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Elena E. Chebotareva

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ARTICLE

Engineers: Bridging the Gap between Mechanisms and Values

Elena E. Chebotareva

Department of Philosophy of Science and Technology, Saint Petersburg University, Saint Petersburg, Russia

ABSTRACT
Engineers managed to attract the attention of thinkers to their profession and become the protagonists of philosophical discourse. This article explores whether the philosophy of engineering can offer any persuasive help toward a definition of the engineer's 'essence', and considers whether a lack of agreement on this definition is really a problem. This study demonstrates the need to involve the context of social theories both in analyzing the prerequisites of the philosophical consideration of the concept 'engineer' and in the socially significant reasons for attention to this concept. The novelty of my approach lies in considering the phenomenon of 'technopreneurship' within the framework of the philosophy of engineering.

KEYWORDS
Philosophy of engineering; technopreneurship; professional ethics

Introduction

The philosophy of engineering can be distinguished from the philosophy of technology by the attention it devotes to the engineering community, its goals and values, distinctive features, history and professional ethics. In this context, Max Weber's understanding of the term *Beruf* in his *Wissenschaft als Beruf* may offer a contribution to the concept of the modern engineer. The engineer has specialized skills and the results of their execution are can inspire the invention of new things, promote values of freedom and responsibility, destabilize the relationship between the state and the individual, and thus have a broad ethical dimension.

While philosophical research in engineering has been vividly developed over last half of the century, a survey of the book series 'Philosophy of Engineering and Technology' (POET) leads us to the evident conclusion that there has been no agreement as to what comprises the 'engineer concept'. In the second volume of POET, the editor Ibo van de Poel (2009) noted that this volume demonstrates no agreement on the definition of 'technology and engineering *vis-à-vis* each other'. However, 'Most authors, nevertheless, seem to agree that engineering and technology are distinct topics'. A few years later the POET issues of 2015 or 2016 leave us with the same conclusion: from volume to volume we find only disagreements and attempts to write about different issues in engineering without defining what it means to be an engineer.

I plan to consider some contributions to the concept of the engineer and to estimate methods and approaches in use. My own approach considers the premises of the philosophy of engineering in the context of social theories. I explore whether the philosophy of engineering can offer any persuasive instruments for working with a notion of the engineer's 'essence', and assess whether it is really a problem to have no agreement on this definition.

CONTACT Elena E. Chebotareva e.chebotareva@spbu.ru Saint Petersburg University, 7/9 Universitetskaya emb, Saint Petersburg 199034, Russia

Michael Davis' Philosophy of Engineering

Besides different approaches to the concept of engineering, Michael Davis has tried to catch the 'essence of engineers' and its definition for decades, analyzing the professional artifacts inherent in this discipline and trying not to miss a single detail.

Davis argues that the concept of an engineer cannot be understood through the functions that engineers usually perform[1]. Instead, he uses what I call 'difference sensitive optics' which allows us to talk about the external and internal otherness of engineers outsides the frames of their working routine. Claiming that only differences should play a role, Davis (2009a) focuses on the question as to what makes, for example, architects today different from engineers. He examines the specialties of their project presentations and the comparative structure of their education, and then estimates the historical contribution to these differences. His approach in clearing up the definition was also used to identify the differences in the curricula of naval architects and engineers, and in a philosophical interpretation of engineering codes. In his article that examines engineering as a profession, Davis highlights the distinction between function, discipline, occupation, and profession (Davis 2015) and investigates how engineering began to be a profession. Thus, he writes that engineering was historically constituted in such a way that it became an occupation, which tended to attract gentlemen, and let them earn their living as gentlemen. Such an occupation, as Davis claims, 'was, or at least was intended to be, "a profession, not a mere trade or money-making calling"' (ibid). Emphasizing the dignity which engineering as a profession provided for gentlemen, Davis gives the following definition for a profession: '… a profession is a number of individuals in the same occupation voluntarily organized to earn their living by openly serving a moral ideal in a morally-permissible way beyond what law, market, morality, and public opinion would otherwise require'. The moral ideal Davis connects with is a significant public good, that in the case of engineering looks roughly like an improvement in the material condition of society (ibid).

