDonald, 2013).

With an ethnomethodological approach, Deutsch (2007) juxtaposed 'doing gender', referring to a reinforcement of differences between men and women in interaction, with 'undoing gender', referring to a resistance to this 'doing'. In doing so, Deutsch (2007) elucidated an alternative way of (re)creating binaries, that is, a creation of 'sameness' that makes gender less salient. Contrarily, Hirschauer (1994) moved away from the mainstream ethnomethodological view of gender, contending that gender becomes irrelevant and therefore undone when it is not enacted.

Adopting a poststructuralist view like Butler (2004), we challenge the notion that men and women make prevailing gender norms irrelevant by undoing the gendered characteristics stereotypically associated to their sex. Rather, we argue that examining undoing gender renders more nuanced insights into both how masculinity persistently dominates in some domains and how subversions may emerge even as this dynamic is being sustained. Relatedly, Kelan (2010) explored how ICT workers, by 'undoing' gender, created subjectivities that 'enact gender in a way that goes beyond conventional parameters' (p. 190). Hence, a subversion of gender norms is established performatively (e.g., Butler, 2004).

Furthermore, Butler (2004, p. 47) pointed out that undoing gender by contesting symbolic authority is not necessarily 'a return to the "ego" or classical liberal notions of freedom', but rather, it is to insist that 'the norm in its necessary temporality is opened to a displacement and subversion from within'. Hence, Butler's (1993, 2004) focus on the observation and analysing of gendering is not isolated within the individual body, but connects the body with the gender norms that a particular situation renders. Inspired by this, we see gender displacement as potentially agentic, not only in the sense of dissolving gender, but as the subversion of norms producing gender.

Hence, we see that the recognition of the persistent regulative forces of gender scripts is contextual, as was also suggested in Kelan's (2007) analysis of ICT workers. Although men enact normative feminine characters such as emotionality, the discourse of work remains dominated by masculine values. With this, Kelan (2007) emphasized that one cannot fully comprehend the gendering of work without understanding the discursive context in which the notions of 'masculine' or 'feminine' characteristics are being deployed. To use an example from Butler's work (2007, p. 188), the same image of cultural drag may contain a 'double inversion' of gender meanings when appearing in front of a heterosexual audience compared to a transgender audience, because of differing discursive contexts.

Moreover, we argue that gender performativity induces agency of change when people exploit their audience's familiarity with stereotypical feminine or masculine characteristics to generate subversive behaviours. For example, Koller (2004) finds that some women enact feminine stereotypes, and use linguistic features related to these stereotypes, parodying conventional notions of how women should behave in the workplace. Gender performativity thus

maintains double implications in circumstances as these. By doing gender in stereotypical ways, individuals may create a critical reflexivity which disrupts the static gender associations of certain types of professional identity. Hence, the performativity of gender does not only keep people (women) docile, but it also contributes to changing the gender norms in a particular situation. These notions help us explore diverse implications in doing and undoing gender at work. In particular, they broaden our view in understanding femininity enactment.

Previous research has focused on how society and social interaction have assigned meaning to the biological differences between men and women, how gendered discourses assign meanings to the division between the sexes, and how these social constructs remap meaning to masculinity and femininity (Liddington, 2011). With such inquiries in mind, we explore, firstly, what performances 'compel a reconsideration of the place and stability of the masculine and the feminine' and, secondly, what kind of gender performance may 'enact and reveal the performativity of gender itself in a way that destabilizes the naturalized categories of identity and desire' (Butler, 2007, p. 189).

2.4 | The study

We conducted a qualitative, interpretive study using feminist research on the nexus of technology, gender and work, as well as Butler's writing on gender performativity, as the epistemological and methodological touchstone. The assumption of our investigation is that the implementation of digital technology in a male-dominated workplace is a gendering process that contains implications of the formation of organizational culture, power structures and, most importantly, the state of gender (in)equality.

For Butler (2004, 2007), language use and corporeal gestures, acts and appearance are signifiers of doing or undoing gender in a particular social context. These mundane practices remain implications of performativity that either perpetuate existing gender scripts or subvert them, and thereby even rewrite the dominant gender scripts (Butler, 2004, 2007). Therefore, in our study, we examine gender performances of individuals in daily practice by focusing on verbal expressions and bodily actions.

Since the notions of identity and subjectivity are central to our study, we focus on exploring how individuals seek understanding of their work and develop subjective meanings (Creswell, 2013). Meanwhile, we reflect on the 'situatedness of knowledge' (Haraway, 1988) and take a reflexive, interpretive approach, considering our own positionality in the research process. The position of the 'outsider' can be used reflexively to unravel how we 'actively construct our knowledge' (Finlay, 2002, p. 532). Thus, we made use of our own positions as outsiders: women in a masculine-coded work context and academics in need of humble reflection on what digital technologies mean in the metal industry setting.

Furthermore, interpretive researchers may enact multiple sets of theories to 'translate' observable reality in order to render rich understanding of and bring forth the underlying meanings of this 'reality' (Geertz, 1973). In this study, we used Butler's works to understand ways in which men and women carry out gender performances doing and undoing masculinity and femininity; we applied feminist writings on the gender–technology–work nexus to scrutinize how existing gendered scripts of technology and metalwork influence individuals' perceptions of themselves and others. We also engaged with extant studies on doing and undoing gender at work and a broad perspective on the notion of femininity to explore how observable gender performances may either perpetuate or subvert existing gender scripts in the Swedish metal industry.

