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**What are the ‘practices’ in engineering practice?**

Anders Buch, Department of Learning and Philosophy, Aalborg University

Most will agree that engineering is a social and a practical activity. Engineers engage with all sorts of matters and in all sorts of situations of concern to us. As a professional group engineers play a significant role in dealing with the various technologies that play such an important role in our modern societies. Yet engineering is increasingly considered as a science – a theoretical endeavor that use abstract concepts and terminologies and often entertain idealized models to understand processes and the behavior of physical entities. So, although engineering is practical it is also highly theoretical – something that any engineering freshman can testify. This chapter will, however, not enter the troubled waters where proponents either argue that engineering is best characterized as a (theoretical) science or as (practical) craftsmanship (for a discussion along those lines see Pedersen 2014). Neither is it the ambition of this chapter to specify necessary and sufficient criteria of demarcation that separate practical or theoretical engineering from other activities such as e.g. doing physics. Instead I will discuss – on a fundamental and conceptual level – how we can conceive of and study engineering as bundles of social practices, i.e. as important activities, work, doings and sayings in the world. What will be of interest here is to investigate how we – as researchers – should understand the notion of ‘practice’ when we engage in the study of engineering. It is evident that engineering manifests itself through the dispersed and concrete activities of individual engineers. But what – on a conceptual level – institute these activities as engineering ‘practices’? What qualifies certain patterns of performances as engineering ‘practices’? Most of the chapters in this volume set out to describe and understand the dynamics of engineering practices – either in educational settings, work settings, or in the interplay between education and work. But what should actually be understood by ‘practice’ and how can practices be investigated? This chapter sets out to discuss these fundamental questions by drawing on resources from the intellectual tradition of practice theory.

**The Turn to Practice**

The practice theoretical tradition has grown out of anthropology, sociology, geography, history, philosophy and related academic disciplines that have an interest in understanding human action, agency and social activities. Still more scholars have focused on the day-to-day practices of actors in their studies. The turn to practice can be traced back to growing dissatisfaction with social explanations that draws heavily on either structuralist, individualistic or mentalist conceptions of human activity. Sherry Ortner (1984) has argued, “that a new key symbol of theoretical orientation is emerging, which may be labeled ‘practice’ or ‘action’ or ‘praxis’. This is neither a theory nor a method in itself, but rather […] a symbol, in the name of which a variety of theories and methods are being developed”. Practice theoretical approaches thus covers a broad heterogeneous assembly of theoretical positions within the social sciences that agree on shifting the focus of analysis from the individual actor, the isolated subject, bounded systems and representations of knowledge, symbols and ideational meanings to a mundane and practical realm. Practice theoretical approaches thus gives priority to the study of embodied actions, emotions, things, technologies, interactions, encounters, performances and actual use. On this very fundamental level the practice theoretical tradition is guided by Wittgenstein’s critique of representationalism, mentalism and dualisms (cf. 1953) – ‘meaning’ should rather be understood as ‘use’, i.e. embodied practices.

The turn to ‘practice’ can be identified in a number of academic disciplines. Philosophers like Theodore Schatzki (1996, 2002, 2010), Joseph Rouse (2007), Charles Taylor (1995) and Andreas Reckwictz (2002a, 2002b) have sketched out the fundamental ontological and epistemological presumptions of practice theories in relation to agency, the social, and society, and described how practice theories draw on philosophical insights from mainly the late Wittgenstein and the younger Heidegger, but also significantly the early Giddens, Bourdieu, Butler, and the late Foucault. In organizational studies, social scientists like Wanda Orlikowski (2000, 2002), Silvia Gherardi (2006), Davide Nicolini (2013) and others have theorized and analyzed the role of technology within organizational development and change, and learning theorist like Paul Hager (2012) Joy Higgs (2012), Jean Lave (1988, 1991, 2011) and Etienne Wenger (1998) have demonstrated how learning processes are best understood as transformations of and within practices. In another intellectual tradition, namely activity-theory, Yrgö Engeström (1999) and others have studied work practices and stressed the interplay with the material environment and the role of tools as essential features of human practices. The practice theoretical approaches have spread to other areas of research like consumption (Shove *et al*. 2012, Warde 2005), sustainability studies (Shove & Spurling 2013, Cohen et al. 2013), professionalism (Fenwick & Nerland 2014), marketing, branding and many more. In Science and Technology Studies (STS), practice theoretical approaches have appeared most notably in the works of Karin Knorr Cetina (1985, 1999) and Joseph Rouse (1996, 2002), but practice theoretical approaches are held in common with many STS approaches, e.g. in the traditions of ethnomethodology (e.g. Suchman 2007), actor-network theory, and other posthumanist perspectives (e.g. Pickering 1995). Several scientific journals have devoted special issues to the discussion of the new practice approaches within the social sciences (e.g. *Organization* 2000, *The British Journal of Sociology* 2002 and *Human Affairs* 2007) – thus practice theoretical approaches have come to the fore and significantly influenced contemporary social science. Many scholars have observed this impact and describe the increasing attention to social practices as a ‘practice turn’ in social science (Schatzki *et al*. 2001) or a ‘bandwagon’ of practice based studies (Corradi *et al*. 2010).