This special dignity distinguishes engineers from their 'technological competitors'. Davis (2015) argues:

> Like a trademark, the term 'engineer' is valuable only so long as individual engineers generally confirm the expectation that that term invites. Once engineering's special standards became mere window dressing, not much time would pass before only a fool would employ an engineer.

In other places Davis is even more certain about the special value of naming an engineer: The nouns 'engineer' and 'engineering' are not mere descriptors but 'honorifics' conferring a desirable membership. They are 'party terms' like 'Christian,' 'democracy,' and 'profession' (Davis 2009b, 325).

Davis provides the term 'engineer' with such symbolic and social significance that one can compare his definition of engineering with the concept of 'vocation' developed by Weber. Weber, largely in his works such as *Politik als Beruf* and *Die protestantische Ethik und der Geist des Kapitalismus* elaborates the dichotomy between *Berufsmensch* (a man of vocation/profession) and *Fachmensch* (technocrats, specialists) and, Davis' sense of 'engineer' surely belongs to the first.

Arguing that the concept of an engineer cannot be captured through the consideration of practical functions, Davis likewise denies that a philosophical approach can help. He suggests: 'there can be no philosophical definition, that is, one that captures the "essence" of engineering (because engineering no longer has an essence)' (Davis 2009a). In the paper, Davis (2015) investigates the disciplinary origin of engineering, he concludes:

> Like other professions, engineering is self-defining … There is a core, more or less fixed by history at any given time, which decides what is engineering and what is not. This historical core is not a concept but an organization of living practitioners who – by discipline, occupation, and profession – are undoubtedly engineers.

In the article 'Defining Engineering from Chicago to Shantou' Davis attempts to prove that the distinctness of engineer's professional culture is so obvious that it may unite people above other social categories, such as nationality. He compares Chinese and American engineers (as an example he uses Chicago and Shantou) working in his/her own country and abroad, and comes to the

conclusion that 'Engineers were … identified by a common curriculum imparting a common discipline (a culture, that is, a shared way of doing certain things, the distinctive way of doing things we call "engineering")' (Davis 2009b, 336–337).

An epistemically meaningful definition of engineering obviously should be a universal one, and Davis suggests that it is connected to a professional ethics presented in written or unwritten codes.

> Codes of engineering ethics, even those adopted by national engineering societies, typically apply to 'engineers' (without qualification), not to 'American engineers,' 'German engineers,' or 'Japanese engineers.' The codes are also quite similar. The explanation for that unexpected indifference to categories that most would consider important, such as nationality, should now be clear: engineers are engineers the world over – defined by a common culture (Davis 2009b, 336).

Definition as a Problem

It is difficult to argue that any field of research implies an understanding of what the main object of research is. It seems that without a general understanding of what it means to be an engineer we are doomed to rely on various concepts and fundaments and hence lose a common referent when we argue for what it means to practice engineering. For example, such researchers as Carl Mitcham and Robert Mackey have proposed a linguistic and philosophical approach to defining engineering.

> Engineering might be better determined by how the word 'engineering' and its cognates and associated terms (such as invention, innovation, design, technology, science, etc.) are used, especially in relation to each other. From a linguistic philosophical perspective, it would be appropriate to begin not so much with our experiences of engineering but with the words we use to talk about such experiences (Mitcham and Mackey 2009).