2.5 | The empirical setting

The Swedish steel industry has incorporated the global initiatives of digitalization through using smart sensors, automation and advanced IT systems (Herzog et al., 2017) to connect the supply, production and customer chain (e.g., Johansson, 2017). The steel industry is exploring new ways of organizing labour in the face of the ongoing

digitalization of production and business solutions (Asztalos Morell, 2017; Johansson, 2017; Launberg, 2017; Lindell, 2017).

In 2016, ten researchers began an empirical investigation of Digitalized Work and Organization (DAO) within the Swedish metal industry with the purpose of exploring opportunities and challenges in the metal industry in the context of digitalization. The project concluded at the end of 2017. In total, eight case studies were performed, and nine research reports based on these studies were produced and published.

2.6 | Multi-person research

We used a multi-person team ethnographic approach in this research. The participating researchers come from different academic disciplines, such as education, sociology and business administration. Prior to fieldwork, the researchers outlined a general interview frame together which they each used to create their own semi-structured interview guideline. The general interview frame contained the following questions:

- What forms of leadership, organization and work are needed to implement and to benefit from digitalization?
- What challenges and opportunities might be presented by a change in process?
- What kinds of competencies and skills are needed?

In multi-person research, researchers are able to cover a greater area in their fieldwork and to collect rich empirical material. To avoid protectionism, the researchers shared their materials during and after the fieldwork, including interview transcripts and field notes, keeping them in joint storage and sharing their initial impressions of the fieldwork (Clerke & Hopwood, 2014; Erickson & Stull, 1998).

We chose empirical materials from four of the cases for this article. Our selection process primarily considered the weight of the gender perspective in the case study. We also considered the breadth of the scale of digitization, as we wanted to present a comprehensive view of the state of technology development in the industry. The lower degree of digitalization here is represented by workplaces that rely on manual labour and automated machines, but that have implemented a digital information system between some operational units; whereas a high degree of digitalization is represented by workplaces that are fully equipped with robotic devices and whose entire production lines are connected by digital systems that are also linked by the supply chain and customer feedback (e.g., Jernkontoret, 2018). The range of production processes, types of products and levels of digitalization among the chosen organizations are shown in Table 1.

Furthermore, the four case studies that are the focus of this article were all conducted by female researchers, namely the three authors of this article and one other researcher. All four researchers paid particular attention to the gender aspect of metalwork in the context of digitalization. The interviews and observations included 79 male and 24 female participants (which reflects the gender structure of the organizations studied), and the ages of the interviewees varied from 24 to 65. The names of the organizations were anonymized and pseudonyms are used for participants. In this article, we focused on presenting and analysing the narrative and observational data from shop-floor operators, team leaders and team managers involved in shop-floor tasks, as well as administrative personnel involved in recruiting operators. We present a more extensive summary of information on the participants in the Appendix.

The three authors of this article are from two different disciplines, sociology and business administration, and held various theoretically imprinted views, from a feminist studies approach to technology to a Butler-influenced gender perspective, upon embarking on our fieldwork. Our theoretical stances influenced our focus in the fieldwork, which largely enriched the range and interpretation of data. To avoid asymmetrical relations of the researchers interpreting 'the other' (e.g., Clifford, 1986), all three authors were involved in the discussion of empirical materials, each incorporating different theoretical readings of gender–technology–work relations in the early phase. These

TABLE 1 Overview of the studied organizations

	Production process	Type of product	Degree of digitalization
Organization A	Flow	Raw material	Very low
Short production lines. In the factory some machines are several decades old but still in use. Work by operators is mainly tied to a single machine. Automated machines or manual labour. Information between operators and between operators and management mainly face to face or on paper			
Organization B	Flow	Raw material	Both low and high
Standardized products for heavy industry. Most production is done by automated machines, and parts of the production require manual labour. Robots have been introduced in one section of the factory. Work by operators is either tied to manoeuvring a single machine or, in the last section of production, supervising the robot. Communication between operators and operators and management through digital information system between operational units.			
Organization C	Flow and batch	Raw material customer adapted	Both low and high
Customer-adapted products. Automation of various forms began in the early 2000s, at the same time as IT systems for production control were introduced. For this study, two separate units with varying degrees of automation and use of digital technology were included			
Organization D	Single products	Manufacturing	Fairly high
Products have very high demands on tight tolerances and fine surfaces. The factory makes continuous efforts to advance the level of automation of machinery through upgrading CNC-controlled machinery and digitalizing the work process by implementing a new version of the management system, using a wide range of new technologies. The factory is fully equipped with robotic devices and the entire production line is connected by digital systems, linked to supply chain and customer feedback			

discussions helped us gain a profound understanding of ways that are often taken for granted where 'people manage to do things together in observable and repeated ways' (Van Maanen, 1979, p. 539).

3 | RESEARCH METHODS

Our methods consisted of interviews and observations. The interviews were recorded and transcribed. Adopting an outsider's perspective, we took extensive field notes (Pike, 1967). During interviews, individuals made sense of their gendered performances in dialogues with their interviewer, which resembled gendering processes in ordinary social interactions. By speaking of past experiences, the interviewees were able to recollect memories, which we, along with Gherardi and Poggio (2007), consider to be producing stories of their identities. For example, we asked female operators to describe their first experiences in the metal industry. We encouraged them to reflect on the obstacles they faced, including physical and mental challenges that were specifically related to the binary perceptions of technology users. Additionally, the third author was particularly curious about the language use of women as they described digital and automated devices, particularly observing their use of metaphors based on household chores traditionally associated with women.