Also in studies of technical work and in engineering studies some attention has been given to the study of practices over the years. In a review article Stephen Barley (2005) traces the interest for investigating work practices in engineering and technical work back to Marxist concerns with de-skilling of professional work (notably Braverman (1973)) and to the Columbia Studies in the early 1980s that demonstrated that engineering work practices are immensely diversified according to national, organizational and labor market differences (e.g. Zussman (1985), Whally (1986) and Crawford (1989)). But it is only more recently – starting with publications dating from the 1990’s – that a line of studies have started to look more closely at the minute social as well as technical nature of engineering work practices using ethnographic methods of participant observation to unravel the situatedness and complexities of mundane engineering work practices. Bucciarelli’s (1994) study has investigated design practices among engineers using ethnographic methods, Henderson (1998) has look into how engineering work practices are underpinned by the use of drawings and other visual representations, and Vinck (2003) has traced the cultural and practical preconditions that inform engineering work practices. Other notable contributions have also used ethnographic approaches to account for how engineering cultures and practices transpire in everyday work environments (e.g. Downey 1998, Kunda 2006, Barley & Kunda 2004)[[1]](#footnote-1). But only recently Engineering Studies scholars have engaged in more explicit reflections on how to conceptualize and theorize engineering ‘practices’ (cf. Rooney et al. (2014), Johri (2014) Stevens et al. (2014), Buch (2014) and Buch in this volume). These attempts draws on the conceptual work done in the practice based studies outline above and sets out to theorize the dynamics involved in the (re)production and transformation of engineering practices. By theorizing engineering practices along these lines it is possible to highlight the complexities and socio-material heterogeneity involved in the activity of doing engineering. The practice theoretical approach thus offers a productive theoretical and methodological framework for studying engineering activities. In what follows I thus pause to unpack the central concept of ‘practice’.

**Practice(s)**

Although many differences can indeed be found there seems to be agreement within practice theoretical positions that human activities should be studied by focusing on routines, doings and (values in) use. ‘Practices’ – not symbols, meanings or structures – are thus seen as fundamental ‘carriers’ of social phenomena. In trying to understand how practice theorists construe the notion of ‘Practice(s)’ it is useful to reflect on Reckwitz’s distinction between different notions of ‘practice’ (2002, 249):

Practice (Praxis) in the singular represents merely an emphatic term to describe the whole of human action (in contrast to ‘theory’ and mere thinking). ‘Practices’ in the sense of the theory of social practices, however, is something else. A ‘practice’ (Praktik) is a routinized type of behavior which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, ‘things’ and their use, a background knowledge in the form of understanding, know-how, states of emotions and motivational knowledge.