Obviously, these researchers, like many others, associate 'engineering' with 'invention' and 'innovation'. But this doesn't mean that such representation cannot be disputed. In the POET book of 2016, we find the proposition that 'the engineer's domain should therefore not be understood as a closed sphere containing innovation, but rather as a surface organizing the environment in ways that makes it possible to address change as innovation' (Fritzsche 2017). Albrecht Fritzsche (2017), claiming that innovation proceeds as an evolutionary process, supposes that engineers are only 'silent partners' of this. 'Some open innovation initiatives explicitly seek momentary enlightenment in collective experience, reminiscent of Nietzsche's description of the Dionysian. Rational planning and systematic procedure on the basis of professional training seem far away'. Should we associate engineering with the process of innovations, or do engineers play a rather modest role along with other technicians in the great theatricals that we call 'technical progress'? In order to answer that, we have to ask how we can distinguish engineers from their 'technological competitors' which Davis claims do not fit the engineering concept (which is not cleared up yet) and who probably do not really describe their professional experience using the words 'invention and innovation'.

Fritzsche presents the problem of engineering in the spirit of continental philosophy and associates engineering with technology. He tries to understand the essence of technology through the concept of determinacy as well as through negation and a transcendental type of reflection. 'Technology as determinacy is established on a background of indeterminacy; and the actor who does this is the one we call engineer. Engineering, we could say, is always engineering determinacy' (Fritzsche 2017, 309). The final conclusion of Fritzsche is that technology will never be everything, but as soon as there is something, we can consider it technology (since we start to specify the denial and change its negative meaning into something positive, it will become something we can interpret as technology) (Fritzsche 2017, 312).

However this conclusion, to my mind, might highlight some aspects of the philosophy of technology, but does not aid in solving the problem of the concept of an engineer. In the case of such an approach, I would agree with Davis that we hardly grasp the engineering concept by means of classical philosophy. At least through the concept of determinacy, negation and a transcendental type of reflection we hardly can distinguish technology from engineering. On the other hand, if we

follow Davis' idea to apply such a philosophical definition to engineers that lets us distinguish them from other technologists, we are probably demanding too much from philosophy. As Davis noticed himself, engineering has 'a core, more or less fixed by history at any given time', so it seems as though the methods of social science could provide us with a material basis more reliable than that of philosophy.

Evidently, we cannot get over disagreements about the concept of the engineer. ('Any definition of engineering … is, I think, plainly in deep trouble', Davis 2015 concludes.) Taking into account all these contradictions, I want to raise the question whether it makes any sense to continue these studies in the philosophy of engineering. I suggest that we must substantiate the benefits that philosophy will presumably attain by continuing to work hard on defining 'engineers' (and what benefits such attainments might bring to engineers themselves). The researchers Mitcham and Mackey partly answer this question arguing that philosophical investigation can lead to changes in engineering: 'Perhaps it would be more accurate to say that we aim to change engineering by attempting to understand it philosophically, that is, by introducing engineering into philosophy and therefore, however indirectly, by insinuating a measure of philosophy into engineering' (Mitcham and Mackey 2009). Nevertheless, they rather talk about the philosophy of engineering and technology in principle, not trying to distinguish engineers from 'other technologists'.

I think it is important to pay attention to the emergence of the question of the engineer in a philosophical context. Was this question a consequence of the internal logic of the development of the philosophy of technology, or was it imposed in connection with certain social and technological transformations and had an external nature? Of course, we remember the words of Imre Lakatos that 'Philosophy of science without history of science is empty; history of science without philosophy of science is blind' (Lakatos 1971, 91). In this case, we can replace 'science' with 'technology', meaning that philosophy must submit all the heroes of the history of ideas to its scrutiny. In our time, engineers are becoming such heroes, but one question concerns me: do they really bring us new ideas related to the technological future, or do they just end up being held hostage to political rhetoric, social expectations and economic demands? I think this question is philosophical, but its consideration demands attention to the history of the issue, that is, the broad context of the social sciences, without which the philosophy of engineering would remain empty.

What makes engineers the heroes of modern history and the subject of new directions within the philosophy of technology? While the philosophy of engineering is torn with doubts and controversy, there is one sphere that has been developing rapidly – engineering ethics (Davis 1991). The reason is rather clear, for example, as Mitcham and Mackey noted 'one of the major challenges facing engineers and non-engineers alike concerns figuring out what constitutes the ethical responsibility of those who practice and those who benefit from engineering' (Mitcham and Mackey 2009).