Observation is another important activity in ethnographic research. Observations were particularly useful for our study, which used Butler's writings as its methodological touchstone. We acted as passive observers, paying attention to how individuals interacted with each other and with digital devices and machines. For Butler, the 'body' and its movements and actions signify inscriptions from a cultural, contextual source that is '"external" to that body' (Butler, 2007, p. 175). Hence, operators' corporeal actions render important information about external gender scripts, and demonstrate ways in which individuals perform gendered identity in particular contexts. Along these lines, we captured the bodily actions of operators at work, including gestures, postures, facial expressions and appearances. For example, the second author observed a scene in which tattooed, muscular male bodies were placed in front of monitoring screens, resembling women working in administrative tasks. The first author focused on how

women working in a unit dominated by men used gestures, postures or tone in their voices to either signify femininity or to avoid being perceived as 'girly girls'. We were all interested in unravelling how operators perform masculinity and femininity in workplaces where digitalization has changed earlier masculine inscriptions of labour (McDowell & Court, 1994).

3.1 | Coding and analysis of materials

Coding and analysis of materials took an iterative route. First, as mentioned in the previous section, we selected materials that contain reflections on gender identity and the use of gendered symbols. After this, we entered a literature review phase in order to find theoretical anchors for these materials. This led to the second phase of coding these materials, where we identified transcripts associated with gendered notions of work and technology. With this, we tried to outline a dominant 'gender script'. Based on this, we then tried to understand how men and women positioned themselves in the context of digitalized work processes. For example, we illustrated the ways in which the women described their first experiences entering the metal industry; we demonstrated how they problematized their own existences in metalwork. We also classified ways in which male operators expressed their views of work and their female peers, as a way to understand how the dominant script steers individuals' views of themselves, others and their work.

In the next phase, in line with Butler (2004, 2007), we classified our materials into two major categories — performances of 'conforming' and performances of 'subverting' — to the existing gender scripts of metalwork. We aimed to understand how individuals do masculinity by undoing femininity, and how they undo the masculine script by doing femininity differently. The result of this round of coding of material was used as our final analytical frame.

Following this, by drawing on different views on the nexus between gender, technology and work, we engaged in another layer of coding (Harding, 1986; Kelan, 2010; Lie, 1995; McDonald, 2013). That is, we thoroughly discussed what gender performances actually do, or are potentially capable of doing, as performativity in terms of the generation of potential changes or as perpetuations of the existing gender scripts of technology and work.

4 | ANALYSIS

4.1 | Changing exploitative expectations of masculinity

In this study, we observed that the conventional masculine virtues of controlling and taming through physical power are losing their dominant position, as there has been a shift towards emphasizing the skills of mastering and controlling complex production lines, which are becoming increasingly digitalized. However, we have found that the conventional gender scripts containing exploitative expectations on physical power and toughness are still frequently reflected upon, woven as they are into the work processes that involve digital technologies. We contend that this pattern risks giving way to the perpetuation of masculine norms in shop-floor work units. Drawing on Butler's (2007) notions, we observed that both men and women take masculine connotations as the 'standardized' gender inscriptions in digitalized workplaces to define whether they are 'fit' or 'unfit' for the required tasks.

As an example, Bengt was an operator working to monitor the welding of hot steel. He described his female co-workers as being unsuited for the work they were assigned to:

> Sure, there are many more women working as operators in our industry ... Still, you need to constantly learn new things, and you have to be able to fight a great deal here, and unfortunately many of the ladies that come are too shy to say anything, but you can tell that they don't thrive.

Bengt's narrative depicts work in the metal industry using classical masculine imagery by broaching the notion of aggression, as in the use of the word 'fight'. Yet, in Bengt's reflection, we find an example of new boundary maintenance. In a digitalized metal industry, where physical strength is no longer sufficient for excluding women from the mastery of the material, a new masculine discursive element appears that frames women as unfit for the job by implying that they are not good at 'learning new things'.

Indeed, in Bengt's work unit, the control functions of digitalized manufacturing production lines are monitored by teams of men placed in manoeuvre rooms servicing multiple functions. The tasks involve the monitoring of screens and flows of information that resemble duties typically associated with women's office work. Yet, compared with the number of men in the monitoring room, there are fewer women participating in similar tasks. Sally, recognizing herself as one of the few women working on the monitoring tasks, commented with a tone of obvious disappointment:

> *In fact, now you see my work is mostly sitting in front of the computer. My job is mainly to monitor the fully automated operation lines and to put data into the computer ... but still, few women come to work here ...*

In contrast to many female operators in digitalized work units, younger men, particularly those who are familiar with computer skills, express pride and confidence at work, taking digital technology as a new domain that they naturally thrive in, as if the digitalized devices are just another 'toy for the boys' (e.g., Faulkner, 2001, p. 80). Johan was a 30-year-old operator who had just been promoted to a team-leader position in the logistics department, based on his computer skills. He expressed his overt pleasure in performing this new task:

> *Now my job is very much like those who work in an office. Instead of carrying and moving heavy parts in and out of storage, I only deal with information in the computer systems. This information is crucial regarding our storage supply, customer orders ... You see my generation growing up with computer games have found our place to shine.*

Here, we detect a pattern of the 'renewing' of masculine notions along with technology development (e.g., Kimmel, 1990). Whereas older male operators use their years of experience as the basis for expressions of pride and confidence, the younger generation deliberately refers to skills with computers as an obvious advantage in work.