Practice theorist study both ‘praxis’ and ‘praktik’, but it is essential to understand how ‘praxis’ and ‘praktik’ are related and how they differ. Schatzki (1996, 89-90) has spelled out the different notions. One sense of practice (i.e. that of ‘praxis’) denotes “…performing an action or carrying out a practice…”. In this sense individuals are carriers of practices because they *perform* specific patterns of actions and thus enacts the practice. But practices can also be seen as coordinated entities (i.e. as ‘praktik’). In this sense a practice is seen as a “…temporally unfolding and spatially dispersed nexus of doings and sayings.” Schatzki characterize practices further:

Examples are cooking practices, voting practices, industrial practices, recreational practices, and correctional practices. To say that the doings and sayings forming a practice constitute a nexus is to say that they are linked in certain ways. Three major avenues of linkage are involved: 1) through understandings, for example, of what to say and do; 2) through explicit rules, principles, precepts and instructions; and 3) through what I will call ‘teleoaffective’ structures embracing ends, projects, tasks, purposes, beliefs, emotions and moods. (1996, 89)

In this latter sense of practices it is an essential claim of practice theory that the performances of individuals are linked and interconnected in specific ways that forms durable nexuses of actions. The configurations of the actions – doings and sayings – can endure in time and space and thus ‘carry’ constellations of actions. It is important to notice that practices are not social structures that steer actions – on the contrary individual actions contributes to the (de)stabilization of patterns of actions by enacting the patterns or deviating for the patterns of actions.

I will shortly return to the organizing linkages of practices. But first it is important to make yet another distinction in relation to types of practices. As we act we constantly engage in different practices. Some of them are very common and appears in many (different) situations. ‘Calculating’ is an example of such an activity. It might be performed by individuals in mundane settings – e.g. in supermarkets where costumers are shopping for ‘best buys’ (Lave 1988) – or ‘calculating’ might be performed by highly specialized particle physicist in esoteric settings (Traweek 1988). What unites both of these instances of human performances into a common practice could roughly be described as the individuals’ ability to manipulate numbers, figures, symbols, etc. according to specific rules – say those of multiplication, division, subtraction and addition. A common understanding of what it means to ‘calculate’ holds the constituent actions together, although other circumstances – including the ends, purposes and beliefs of the actors – might vary significantly. These kinds of weakly linked practices Schatzki calls *dispersed* practice (1996, 91). Other sorts of more strongly linked practices can be characterized as *integrative* practices (Schatzki 1996, 98 ff.). Individuals engaging in integrative practices do not only share specific practical understandings about how to ‘go on’ in certain respects (e.g. to calculate). They also often abide to specific explicit rules, regulations and instructions of a domain, and they might also be united in upholding common perspectives, ends, tasks, projects, beliefs and emotions. This is the case in engineering practices. Let us turn to these integrative practices in order to investigate some of their key features.

**Social order and engineering practices**

As explained Schatzki broadly characterize practices as sets of doings and sayings (1996, chap. 4). Practices thus weave together bodily actions as well as linguistic utterances, gestures, etc., and subsume what in other theoretical traditions are labeled as behavior and discourse. What unites these actions and linguistic utterances into sets of doings and sayings are the specific tasks and projects that impose orderings of the actions. What makes us characterize a reading of a thermometer or the reporting of temperature increase as part of engineering practices are by reference to the tasks (e.g. doing experiments) and the project (e.g. developing enzymes) of which they are a part. Practices are thus composed as hierarchically ordered wholes that have certain duration in time. The regularity of the doings, sayings, tasks, and projects does not have to be constant over time in order to qualify as practice. Practices can change and innovate over time and it is a matter of empirical investigation to trace these changes as they unfold. But for doings and sayings to qualify as part of a practice it is essential that regularities can be detected and disruptions are outbalanced by continuities.

 Practices thus indicate that human activities are linked through certain *normative orderings*. One essential ordering element is the *practical understandings* of the actors. Actions are considered competent and qualified according to standards and procedures – mostly implicit and tacit by nature. The bio-chemical engineer who is engaged with the development of a new enzyme must know how to deal with experimental settings and among a lot of other things know how to read a thermometer. Furthermore she must be able to identify why and when it is appropriate to read the thermometer and how to respond to an increase in temperature in the experimental situation. She must be able to see things like an engineer (cf. Goodwin 1994) and frame problems and (research) questions accordingly. Practice theory emphasizes that these activities are founded in the practical skills and know-how that actors acquire through participation in practices and through drill. Practical understanding displays an ability of knowing ‘how to go on’ and having ‘a feeling for the game’, thus acting according to the prevailing standards of the practice. Bourdieu stresses (1990, chap. 4) that the acquisition of the skills is very much a matter of bodily incorporation and Wittgenstein highlights the importance of drill and training in learning how to follow rules and partake in ‘a form of life’ (1958, §218ff.). From a practice theoretical perspective it is important to understand the *processes of becoming* an engineer and understand how the practice of engineering is reproduced through learning and training activities. That might be in engineering schools and universities but also very significantly in work practices. In a practice theoretical perspective (engineering) practices thus only exists as continual (re)productions, accomplishments or performances in contingent settings.