I suggest that the philosophy of engineering aims to determine the figures and domains which would be in some way responsible for the consequences of technological progress since the institutes of professional ethics are not sufficient for our contemporary condition. Nowadays scientific and political discourse is putting demands on 'responsible innovation' (Guston et al. 2014) and accountability on the part of engineers (Johnson 2017). The idea of responsibility and accountability of those who nominally manage the technical interface of global transformations seems quire amenable to society and gives the hope that our future on the road of technical progress is under steady hands. Thereby the definition of the 'engineer' concept becomes essentially important.

Social Context of Engineering. The Heyday

We have come to the conclusion that social inquiry is the prior context for the philosophical study of engineering. Obviously, the philosophy of engineering is associated with the sociology of professions and the problems of professional ethics while local historical contexts in their comparison to

global trends are also important. This article is not devoted to lengthy historical digressions, so I will touch on only a few fundamentally important milestones.

The first of these is the entry of engineers onto the historical scene as a progressive productive force, ensuring economic growth at the turn of the nineteenth and twentieth centuries. This historical moment is reflected by Thorstein Veblen (for example, in his work *The Engineers and the Price System*, originally published in 1919), where engineers were presented as the principle agents behind the overturns that could be expected of the twentieth century as a class able to use the fruits of technological development for the benefit of public reorganization and the achievement of economic efficiency. Yet Veblen (2001, 63) also saw that they were being suppressed under the 'businesslike control' of the industrial system: 'The experience of the past few years teaches that the usual management of industry by business methods has become highly inefficient and wasteful, and the indications are many and obvious that any businesslike control of production and distribution is bound to run more and more consistently at cross purposes with the community's livelihood, the farther the industrial arts advance and the wider the industrial system extends'. The situation will only get worse, Veblen (2001, 63) believes: '… it is to be admitted, regretfully perhaps, that with every further advance in technological knowledge and practice and with every further increase in the volume and complexity of the industrial system, any businesslike control is bound to grow still more incompetent, irrelevant, and impertinent'.

Taking into consideration Veblen's views presented in different works we can see that engineers for Veblen are figures to whom he assigns a certain role based on his philosophical positions. Therefore, he does not seek to separate engineers from other technologists, as Davis does. For example, in *The Engineers and the Price System* he writes:

> But these specialists in technological knowledge, abilities, interest, and experience, who have increasingly come into the case in this way – inventors, designers, chemists, mineralogists, soil experts, crop specialists, production managers and engineers of many kinds and denominations – have continued to be employees of the captains of industry, that is to say, of the captains of finance, whose work it has been to commercialize the knowledge and abilities of the industrial experts and turn them to account for their own gain (Veblen 2001, 39).

Thus engineers in Veblen's understanding are 'specialists in technological knowledge, abilities, interest, and experience' and their most important role is to be a class that is opposed both to 'The Guardians of the Vested Interests' and to the leisure class, at the same time being the real productive economic power. But this concerns only productive engineers, whereas engineering consultants and efficiency engineers in Veblen's theory are more likely to serve business and predatory purposes[2].

Along with Veblen, on another continent the first Russian philosopher of technology and engineering, Peter Engelmeyer developed his concept of the engineer. He wrote in his work 'In Defense of General Ideas in Technology' (Engelmeyer 1915): 'Life itself, and history with it, are irrevocably moving forward that true creator and manager of the economy – the engineer. He is being thrust from his workshops into the social arena and ever closer to the helm of state. And should we allow ourselves to follow in the footsteps of wise Plato and dream of the perfect state, then it shall be easy to arrive at the conclusion that … in the modern state the foremost position must irrevocably be held by the engineer …' Engelmeyer connects the concept of an engineer with the concept of an inventor and wrote a lot about technical creativity, invention and related problems (patenting, for example). Thus, in 1897, he published a guide for inventors *Inventions and Privileges* with appendices, including the law on privileges and additions to it, as well as instructions for its documentation. It is curious that, in place of a preface, Engelmeyer included an approving letter addressed to him by the great Leo Tolstoy.