Nonetheless, when we observe masculine characteristics being asserted frequently in mundane work practices, we discover a new form of masculine embodiment of technology that simultaneously obstructs the traditional imagery of masculinity. The muscular male bodies, which used to be the symbol of power in the metal industry, are no longer exposed to danger or are expected to endure heavy manual labour in most digitalized work units. They are now being placed in front of monitors watching and controlling digitalized technologies. In line with Butler (2007), this new type of corporeal presentation reminds us of cultural 'drag' performances. The 'displacement constitute' suggests a 'double inversion' of the meanings of openness to 'resignification and recontextualization' (Butler, 2007, p. 188). On the one hand, the association between expressively tattooed, muscular male bodies and symbols of the new technology may 'revert the inner/outer distinction' (Butler, 2007, p. 189) and compel radical rethinking of the presuppositions of gender identity in metal workplaces. On the other hand, this new imagery may be understood as the emergence of new symbols of masculinity in digitalized metal workplaces.

This part of the analysis shows that, along the change of exploitative expectations of metalwork tasks, both men and women, by continuously using masculine symbols, assert and sustain the tenacity of masculine associations with technology and metalwork.

4.2 | Conforming to and contesting the masculine embodiment of technology

In this section, inspired by previous research focusing on the process of doing and undoing gender in the workplace (e.g., Kelan, 2010; McDonald, 2013), we focus on analysing the experience of female operators to explore how their actions contribute to sustaining or changing the gender norms in digitalized metal workplaces. We discover that the performativity of gender both enforces the existing gender order and renders opportunities for change. It shows that female operators enact masculinity and femininity interchangeably as expressions of their identity as competent steelworkers.

The masculine meaning constitution, according to Butler (2007), requires that women 'reflect that masculine power and everywhere reassure that power of the reality of its illusory autonomy' (p. 61). We find that female operators from several organizations are actively undoing femininity to adhere to the masculine 'gender scripts' in the context of digitalization (Cockburn & Ormrod, 1993). This, in Butler's terms, describes how women 'reconfirm' and 'augment' a masculine identity through the recognition of the authority of this identity (e.g., Butler, 2007p. 61).

Over a long period of time, men's bodies formed the externalized, corporeal 'gender scripts' of work tasks in the metal industry. Women were on the receiving end of technologies rather than on the creating end (Arnold & Faulkner, 1985). While digital technology has transformed the virtue of work in many workplaces, the association between masculinity and technology has become deeply permeated in metalwork. Both men and women have come to accept the fact that the design of technologies often assumes the sex of the operator to be male. Clara, who was in her forties and used to work as a truck driver at the steel plant, expressed her early work experience:

> First, I was a truck driver, loading scrap and unloading cars and, yes, I drove around in this giant truck. My knees were so sore because I couldn't reach the floor … since I have short legs.

What we sense here with Clara's statement is that she takes the masculine expectations of technology as natural logic. She problematizes her feminine physique without questioning the fundamental bias that lies in the design and the development of the technology.

We see such narratives as a way for female operators to adapt to a socially acknowledged connection between technology and the male gender (Harding, 1986; Lie, 1995). They use this symbolic connection to describe tasks, tooling and products. For instance, the machines performing tasks previously performed by men are referred to as 'he' by female operators. The operators described the process in which a board equipped with a laser eye moves metal bars to the oven as '"he" reads it into the system'. Moreover, materials processed through the factory attain an anthropomorphized shape associated with the male gender, too. We find that these linguistic features, enacted daily on the shop floor, strengthen the symbolic connection between digital technology and masculinity.

Furthermore, many female operators consider themselves a 'rare species' at work. Their narratives demonstrate inner struggles, whether the concerns be remaining exploitative expectations of physical power or the general disbelief and disapproval of the presence of women in the male domain. Despite working alongside their male peers, and maintaining the same pace and patterning in various processes, many female operators feel the need to constantly prove themselves as capable steelworkers. They describe, with certain discomfort, the need to conform to a masculine way of behaving. Maria, a female operator working with steel casting, described the metal workplace as emotionally detached and insensitive, characteristics that women need to make an effort to adapt to:

> There are many men working here so you have to manage a certain mentality. It is difficult emotionally but you can't be too sensitive. You have to handle it. Well, men and women are different, that's the way it is.

Here, we see narratives such as Maria's maintaining 'double implications'. They function both as the recognition of the power related to masculine identity (e.g., Butler, 2007), and as evidence of how female operators acknowledge the issues in the dominant masculine norms. By openly expressing acceptance of such norms, women 'smuggle' in

characteristics that differ from the existing masculine notions. We find that these narratives create a particular effect ironizing the static masculine image of a steelworker (e.g., Koller, 2004).

Furthermore, we discover that some female operators playfully use metaphors that are stereotypically regarded as feminine to depict their current working conditions. For instance, Rosa, a 27-year-old operator, described the hot grinder she monitored to be 'like the dishwasher at home', while Agneta, a 30-year-old operator, compared the hot rolling of steel to 'using a pasta machine'. Meanwhile, Minna, a 36-year-old steel caster, described her relationship to the rather unreliable dry pulp machine in terms of child-rearing: 'this is like running after small children'.