 Another ordering element is the *explicit rules*, regulations, instructions, standards, and procedures that are pertinent for specific practices. Engineering is a profession that is regulated by professional bodies, legislation, corporate rules, standardization of equipment, safety procedures, etc. The institutional role of engineering as a profession in society is regulated through myriads of restrictions and allowances that shape and order the labor processes through e.g. the division of labor among professionals, and the incentive structures in wage or contract labor. These explicit regulations are very much based on conventions and bear huge national differences. But they are essential in shaping the practices of engineering education and work. Gary Downey and Juan Lucena (2005) for example demonstrate how the ongoing internationalization of engineering work has ramifications for engineering education and thus the formative training of engineers into the profession. In studying engineering practices it is however essential to pay attention to how local rules and procedures are enforced by legislation, organizational procedures of regulation and codes of conduct.

Schatzki sees *teleoaffective structures* as a third ordering element that links doings, sayings, tasks, and projects in practices. “[…] teleoaffective structures establish, inter alia, a field of correct and acceptable ends, a selection of acceptable or correct projects to pursue for the sake of those ends, a variety of acceptable or correct tasks to carry out as part of those projects, a range of acceptable or correct ways of using objects, and a variety of acceptable and even correct emotions, feelings, and passions.” (Schatzki 1996, 124).” The structures need not be explicitly conscious goals to, or ends in view for the actors, but should rather be seen as structural signifiers that give an overall sense to actions. Schatzki emphasize that these structures are recurring effects of actions and should not be conflated with structuralist accounts. Teleoaffective structures emerge when there is general agreement about what is acceptable or unacceptable to do in situations. The presence of teleoaffective structures does not exclude controversy or disagreement about specificities but provides an overall sense of purpose and direction for the activities. The structures both produce the practice and are produced by the practice. As an example teleoaffective structures are enacted in engineering practices when engineers sets out to operationalize and optimize processes of production and flows, when relevant factors are identified for calculation and when irrelevant circumstances of a situation is relegated from an experimental setup. Mostly it is not debatable what should count as respectively relevant and irrelevant circumstances. Engineers normally strive to eliminate ‘the human component’ in designs because human action is difficult or impossible to calculate. Thus a general purpose in most engineering practices is to frame situations and problems in ways that make them amendable to quantitative calculation and eventually instrumental manipulation according to specified means-ends relations. The imperative of prediction and control is thus pertinent in engineering practices and provide an overall normativized threshold for preferences and acceptable action. Deterministic models, repeatability, standardization, effectiveness, calculability, unambiguousness are goals, values and virtues that – on a fundamental level – inform engineering work and describes the overall teleology installed in engineering practices.

 A final ordering element relates to the *general understandings* that are available to and shared by actors within a practice, though these general understandings, as the word indicates, are not proprietary of specific practices, but are generally shared norms and values. However, they are also active in structuring specific practices. Engineers like all other members of a community endorse certain religious, ethical, ideological, or political norms. Many of these are codified in codes of conduct within companies or professional societies and associations (cf. Van de Poel & Royakkers 2011, chap. 2), but they need not be explicitly stated to be conductive. These general understandings thus often span different practices and can make them overlap at specific junctures in history.