Engelmeyer, like Veblen, considered engineers to be most progressive class capable of good governance. Engelmeyer thought of engineers as people with a vocation for creativity, discoveries and innovations; but although he wrote quite a lot about it, he did not introduce the concept of innovation into his scientific work.

Joseph Schumpeter, a contemporary of both Veblen and Engelmeyer, in *The Theory of Economic Development*, argued that in a developing economy innovation plays a key role, prompting the new business to replace the old (this process Schumpeter later called 'Creative Destruction'). Schumpeter was probably the first who coined the concept of innovation in the discourse of economic theory and also brought in a new actor – an innovator to the historical scene and tried to characterize him. Schumpeter's innovator (he called him an entrepreneur) does not necessarily make a profit, although he is solely involved in its creation (profit goes to the owner of the enterprise, just like rent to the owner of the land). His main motive is the desire to struggle and the desire for success for its own sake. He is a typical upstart, devoid of tradition and following a special spirit – *der Unternehmergeist* (entrepreneurial spirit). Despite the temptation to ascribe the *Unternehmergeist* to innovative engineers, it should be noted that Schumpeter did not share Veblen and Engelmeyer's technocratic views. In his theory, Schumpeter, like Veblen, draws attention to the confrontation of engineers and economists, that had been observed in the form of personal contradictions between the technical and commercial management of the enterprise. However, Schumpeter believed that in practical life purely technical issues should recede into the background in comparison with economic ones if they collide with the latter. Schumpeter (1934 2008)) suggested that expediency ultimately dominates both in technical and economic production, and one can explain the differences between them with regards to the difference in the nature of these expediencies.

The theories presented here have their drawbacks, but, in my opinion, as a composite whole, they give a completely objective assessment of engineers as a class that received special status at the turn of the twentieth century.

The Overthrow of Engineers and the Problems of Professional Ethics

Around the middle of the twentieth century, engineers ceased to be regarded as a class ready to stand at the helm of power, and their professional independence declined markedly. Edwin Layton, in a study of engineers during this period, points out that, contrary to Veblen's assumptions, the main problem of engineers is not with capitalists but with the former's relationship to bureaucracy. The dilemma lay between professional independence and bureaucratic loyalty. Likewise Layton (1962) suggests that it is unacceptable for engineers to play the role of 'revolutionaries'.

This new position has significantly affected the most substantial aspect of the concept of engineer – professional ethics. To argue this thesis, I turn to one of the most influential works in the social sciences – Merton's *Social Theory and Social Structure*, where it concerns engineers from an altered position. Since we have devoted attention to the importance of definition, we most note how Merton addressed this topic. The vague and ambivalent definition of engineer also poses a problem for sociological analyses, but Merton defines engineers by means of their functions (a definition Davis disagrees with) because in his theory the final implications play the major role.

> The large and multifarious family of men called engineers have a far-flung kinship, but they also have much that marks subgroups off, each from the others. There are military, civil, mechanical, chemical, electrical, and metallurgical engineers, and so on down through the hundreds of titles found among the members of national engineering societies. But whatever their specialty, so long as they are concerned with the design, construction, or operation of the equipments and processes of production, they are confronted with social and political implications of their position in our society (Merton 1947, 621–622).

According to Merton, there are three obstacles which prevent engineers from recognizing the social and political implications of their position: (1) the marked specialization and division of scientific labor, (2) the applications of professional codes governing the social outlook of engineers, and (3) the incorporation of engineers into industrial bureaucracies (Merton 1947, 622).

Briefly stated, the intensified division of the labor between 'scientist' and 'engineer' has served to relieve them from the social responsibility for their work. (Merton 1947, 622–623) notes: 'The occupational code focuses the attention of engineers upon the first links in the chain of

consequences of technological innovation and diverts their attention, both as specialists and as citizens, from succeeding links in the chain as, for example, the consequences for wage levels and employment opportunities'.