Women who opt to work closely with technology are often regarded as potentially rejecting meaningful engagement in the social world and, as such, are prone to 'gender inauthenticity' (Cockburn, 1983b; Keller, 1987). We found that when female operators dealt with 'hard' technology in heavy industry by using metaphors for domestic chores or tools, such as kitchen appliances, their narratives blurred the hard–soft dualism of technology and disrupted the standing dualism between masculine emotional detachment and feminine emotional connectedness. Here, we do not intend to exaggerate gender binaries by associating domestic tasks with women. Rather, we capture how women exploit stereotypical feminine notions in humorous language use and playful expressions to cleverly parody existing gender scripts without resorting to militant protest. We see this as a type of subversive act that disrupts the masculine script of digitalized metalwork.

Moreover, in the metaphors used by female operators, we again find expressions that contain 'double inversion' meanings (Butler, 2007). Clara, who was very concerned about her 'unfit' physical form as a truck driver, later happily described how she finally got the seat in her newly designed truck adjusted to fit her body so she could reach the pedals without stretching her legs. She laughingly said: 'Now I sit in the truck like a princess.'

A small body is the hallmark of binary sexual desire (Lundgren & Kroon, 1996), whereas a princess is the symbol of feminine glory and mastery. According to Clara's narrative, women become the master of technology as a 'princess' by reinforcing a subordinate femininity. This can be seen as a subversive act, staging extreme femininity in a masculine coded context. Yet, the trope of the princess also highlights the relevance of Butler's notion of how the heteronormative matrix perpetuates sexual desirability. Thus, referring to the metaphor of the princess, we find Clara reinforcing her image as a sexually desirable, 'normal' woman who meets her performance challenges in a masculine workplace. Yet, being a princess assumes that one takes a role subordinate to that of a male king as the father. Indeed, Clara's open assertion of the feminine aesthetic ideal in a masculine workplace also implies the existence of a patriarchal higher power.

According to Butler (2007), people use poetic language, expressions of the pleasures of maternity and methods of parody to constitute a local displacement of the paternal law, temporary subversions. The metaphors of domestic chores and the stereotypical feminine appearance depict a feminine desire or demand, and are capable of disclosing or promising an 'eventual disruption and displacement' of the masculine fixity (e.g., Butler, 2007, p. 64) of technology and work. Both the verbal expressions and embodied gestures among the female operators exemplified such gender performance.

Annie, whose main task was controlling the operation line by monitoring the sensors, had long fingernails, which she painted to perfection. She showed off her colourful nails while typing, making a pleasant noise with them as they touched the plastic keyboard. Mainstream feminism depicts the performance of feminine beauty as a subordinating practice (Jeffreys, 2005), staging feminine sexual desirability for the masculine guise. However, by considering the context where dominant (masculine) gender norms are deployed, we interpret here that women stage their feminine desirability and beauty as a subversive act through which they challenge assumptions on the exclusionary nature of work in the metal industry.

In addition to the parodic linguistic features and corporeal signs that forge displacement and implicitly contest the conventional gender order, we detect another type of narrative that straightforwardly highlights the advantages of feminine characteristics in technology-dense metalwork and directly challenges the existing masculine 'gender scripts' (e.g., Cockburn & Ormrod, 1993).

Sara, as the only female operator in her unit, expressed a sense of pride. She deliberately stressed the advantage of being a woman working in the metal industry.

> *I am good at learning new things. I actually think many women are like me, flexible, smart and with more patience ... we learn new knowledge fast. You see Olof, who is working outside this room, he has worked here for many years. But he refuses to learn so now he works outside this studio and still uses the manual tools.*

The physical layout of Sara's unit affirms her narrative. The work unit contains two separate parts divided by a glass door. The part where Sara works is equipped with computers and digitalized tooling; the other part, where Olof works, remains equipped with traditional manual tools. Sara was not alone in making statements about women's potential advantages in this study. Many female operators in different organizations openly discussed various strengths of being women, such as being adaptive in a rapidly changing environment, being sensitive to new elements at work and showing understanding of/appreciation for the entire process of work. We see such use of language as a first step in the construction of a new image of a competent steelworker, which radically subverts the enduring world's judgement (Probyn, 1993): that women are incompatible with technology and heavy industry.

4.3 | Using binary gender stereotypes and changing the masculine script of work

We find that gender stereotypes are broadly used in metal workplaces, particularly in teamwork. We detected that the use of such notions leads to diverse implications regarding gendered performances and the state of equality between male and female operators.

When people are treated differently according to their advantages and weaknesses, some individuals may gain access to work while others are excluded. For example, despite their alleged advantages in tasks that require manual labour, men are described as being easily stressed and inclined to demonstrate excessive pride in their work. By contrast, women are seen as calmer, with a higher degree of stress tolerance, and they are seen as being more careful and considerate of the entire flow of working processes. As one of the male foremen, Oskar, put it:

> *[women] do not become as stressed as [men] ... No, they have their calm tempo. They hang around and do multi-tasking and do not get distracted easily. They think about how different tasks connect with each other ... Strangely enough, they often manage it better than guys ... with much less risk of accidents.*

Similar to Oskar, quite a few male operators, while upholding their view that 'girls' are not naturally suited to tasks within the metal industry, described characteristics associated with normative attributes of femininity, such as timidity, calmness and patience (Heilman, 2001), as advantages in the digitalized workplace. We see these comments as the evidence of how qualities associated with stereotypical femininity have begun to gain recognition in digitalized workplaces.