These ordering elements of practices are not meant to be jointly exclusive or exhaustive characteristics. On the contrary the elements are combined in the doings, sayings, tasks, and projects of the practice in complex and interwoven ways. Thus the specific constellation of these – and maybe other – elements compose the uniqueness of the practice. Furthermore, practices are always situated in specific orders or arrangements that comprise both practices and non-human/material objects. The arrangements and the social practices thus jointly constitute the overall site where things exist and events happen (Schatzki 2002, p. 63). Sites are a special kind of contexts – namely the kind where practices unfold in activities and events. To put this point another way, sites are the kind of contexts where actors’ ends and human intentions matters. Sites are thus not only locations in objective time and space or even activity-place space, but they are also significantly teleological located. Sites are part of ‘wider scenes’ of events and activities. The bio-chemical engineers reading of the thermometer is an activity that is part of the event of the experiment. Likewise, the experiment is part of a project about the development of new enzymes, and this project, in turn, a part of a company’s ambition to develop new products that can increase profits, etc. Sites are thus nested. For an event or activity to occur within a site is tantamount to that event or activity being a constituent part of that context. Activities and events are thus both contained in the site, but also an integral part of the sites makeup. Finally, it is important not to regard the ordering elements as ontological entities. The ordering elements should rather be viewed as phenomenological constituents that render social phenomena intelligible and that helps us – as social scientists – better understand the dynamics and processes that lead to the emergence, persistence and dissolution of engineering practices.

**Engineering practices and material reality**

Engineering practices in a fundamental way revolves around material objects, tools and physical processes. As social phenomena engineering practices are thus affecting the world in all sorts of ways. Engineering practices shape technologies, manipulate material objects in physical and chemical constellations, intervenes with biological organisms and influence and affect other human practices. It is thus an essential feature of engineering practices to impact and change the physical environment to achieve favorable objectives. But it is certainly also the case that engineering practices are affected and shaped by material reality. To a large extent engineering practices have developed around specific physical and material phenomena and domains of purposive actions that relate to specific materials or physical principles – e.g. electrical engineering practices and chemical engineering practices. The materiality of an engineering domain is thus constitutive in more ways for shaping specific practices. The mere spatial size of the physical materials dealt with and the temporal unfolding of the processes in materials makes a difference for how diverse engineering practices are organized and the scientific principles, theories and methods adhered to in these practices. Work practices differ immensely for engineers dealing with respectively synthetic biology and civil engineering. For one thing the nature and character of the material domains dealt with are thus constitutive of engineering practices. In a quite obvious and banal sense you would not have electrical engineering practices without material equipment and apparatus that can measure voltages and you would not have chemical engineering practices without laboratories, minerals, etc. Secondly, engineering practices and material arrangements are related in the sense that the material arrangements becomes intelligible as objects for prediction and control through the engineering practices. The engaged and goal directed character of engineering practices brings forward specific features and aspects of material reality – namely those aspects that are of our concerns. Thirdly, material entities relates to engineering practices as resources that can resist or accommodate the practices during the course of research, experiment and other manipulative activities (Pickering 1995), and material arrangements can prefigure engineering practices in the sense that material arrangements can make it harder or easier, quicker or slower, more or less feasible to pursue lines of action and obtain certain objectives (Schatzki 2002). Finally, engineering practices and material arrangements are of cause related through causal mechanisms as when action affects material entities and visa versa.

Let me just elaborate a bit more on how material arrangements and engineering practices can be said to relate. In the literature there is no consensus as to whether material objects should be considered as a *part of* social practices or whether social practices are better construed as a social domain that *interacts* with material domains. Following Shcatzki’s account my narrative has opted for the latter stance. The nature of the interaction between material arrangements and practices can be construed in different ways, ranging from the perspectives of ‘technological determinism’ and ‘material determination’ on the one hand and variants of social constructionism on the other hand, where practices are conceived as self constitutive social formations. According to ontological preferences the relationship between social practices and material arrangements can thus vary. Schatzki takes a balanced stance when he describes the relationship between material arrangements and social practices as one of prefiguration. For material arrangements to prefigure social practices means that material arrangements affects social practices by “… the channeling of the physical causality that laces through the social site. (Schatzki 2002, 211)”. We can thus say that engineering practices – like any other social practices – are channeled by the physical occurrences that affect human activity and more specifically that engineering practices are affected by the interplay with physical objects in e.g. experiments, when engineers interact with apparatus, when materials do not ‘conform’ as initially predicted, etc. As engineering practices often try to engage with and change material arrangements engineering practices are thus also shaped by the interaction with physical objects. Materiality should thus play a significant role in our accounts of how engineering practice evolve, transpire and change.