Agreeing with Weber and Veblen, Merton (1947, 82) notes: '… the danger that this occupational perspective, involving the rationalized abdication of social responsibility in favor of that of the administrator, may be transferred by engineers beyond the immediate economic enterprise. From this transference of outlook and the resulting trained incapacity for dealing with human affairs there develops a passive and dependent role for engineers and technologists in the realm of political organization, economic institutions, and social policy.'

Merton's conclusion is similar to that of Mitcham and Mackey who suppose that philosophical studies can lead to changing engineering: 'by introducing engineering into philosophy and by insinuating a measure of philosophy into engineering' (Mitcham and Mackey 2009), only Merton proposes insinuating a measure of sociology into engineering. Merton suggests a social research program, the familiarization with which would help engineers understand the issue of their responsibility, a need that they do not yet recognize. Only when those equipped with the skills of social research make available an adequate body of scientific knowledge can those working with the skills of engineering extend their sights from the individual business enterprise to the larger social system. (Merton 1947, 83).

Modern sociologists are still guided by Émile Durkheim's initial position in discussing most cases of professional ethics and morality. Durkheim believed that professional groups are the only significant institutional actors capable of effecting moral regulation in a capitalist economy and moral regulation is not based on external disciplinary coercion, but on general ideas and ways of thinking shared by members of the professional community (Abramov 2018).

It is obvious that, historically, professional ethics and morals have formed differently in different types of states. Thus the moral foundations of professional activity in countries with a continental model of professionalism were formulated by the state and professional ethics is tied to bureaucratic principles (Abramov 2018). For example, French researcher Christelle Didier (2009) notes that engineering ethics '… created in the United States in the 1980s, has since developed in other countries, starting with countries where the professional organizations have a code of ethics. In France, this concern is novel and faces some specific problems: it is not well understood. While some observers question its theoretical foundations and methods, others simply doubt that the engineers' professional activities may raise specific ethical questions'.

The difference of national traditions is reflected in modern approaches to professional ethics, giving rise to contradictory assessments. 'Traditionally professions secured (or at least asserted) public trust by virtue of their professional status (body of knowledge, extensive training, extra-moral ethical standards). However, the reports cited above suggest that the traditional claim to work for the benefit of society, by which professionals secure social status, no longer has credibility' (Fawkes 2012, 119). Currently interpretations of professional ethics tend to reflect the split between approaches to professionalism, which Sciulli (2005) calls functionalist and revisionist; the first consisting of those who see professions as maintaining status quo and playing a positive role in social development (such as Durkheim and Parsons) and the latter who follow Weber in critiquing these claims and perceiving professions as bureaucratic mechanisms to promote exclusivity and monopolistic practices (Larson, Johnson, Friedson, for example). (Fawkes 2012, 119). 'Functionalists can be said to envisage professional ethics as embodying the profession's commitment to social value and also to offer a protection for ignorant clients. Revisionists see professional ethics as empty and self-promotional. Most codes are constructed by the former group, setting out criteria for the ideal-typical professional. But, as Larson points out, the display elements of the ideal-typical constructions 'do not tell us what a profession is, only what it pretends to be …' (ibid). Didier (2009) adds: 'They [codes of ethics] can also be seen as a strategic tool to defend the corporation's interests'.

The Anglo-American model of professionalism is usually associated with a functionalist approach (Abramov 2018). This model thus creates certain prerequisites for a philosophical understanding of

engineering ethics codes. Probably this premise can explain Davis' position by emphasizing the role of professional ethics in the engineer's essence, which can help us to define engineers. For example, comparing American and Chinese engineers, Davis writes: 'a code of ethics might be implicit in the technical standards all engineers share. Such an implicit code would be "unwritten" (in the sense of not being written in a single short document called "a code of ethics") and yet in writing (that is, written into all those formal technical standards)' (Davis 2001, 334). However, the Chinese engineers may have quite a different code as China belongs more to the group of countries with a continental model of professionalism still strongly influenced by the position of the state.