For Butler (2007), gender is an enactment that 'performatively constitutes the appearance of the interior fixity' (p. 95), and the incorporation of gender identifications is more of a 'fantasy of literalization' (p. 95). Here, we capture salient narrative performances highlighting and reinforcing an idealization of stereotypical gender distinctions or even gender bias in the digitalized workplace. There is an obvious technical–social dichotomy at work in the descriptions of both male and female operators: males dominate in the areas of physical strength and technology, whereas women are stronger in social aspects, such as being caring and patient, and are more capable at holistic problem-solving (Trescott, 1984). On the positive side, feminine characteristics are being recognized as strengths in team collaborations in digitalized metal workplaces. However, the trend of assigning stereotypical femininity and masculinity to work tasks widens the binary gap and further genders metalwork with technology-related categorizations.

This study finds that stereotypical gender differences are being used to restrict women to a narrow scope of positions in the production line. For example, certain dead-end jobs that are described as the most stressful and demanding, such as overhead crane driving, have been increasingly assigned to women upon the argument that women are especially suitable because of their 'calm' nature and 'not getting stressed out'. Interestingly, we find similarity in the gendering complicity illustrated by Kelan (2007) in the digitalized metal industry: when feminine characteristics are recognized as necessary qualities in teamwork, they are also used to justify the argument of why women are not seen as suitable for technological tasks. For example, Lennart, a line manager, stated that:

> We recruited women but then they came from hairdressing, they came from taking care of little children and such chores. They are careful and considerate and all that, but it is ... devastating ... because there is no real technological interest or technological knowledge.

The above quote further suggests that there is a persistent misinterpretation of the association between women and their advantages and strengths, which continues to marginalize women in the context of digitalized metalwork. On the one hand, we find that female operators in digitalized workplaces face normative pressures similar to female engineers, because they have to struggle to be seen as being 'as good as' their male peers (Carter & Kirkup, 1990; Cockburn, 1983b). On the other hand, we find that flexibility and multi-tasking have been described as feminine traits, associated with women's multitasking in the home. In the traditional production process, traverse driving was one task that women were found frequently doing. Women were seen to be acceptable for performing this otherwise dead-end job in the occupational careers of workers, often based on contract work, due to their ability to handle stress and to care for the needs of others in the production chain, as they passed products from one operator to another. We see both of these traditionally feminine virtues are of great importance in the demands made by work in the digitalized factory. Nevertheless, we are cautious about the risk that the existing dichotomist reasoning of technology may implicitly contribute to widen the binary segregation of job roles and continue to exclude women from more advanced technical tasks.

5 | DISCUSSION

Drawing on Butler (2004, 2007), and feminist notions of the nexus of gender, technology and work, as well as a broader feminist perspective in understanding the concept of femininity, this work explores how existing gender scripts of technology and metalwork regulate gender performances, and how displacement in gender performance creates opportunities for change. With this work, we highlight women's agentic role in gendering the metal industry in digitalization.

Findings suggest that the shift in exploitative expectations, combined with the influx of women in the industry, forges new elements in the gendering process in digitalized metal workplaces. The interplay between operators, digital technology and conventions of work asserts and rewrites the persistent association of metalwork with masculinity, and it renders opportunities for qualities that stereotypically belong to women to gain recognition and advantage in the previously male-dominated metal industry. This increases the complexity and ambiguity of the gendering of metalwork.

Furthermore, in line with Butler (2004, 2007), we detect gender performances that indicate potential changes in gendering the digitalized metalwork in the following ways. First, we explore both women and men engaging in doing the masculine gender norms and contributing to forging a discourse where the masculine sphere of work has gradually moved from a seamless connection with exploitative expectations of physical strength (e.g., Baron, 2006) to an emphasis on the intellectual mastery of IT and computer skills. In this process, women contribute to strengthening masculine associations with technology by actively *undoing* femininity, just as women in leadership positions do (e.g., Hirschauer, 2001), so as to appear to be 'appropriate' workers in engineering (e.g., Faulkner, 2009a). Some

scholars have suggested that both men and women enact masculinity at work, and this may not always reinforce the hegemony of masculinity and the subordination of women to men (Connell, 1987, 2005; Martin, 2001). However, we consider, in the early phase of digitalization in the metal industry, certain masculine expectations are being replaced by other exploitative expectations, *doing* masculinity and *undoing* femininity emphasizes the male advantage and reassures the authority of the masculine identity (e.g., Butler, 2007) in the realm of the creation and use of new technology (e.g., Harding, 1986). In such contexts, we contend that proper organizational guidance and support need to be in place to prevent digital technology from becoming a new arena for the inevitable extension of hegemonic masculinity control (e.g., Kimmel, 1990), and women being further marginalized.

Second, we find that women contribute to re-scripting digitalized metalwork through enacting gender beyond conventional parameters in different ways. Our findings indicate that women do not merely passively do masculinity as the only strategy to survive and thrive in masculine-dominant occupations (e.g., Billing & Alvesson, 2000; Pilgeram, 2007; Wajcman, 1998) and view their bodies as problematic signifiers in a masculine-dominated workplace (e.g., Brewis & Sinclair, 2000). Rather, through verbal expressions, the use of gestures, beauty and appearance, they both bravely enact stereotypical feminine characteristics to disrupt the persistent masculine image in metalwork; and they carry out acts that firmly associate feminine attributes positively with know-how, competences and skills in digital technology and metalwork to position their status as competent steelworkers. With these dynamic acts, they are rewriting the position of femininity in digitalized metal workplaces.