**The dynamics of practices**

Although this anthology focus specifically on understanding engineering practices within work and education it must be acknowledged that these practices are always intertwined with other practices. Engineers are not only engineering students, engineering educators, engineering employees, etc. They are also men and women, people of race and ethnicity, family members, citizens, etc. In their daily lives engineers are involved in a plethora of practices – domestic practices, sexual practices, parental practices, recreational practices, etc. Engineering practices – like any other practices – are never found in isolation but always in conjunction with other practices. In a diachronic perspective engineering practices thus co-exists with and are partially dependent on institutional practices of wage labor, meritocratic practices found within educational institutions, scientific practices, etc. And in a synchronic perspective we can observe how people enter and leave engineering practices and how practices are transformed over time. In the course of an engineering career it is often seen how engineering work gradually transforms from being preoccupied with technical issues to gradually incorporating managerial issues; we can observe how people are initiated into engineering practices through education and/or work; and we can see people leave engineering practices when retiring or in order to pursue other occupational careers. It is also the case that people can partake in practices in a lesser or higher degree. By partaking in the discursive practices of engineering non-engineers can gain ‘interactional expertise’ and ‘pass’ as engineers although they do not have a diploma in engineering and do not (yet) possess ‘contributory expertise’ that enables them to do the job of the engineer (Collins & Evans 2007). Thus individuals can occupy more or less peripheral and central positions within practices (Lave & Wenger 1991) and their positions within practices can alter according to the path taken by their learning trajectories (Dreier 1997). Individuals thus partake in several practices simultaneously, enter and leave practices, and contribute to the transformation of the practices by their involvement. Practices thus in general both constitute the ‘medium’ in witch human activity transpires and structure human activity; and engineering practices forms subsets of the totality of practices existing in different sites.

An ample understanding of the dynamics of engineering practices must therefore consider how engineering practices are interwoven with, relates to and intersects with other significant practices and material arrangements. It must be understood how the normativities of regimes of engineering practices intersect with other regimes of mutual accountability – say in business practices or educational practices, and it must be understood how these practices interacts with material arrangements. The sway and territory of engineering practices can thus be concerned and identified by investigating liminal practices – cases where engineering practices are bordering on and negotiated in relation to other regimes of intelligibility and accountability. Engineering practices are thus always bundled up with other practices and material arrangements. If you step out of one practice you always step into another – practices are interconnected, bundled and forms a continuum of social activity. In this volume we are especially concerned with how engineering work practices and engineering educational practices are formed and intersects to constitute engineering practices. But it is important to recognize that this perspective necessarily must be partial, reflecting the research interest of our endeavors. Engineering practices are bundled up with multiple other practices in meshes of intelligibility structures that constitute the ‘worlds’ engineers live within – these worlds can only be discerned in partial ways. But it is important to stress that practice-based approaches are not concerned with the study of ‘life worlds’ *per se* and the subjective experiences of individuals that partake in the practices. The studies focus on the dynamics of the practices – how they emerge, develop, persist and dissolve as structural formations. Here individuals are seen as carriers of the practices. But without the individuals’ performances the practices would not be reenacted and no structural formations would be found. It is within these contingent and emergent formations of individual performances that social activity transpires and social orders are established, and it is here we can locate engineering practices.