For example, Gui Cao, a Chinese researcher, describes his understanding of engineering ethics as 'a multiplayer game effected at various levels among (a) lower level technicians and engineers, ...(b) middle ranking engineering ethics education, . . . the philosophy of technology; and (c) top national and international technological policies' (Cao 2015, 1630). Cao points out that '. . . engineering ethics education has not been accorded proper attention in China. As the subordinate of "Two Courses" (Marxist theory course, ideological and moral education), engineering ethics have not achieved the status of an independent discipline' (Cao 2015, 1618–1619). 'Admittedly, engineering ethics differs in China and the US because of different historical backgrounds, philosophical views, cultural traditions, religious heritages, and political tendencies' (Cao 2015, 1632).

In addition, even in the same country engineers are a diverse group that can be divided into separate communities each with their own ethical responses to the professional model. There have been a number of studies on gender differences and their ethical implications, but we still find a number of differences that need to be explored. These include the issue of engineers with autism (ASD) as well as their researchers with the same diagnosis; a virtue-based approach to engineering ethics has the potential to isolate individuals with ASD and to devalue their contributions to moral practice (Furey 2017).

Of course, the spectrum of engineering ethics study in social theory is much broader than that presented here, and is associated with a wide range of issues of research theory and practice: the problem of measuring professional ethics, its correlation with universal human morality and connection with human biological nature, and so on. Nevertheless, I believe that in this section I was able to show the role of the social sciences in understanding the essence of the engineering profession, in that it is primarily determined by the historical and social context underlying our philosophical judgments. But this circumstance does not diminish the role of philosophical judgments, since they, in turn, indirectly and implicitly influence this socio-historical context.

The Second Coming of Engineers

It is obvious that sociologists do not have a problem with the conception of 'engineer' as such, and so they make no effort to precisely determine what distinguishes this profession from other technical ones. If sociologists need to clear up some features of engineering ethics, they (at least in Russia) more or less follow Merton's definition: engineers for them are those professionals concerned with the design, construction, or operation of equipment and processes of production, and they are confronted with social and political implications of their position in society. (Abramov 2016, 98)

With this in mind, I would like to question the extent to which social sciences and philosophy of engineering coincide and differ in their aims and goals, whether they are occupied by the same object of investigation, and why philosophers around the world so vigorously argue with each other about the essence of the engineer.

When the professional independence of engineers was suppressed by the economic and bureaucratic pressure in the middle of the twentieth century, and few expected to see them in the vanguard of a global transformation, it would seem that the interest of philosophers in engineers would subside. It would seem that technocrats of all stripes had given up hope for engineers to be the progressive force of history, capable of ruling the world through reason and impartiality. But engineers again managed to attract the attention of thinkers to their profession and become the

protagonists of philosophical discourse. What are the reasons for this 'return'? I suppose that this is due to the increased role of technology in the world and, most importantly, to the nature of technologies that are changing habitual institutions and social structures.

If we generalize as much as possible, the technologies of the past worked for the sake of the State, while modern technologies can work against its integrity and potentially against such a world order when a society entirely depends on the State and all its violence and coercion. For example, the introduction of such an innovation as blockchain technology may make it possible in the future to reduce the role of the State and to start the formation of free autonomous communities of a new type. The researcher Brendan Markey-Towler (2018) examines anarchist utopian theories that may finally acquire reality through the capabilities of blockchain technologies and allow us to rethink the relationship between the person and society. Due to the fact that it is possible to create, store, transmit and correct information beyond the interests of the state and ensure full transparency, the necessity of the state in the life of society is called into question. Markey-Towler believes that this problem can be solved by the creation of free institutional systems operating on a competitive basis and open to all. Blockchain deals primarily with moral obligations, which can restore relations between institutions and the state. Using the blockchain provides an opportunity for a community of Internet technologies developers to demand a new level of human rights recognition, to realize civilian intervention in areas where military intervention is deemed inappropriate (Hughes 2017).