This observation, along with Butler's notions on gender performativity, gives our analysis fresh insight into women's gender performance in masculine-dominant workplaces. In this context, we do not judge the enactment of normative femininity in the male-dominated workplace as women being submissive to the masculine control. Rather, they use it as a source of pleasure, agency and enhancement of their self-worth parodying and contesting the masculine norm (Koller, 2004; McRobbie, 2009) in digitalized metalwork. Doing 'femininity' this way thus allows for a 'useful, feminist, self-definition to emerge' (e.g., McRobbie, 2009, p. 13). Hence, we interpret different approaches of doing femininity as equally important and agentic. They maintain the potential to radically eliminate the notion that femininity is incompatible with technology (e.g., Butler, 2007; Cockburn, 1983a).

Our third finding renders conflicting insights. We find that acknowledgement (by both men and women) of stereotypical gender characteristics is being deliberately used in teamwork planning in the digitalization context. On the one hand, this indicates a salient division between the advantages and disadvantages associated with men and women in digitalized work tasks, which, in turn, leads to widening the binary gap (e.g., Wajcman, 2010). On the other hand, this finding suggests that appropriateness of work-related performances at metal workplaces are no longer centralized with masculine values; feminine attributes such as calmness, patience and adaptability (Heilman, 2001), as well as affective qualities (Jarrett, 2013; Kelan, 2007), are increasingly gaining recognition in the digitalized metalwork environment. Nonetheless, marginalization of women has not been eliminated. Male operators, through emphasizing masculine qualities as major competitive advantages in team collaborations, treat their female peers as 'others', as less important members (e.g., Irigaray, 1985). Simultaneously, the same feminine qualities are at risk of becoming the very reasons by which women are locked in a narrow range of dead-end positions. This shows that inequality between normative association of masculine and feminine values, qualities and characteristics still exists in the metal industry.

In this study, findings corroborate the argument about the reasons for men's dominance in technology lying within cultural associations of mastery over nature and science (Balsamo, 1998; Burfoot, 1997; Caputi, 1988; Faulkner, 2001; Harding, 1986). This is partially due to relentless validation of masculinity in industrial workplaces (e.g., Baron, 2006). However, women's participation in digitalized metal workplaces brings about great potential for change. The influx of women and new ways of organizing tasks upon the implementation of digital technology lead to diversified performances in metal workplaces. Historically, masculine notions maintain power and dominance inseparably from structural facilitations in society and in work organizations (Baron, 2006; Gherardi, 1994). It is thus critical that proper managerial models and organizational culture should be in place to enable and sustain diverse gender performances, including the enactment of femininity — be it in the form of stereotypical feminine

characteristics or militant feminist pursuits for empowerment — and to permeate the normative discourse in the digitalized metal industry.

6 | CONCLUSIONS

The metal industry has long been symbolically linked with masculine themes, and modern technology is closely associated with masculinity. Responding to Faulkner's (2001) concerns, our study confirms that these two types of masculinity are merging ever more closely in the metal industry in the context of digitalization re-formulating masculinity with new resolute and heroic elements (Kaster, 2001), which continuously greatly impact symbols, identities and relations at work (Lie, 1995).

However, women's participation has indeed begun to dissolve the persistency of the equation of technology, masculinity and metalwork, just as it has brought a different style to the world of sciences (Barinaga, 1993; Morell, 1993). By enacting femininity differently, and constructing divergent self-images as competent steelworkers, women are re-scripting gender in metalwork. We have captured several new ways of feminist reflexivity, which we find transcending the conventional parameters of technology and metalwork. As relatively new participants in the shop-floor units of the metal industry, women, with their own actions, have begun to build a new foundation for feminist subversion. Moreover, drawing on Butler's (2007) notions, we further argue that our findings may form the basis for needs and directions of future technology development, such as challenging the existing assumptions of designing machines and devices to fit diverse users.

Finally, we clarify that, although we use binary gender notions to describe and distinguish performances, we do not intend to devote this work to illustrate a 'feminized' metal industry. Rather, the findings indicate that the gendering of work is a complex and ambiguous process in which, by including labour forces with different backgrounds and competences, diversified gender performances will gain recognition in workplaces, and the binary gap between men's and women's advantages in technology and metalwork may blur and dissolve. In order for organizations to pursue and achieve further gender equality, we need to respond with openness and a supportive cultural milieu to encourage diversified performances that do not signify power distribution between the sexes at work.

ORCID

Janet Johansson https://orcid.org/0000-0003-2125-5451
Ildikó Asztalos Morell https://orcid.org/0000-0002-3442-187X
Eva Lindell https://orcid.org/0000-0001-6955-8350

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AUTHOR BIOGRAPHIES

Dr. Janet Johansson, she gained her doctoral degree from Stockholm Business School, Stockholm University in Sweden. She holds a Senior Lecturer position at Linköping University in Sweden. The focus of Dr. Johansson's research is primarily on equality, diversity and inclusion. Particularly, she takes a Critical Diversity Studies' perspective focusing on revealing underlying asymmetrical power relations that are being reproduced and strengthened in organizational strategies and practices under the name of equality. Dr. Johansson is currently conducting research on the issues of equality, diversity and inclusion in the performing arts industry in Sweden. In this current research project, Dr. Johansson investigates and scrutinizes, as well as offers socially innovative implications to the equality, diversity and inclusion strategies and practices of the publicly funded Swedish cultural organization.