The dynamics that mold the relations and interactions of individuals into social practices can manifest themselves in different forms. I have already sketched Schatzki’s account of how social orders emerge through the interplay of practical and general understandings, rules and teleoaffective structures. Changes in engineering practices can take place when the constellation between rules, teleoaffective structures and general and practical understandings change. The introduction of new rules for how engineering work is organized within a company can change engineering work practices (cf. Buch chapter X this volume), and the introduction of new projects, tasks and objectives to be pursued can affect the teleoaffective structures of practices and likewise result in transformations. It is often the case that changes in practices are set in motion by material innovations and the introduction of new technologies (though this is not a necessary cause for practices to change). The introduction of digital technologies severely changed engineering work practices and educational practices – certain skills and competences became obsolete and new ones became paramount, new principles and rules for work organizations appeared, etc. Thus changes in material arrangements can affect the emergence and evolution of engineering practices. But it is important to stress that the practice-based approach outlined here is skeptical to both ‘technological determinism’ and perspectives that construes social order in terms of pure processes of ‘social constructions’. Social practices and material arrangements should instead be understood as co-constitutive realms that intersect in seamless ways in situated everyday activities – certain engineering practices paves the way for technological innovations and transformations of material arrangements, and new technologies and alterations in material arrangements prefigure engineering practices in specific ways. Changes – as well as the preservation of – engineering practices must thus be understood as (re)configurations of the nexuses of human practices and material arrangements and researched by tracing the specificities of the morphing of the nexuses.

**Researching practices**

The practice theoretical approach in many ways sets a new agenda for our understanding of social phenomena, social order, how social phenomena relates to materiality and how change come about. Its refusal to frame social phenomena and human activity in the idiom of the Cartesian epistemology of ‘opposites’ has fundamental methodological consequences. The practice theoretical approach construes social phenomena and human activity in a thoroughly relational ontology that refuse to work within a binary framework of dualisms. Refusing to accept absolute demarcations between agency/structure, inside/outside, mind/body, rationality/emotions, theory/practice, nature/society, etc. as the point of departure for explanations the approach instead seeks to trace how these dualisms are instantiated and reenacted in social practices. In this perspective practices – understood as the realm of social performances and actions (the doings and sayings of actors) – should be the object of critical analysis and the researcher should not presuppose but instead try to explain how they are instituted in a social realm in the first place. Honoring this imperative means that it is not legitimate to presuppose ‘natural’ or ‘absolute’ distinctions between engineering and science, practical and theoretical work, technical and social elements, professionalism as opposed to craftsmanship, engineering education versus education in say communication, hard and soft skills, etc. In facts these dichotomies should be perceived as the explanandum of critical scholarly analysis. The study of engineering practices in work and education thus seeks to understand how the social categories and distinctions are constructed, reenacted and naturalized within a social realm. Social action and the performativity of the actors in the social realm is thus the object of investigation, analysis and explanation in the practice theoretical approach. Although of immense importance this general ontological statement of the practice theoretical approach does not give much methodological and practical guidance to the study of engineering practices. We need to consider in more detail how to approach and frame the study of human activity conceived as a seamless continuum of performances – doings and sayings. The social ontology outlined above must be supplemented by methodological considerations. If human activity and the social should be conceived in thoroughly relational terms, as I have argued, and if social reality should be conceived of as nexuses of practice-order bundles that are propelled and morphed by human and non-human doings – how are we to study this extremely complex, relational and intertwined mesh that transpires and extends almost indefinitely in space and time? Where should our research start and end and how should it be delimited in order to provide sound analysis and explanations?

As previously explained human activity transpires in social practices that are delimited in ‘sites’. Humans are engaged in social practices that are delimited and ordered by sets of rules, understandings, purposes, ends, directionalities, and normativities. In fact, engaging in practices is how the world is disclosed to humans – it is through engaging in practices that something becomes intelligible to someone as something. In this sense the understanding of human practices is a necessary precondition for understanding how social sites are established in the first place. If we – as social scientists – want to understand how engineering education unfolds as a social phenomenon we have to grasp how ‘engineering education’ becomes intelligible – and how the practices of engaging in engineering education is reenacted through engaging in social practices. Investigating these practice we have to ask questions about what makes actions purposeful: What the students want to obtain by enrolling in engineering education?; how faculty defines ‘engineering’ in the construction of the syllabus?; what economic and institutional incentives, rules and rationales that govern engineering schools and universities?; who has the authority to define what ‘engineering work’ is or ought to be and how they go about defining something as engineering work – as opposed to non-engineering work?; who are admitted to partake in engineering practices and who are excluded?; how does material arrangements and objectual practices (Knorr Cetina 2001) prefigure and propel engineering research and work? – and many more questions. In asking – and answering – these questions we discern the phenomenon under investigation by explicating the differential cuts of the actors that are involved in and who co-produce the practices. This hermeneutical endeavor brings forward the site by relating and positioning the social activities – doings and sayings of the actors – in a context.