The links between science, government and business in the modern world are transformed and engineers are likely to find a new position in it. But are these really the professionals we can call 'engineers', or should a new definition be invented for the influential new class of professionals related to key technologies and advanced innovations? Such a definition is already known and it was formulated by Schumpeter's logic who, in his day resolved nearly the same problems in the search for a new concept. Modern social sciences use the concept 'technopreneur' which apparently indicates a direction for new economic and educational strategies. Some researchers have sketched out a rough portrait of the technopreneur as an academic involved in technological development with grants used to validate the commercial prospects of their innovations as well as a business person involved in technically intensive activities outside of their main source of employment (Dottore and Kassicieh 2017). Technological entrepreneurship is recognized as a key driver of successful technological innovation (Petti and Zhang 2014).

Should we distinguish between engineers and technopreneurs within the framework of the philosophy of engineering? I am sure that the phenomenon of technopreneurship has become a new step towards technocracy and the return of engineers to their high positions at the beginning of the twentieth century. Now we cannot assert that the technical part of an enterprise is an antagonist to the commercial part; technopreneurship looks like the synthesis that removes these antitheses. Does this mean that engineers and technical specialists change themselves, acquiring commercial competencies that were not inherent to them before? At least one study shows that this is not the case, and knowledge of the market is completely unnecessary to the engineer-innovator, and to some extent even harmful.

> Prior knowledge of ways to serve markets and technology knowledge were the best predictors of innovation. However, the results are curiously counterintuitive – while technology knowledge was positively correlated with innovation radicalness, knowledge of ways to serve markets was negatively correlated. This suggests that knowing less about ways to develop and package a future product or service at discovery may be advantageous for creating frame-breaking innovations. Individuals who know less about customer problems and lack knowledge of ways to serve them, yet have heightened technology knowledge at discovery, appear best positioned to create breakthrough innovations (Marvel and Lumpkin 2007).

Conclusion

This study is certainly one way of telling the story of engineers, but not the only one. I believe that I was able to convincingly demonstrate the need to involve the context of social theories both in

analyzing the prerequisites of the philosophical consideration of the concept 'engineer' and in the socially significant reasons for attention to this concept. Within a philosophical point of view, modern engineering ceases to be a means (this role is assigned to everything 'technical') and acquires the character of a goal. Engineering knowledge becomes the pure embodiment of power in the Nietzschean sense. Therefore, all professional areas that have a pronounced influence on society and a potential to do so are called 'engineers': bioengineering, social engineering, and others. Accordingly, the issues of professional ethics cause concern and bring the field to a new level of discussion.

I propose that philosophers of engineering have no burning need to determine an exact and universal definition of the 'engineer'. Besides, I am merely following the ideas of John Law who supposed that we cannot get clear and accurate results by exploring a reality that is vague, multiple, heterogeneous, and uncertain in nature (Law 2004). It is much more important to answer the question as to why this concept is interesting to us, whether it has any intrinsic meaning within the domain of philosophy, and why we may consider it necessary to differentiate the philosophy of engineering from the philosophy of technology. Or are philosophers, in the spirit of Weber' criticism, trying to *enchant* themselves with the concept of 'engineer'?

Notes

1. The first, to equate designing, building, or the like with engineering makes distinguishing engineers from other technologists impossible. Second, to equate engineering with designing, building, or the like gives a misleading picture of what engineers in fact do (Davis 2009a).
2. Edwin Layton has criticized this position (Layton 1986, 111).

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Notes on contributor

Elena E. Chebotareva has a PhD in philosophy and is an associate professor in the Department of Philosophy of Science and Technology in the Institute of Philosophy at the Saint Petersburg University. She teaches Philosophy and History of Science and focuses on topics in the Social Epistemology and STS issues. She is currently carrying out research on the revolutionary transformations in science as a factor of innovation processes. She is a board member of Russian Society for History and Philosophy of Science. e.chebotareva@spbu.ru

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