Ildikó Asztalos Morell is a sociologist and working as an Associate professor at the Swedish University of Agricultural Sciences at the Division for Rural Development. Her research interests are gender regimes in organisations and welfare and intersectional aspects rural development.

Eva Lindell Dr Eva Lindell is a senior lecturer in Business administration at Mälardalen University. Her research focuses on digitalisation, changes in organisations and labour market with a perspective of discourse analysis.

APPENDIX

Number of respondents per organization; role, gender, age of respondents and length of interviews and observations

Organization	Interview number	Role	F(emale)/M(ale)	Age	Interview time (h, min, rounded to nearest 10 minutes)	Observation time (h, min, rounded to nearest 10 minutes)
Organization A	1	Production manager	M	40	1:10	
	2	Head of logistics	F	40	1:00	
	3	Vice president	M	50	0:50	
	4	Head of production	M	55	1:00	
	5	Operator	M	54	1:00	
	6	Operator	M	30	1:00	
	7	Operator	M	53	1:00	
	8	Operator	M	59	1:00	
	9	Technician	M	49	1:00	
	10	Production manager	M	48	1:00	

Organization	Interview number	Role	F(emale)/M(ale)	Age	Interview time (h, min, rounded to nearest 10 minutes)	Observation time (h, min, rounded to nearest 10 minutes)
	11	Operator	M	26	1:00	
	12	Operator	F	35	1:00	
	13	Operator	M	27	1:00	
	14	Operator	M	42	1:00	
	15	Operator	M	49	1:00	2:00
	16	Production manager	M	60	1:00	
	17	Operator	F	30	1:00	
	18	HR director	M	49	1:00	
	19	Production manager	M	53	1:00	
	20	Operator	F	31	1:00	2:00
	21	Operators	F + M	–		2:00
	22	Project manager, Head of logistics, Production manager, Manger R&D, Controller, Vice president	M + F + M + M + M + M	–		1:30
	23	Operator	M	–		2:00
	24	Vice president, Head of logistics, Manager R&D	M + F + M (second meeting)			6:30
	25	Operator	F	–		1:20
Organization B	1	Operator	M	30	0:50	
	2	Operator	M	33	0:50	
	3	Operator	M	24	0:40	
	4	Operator	F	29	0:40	
	5	Operator	M	34	1:00	
	6	Operator	M	32	1:00	
	7	Operator and labour union representative	M	52	1:00	
	8	Operator	F	36	1:00	
	9	Operator	F	27	1:00	
	10	HR administrator	F	45	0:30	
	11	Head of operations	M	40	1:00	
	12	Technical director	M	39	1:20	
	13	HR director	M	59	1:10	

(Continues)

Organization	Interview number	Role	F(emale)/M(ale)	Age	Interview time (h, min, rounded to nearest 10 minutes)	Observation time (h, min, rounded to nearest 10 minutes)
	14	Retired operator and HR consultant	M + F	–	2:30	
	15	Operator	M	–	2:00	
	16	Operators	M + F	–	0:30	
	17	Operator	M	–	2:00	
	18	Operator	M	–	2:30	
Organization C	1	Production manager	M	33	1:10	
	2	Production unit manager	F	46	0:20	
	3	Flow manager	M	36	1:20	
	4	Flow manager	F	36	0:40	
	5	Flow manager	M	–	0:10	
	6	Head of planning	M	40	1:00	
	7	Team leader	M	–	1:20	
	8	Production technician	M	38	1:40	
	9	Operator	M	34	0:50	
	10	Operator	M	63	0:50	
	11	Operator	M	28	1:30	
	12	Operator	M	50	2:00	
	13	Production manager	M	–		2:10
	14	Production manager	M	–	2:10	
	15	Production manager and Operator	M + M	–	0:10	
	16	Flow managers	M + F	–	1:10	
	17	Flow manager	M	–	1:30	
	18	Helper, Team leader, Operator, Flow manager	M + M + M + M	–	1:30	
	19	Helper	M		0:50	
	20	Operator	M	42	0:10	
	21	Helper	M	29	0:10	
	22	Operator	M	45	0:40	
	23	Operator	M	65	0:10	
	24	Operator	F	45	0:50	
	25	Operators	F + M	–	0:50	

Organization	Interview number	Role	F(emale)/M(ale)	Age	Interview time (h, min, rounded to nearest 10 minutes)	Observation time (h, min, rounded to nearest 10 minutes)
	26	Operators	F + M + M	–	0:40	
	27	Operator	M	–	1:30	
	28	Operator	M	–	0:50	
	29	HR manager	F	–	0:50	
	30	Process technician	M	–	0:40	
	31	Operators	F + M	–	1:30	
	32	Production unit manager, Operator, Operator, Coordinator	F + F + M + M + M	–	0:50	
Organization D	1	Team leader	M	61	1:10	1:20
	2	Team leader	M	53	0:40	0:20
	3	Team manager	M	52	0:40	0:20
	4	Operator	M	32	0:30	0:10
	5	Operator	F	50	0:40	0:20
	6	Operator	M	44	0:40	0:20
	7	Operator	F	53	0:30	0:10
	8	Operator	M	32	0:20	0:20
	9	Operator	M	44	0:40	0:10
	10	Team leader	M	53	0:30	0:20
	11	Manager quality and environment	F	41	1:00	0:20
	12	Manager supply unit	F	41	1:00	4:30
	13	HR manager	F	61	1:10	0:30
	14	Production manager	M	46	0:40	
	15	Plant manager	M	44	0:50	