The investigation of social sites is the objective of ethnographic research. In the tradition of anthropology ethnographers have studied ‘exotic’ cultures and documented the unfolding of rites and religious activities – but also to some extent the mundane practices of everyday life of natives as they expire in tribes and local communities. But it is only more recently that ethnographic methods have been brought to bear on western cultures. It is only with the upcoming of STS in the 1970’ies (e.g. Latour 6 Woolger 1979) and Bourdieu’s praxiological studies (e.g. Bourdieu 1975) that privileged social groups and domains within western culture (such as science, medicine and engineering), has been studied as mundane social activities. Here the mundane activities and practices of scientists, engineers and medical doctors were described and analyzed as social-material phenomena – but still only investigate in relatively confined and localize social spaces such as laboratories, research sites, etc. Since then anthropologists – followed by STS scholars – have argued that the study of modern dispersed and globalized cultures – as e.g. science and engineering – must transcend time, space and departmentalized understandings of sites in order to take into account the interconnectedness of ideas, discourses, power structures, commodities and people (e.g. Marcus 1995, Falzon & Hall 2009). To understand social phenomena in contemporary society the inter-linkages of all these elements must be taken into account and concrete procedures and steps taken by the actors to constructs these linkages must be traced and documented in detail. But also discrepancies, contrasts and the lack of connection between different – but maybe potentially related – sites are of importance in order to find out how social phenomena has emerged, maintained or dissolved. The actual methods used to unravel these complexities may comprise different empirical approaches such as interviews, participant observation, discourse and conversation analysis, policy-studies, etc. – juxtaposed in various ways according to the specificities of the sites under investigation. Among others Adele Clarke (2005) has recommended to use different methods in combination and that the researcher takes upon herself to pursue different avenues into and across the various sites to grasp the nature of the interweaving’s of the sites. The researcher could supplement and combine research strategies of ‘following the actor around’, ‘following the object, idea, process around’, ‘tracing discourses across time and space’, etc. What is of importance here is to understand how the doings and sayings of actors and the material arrangements that interacts with and prefigure the social activities interconnect and how this mesh is transformed in the course of time.

It is also important to reflect upon the role of the researcher in the study of practices and, furthermore, to what purposes the methodologies are considered to be used. What is it in fact that is being studied when we study practices and, secondly, for what purposes are the studies conducted? It is beyond questioning that engineering education and engineering professionalism is a domain of contestations and power struggles (Buch 2012) and any attempt to describe, explain or in any other ways discern what is going on in engineering education is in fact a plea and a vindication of a specific perspective or agenda. The researcher must therefore consider the consequences of her research and to which purposes the ‘results’ of the research might be brought to bear. Firstly, it is important to realize that the practice theoretical perspective is in fact a theoretical perspective. This does not mean that the practices investigated are a mere ‘projection’ of the researcher that is imposed on reality. Neither does it mean that social practices are brute ‘facts’ of social reality manifest independently of theoretical perspectives and methodological preferences. The practice theoretical perspective is in fact a theory-method package that implies/presumes a specific ontology. Secondly, ontologies are always normativized, perspectival and theorized conceptions (Rouse 2002, Barad 2007 – Ethico-epistem-ontolgies) that re-presents (social) reality in specific ways and for specific purposes. So, the researcher must consider what the produced re-presentations in fact sustains and counteracts – which balances of domination, suffering and resistance that are reenacted in making new knowledge claims and upholding/transgressing boundaries (Haraway 1988). The research situation thus inevitably positions the researcher in relation to the site under investigation and prompts her to situate the knowledge claims that are produced. The researcher studying social practices ought thus critically reflect upon (or diffract in Haraway’s terms) the research practices that she reenacts and ask questions such as: What are the effects and consequences of our interventions? Where do these research practices seem to be moving?, What differences might our stakeholders notice due to our research? What impact might our research have to the communities with/in which we are entangled? These are questions of politics, but also questions of research practices.

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1. For a review of the literature on studies of engineering practices see Buch & Jørgensen (2010) [↑](#footnote-ref-1)