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THE ENGINEER AS AN EDUCATOR: GOODS, VIRTUES, AND SECONDARY PRACTICES

Abstract. How should ethical standards be maintained within engineering and engineering education? The present paper addresses this question with relation to the dominant models of engineering ethics (EE) to show that their limits might be overcome by incorporating the vocabulary of neo-Aristotelian virtue ethics. On the basis of the MacIntyrean concept of practice, the secondary role of engineering is highlighted which echoes similar debates concerning education. This similarity is picked up to argue that the role of the engineer in relation to the end-users of their projects should be understood as on a par with the teacher-student relationship. This enables us not only to redefine the internal good of engineering and the ground for EE, but also to indicate the key virtues and educational models for engineering that they should be key parts of.

Keywords: engineering ethics, ethics of technology, moral education, virtue ethics, Alasdair MacIntyre.

With the rapidly growing role of information processing technologies in business, government, and everyday life, as well as with increasing technicization of virtually all areas of life, the moral education of engineers and the effort to develop their sense of the social significance of their work is of the utmost importance. However, existing models of engineering ethics (EE) are limited both in their ability to set comprehensive normative standards that allow to engineering a social role, and in their rhetorical forms of organising the moral orientation.

The present paper outlines an alternative model of EE. I argue that in order to maintain ethical standards as inherent to engineering, a revision of the shared understanding of its place in the system of human activities is required. My argument for this is threefold. I start with a brief discussion of the main models of EE in order to show their dependence on limited accounts of engineering activity. As a remedy, I turn to virtue ethics, and especially the version of it formulated by Alasdair MacIntyre, to highlight the possibilities it offers as a framework for an alternative imaginary of the social embeddedness of engineering and a way of articulating the social and moral bounds of engineers. This is followed by a brief interpretation of this framework which is focused on the similarity between the roles of engineers and of educators, which enables expression of both a set of moral and social commitments, and a range of moral standards expressed as virtues. That is, on the basis of the concept of 'secondary practice' a similarity between teacher-student and engineer-end user relationships is noted, which enables us to extend the scope of both EE and engineering education.

1. Which engineering? Whose ethics?

Instructions within EE codes are typically of two kinds and focus on the engineer as a member of a professional community, or on engineering's social responsibilities (for an overview of EE, see Bowen, 2010, pp. 136–137). The former, focused on standards of credibility, integrity, and the dignity of the profession and its development, as well as on providing career opportunities and supervision for young professionals (e.g., American Society of Civil Engineers, 2020), develops rules that are aimed primarily at sustaining the market position of engineers. It also highlights the significance of engineers' relation to the end users of their projects and the asymmetry of knowledge, and hence power and responsibility, between them. It focuses on the engineer's conduct and the commitments they bring to the profession and extends their performance beyond the rules of the market relationship. As the complexity of life increases, it cannot be reduced to some fixed set of rules, and typically involves an outline of a personal ideal, an image of a perfect professional, that is, which serves as a point of reference for those in doubt (Martin & Schinzinger, 2005, pp. 7–8).

It might be argued that, seen along such lines, EE mirrors the neutrality view of technology (for an overview of recent literature and discussion of this view, see Newberry, 2023). It focuses on the engineer's professional allegiance to the engineering community, and to the clients, and on the personal, human factor he or she brings to their social and market role. Thus, in fact, it is aimed at two goals. The first consists in preserving the engineer's own autonomy as a person and their right to be protected against intrusion from clients, organisations, and the economic environment. The second builds on recognition of the asymmetry of knowledge, and hence power, between the engineer and the client in shaping the end product, and lies in taming the influence of flaws in individual engineers which could affect the satisfaction and lives of clients, and consequently the social recognition of engineering as a distinguished profession. Note that what underlies both these is an attempt to sustain a balance between the dynamics of the profession triggered by the individuality of the people involved in it and the possibilities of its development, and the rights of clients, respectively. Therefore, it focusses on the engineer as a person, and as a moral and social agent, rather than on the long-term consequences of the implementation of their designs. Thus understood, EE, for which codes of professional conduct are the prime method of framing moral standards (see Martin & Schinzinger, 2005, pp. 32–52), focuses on highlighting the responsibilities of engineers as professionals (Smith, Gardoni, & Murphy, 2014) by appealing to their own professional self-recognition, or by including the education in sensitivity of future engineers in their training programs (van Grunsven, Stone, & Marin, 2023, van Grunsven, Marin, Stone, Roeser, & Doorn, 2023).

In contrast to this, the second kind of attitude within EE is focused on the social consequences of engineering activity, with special attention given to the accountability of engineers to the general public and the priority of safety, public well-being, and the public good. Within this framework, engineering is recognised as not only a profession and vocation, with standards of technical excellence, a social role, and the aspirations and modes of personal development typical to it, but also as a social practice (aside from being a [part of] business), which brings important changes to the society that range far beyond the designer-client relationship. It highlights both the standards of safety of those engineered objects that have been long adopted in the life of a society, and innovations with unknown consequences. This undermines the profession-limited scope of EE. For with the growing importance of technology in organising social life on a large scale, and its transformative influence on both the professional and private lives of virtually all human beings, the morally conscious engineer cannot avoid facing questions concerning the influence of their actions *qua* engineer, and their products, for the society as a whole. That is what makes Martin and Schinzinger (2005, pp. 88–115) frame engineering as 'social experimentation' and build its ethical requirements in analogy to those of medical experiments. However, this analogy seems to be more far reaching. For technological innovations *are* social experiments, that is, they trigger certain orientations of social activity (e.g. by providing infrastructure that permit some actions and make others problematic, or bringing into social life innovations that change the kind of activity on which social life rests and providing tools and extensions that transform human agency).

The above addressed distinction of two attitudes in EE is not only a matter of normative choices concerning the scope of reliable bonds imposed on a group of professionals, but is deeply rooted in profound choices concerning the axiology of engineering taken as a vocation and distinguished social practice. That is to say, the kind of EE advocated for does not depend on an individual sense of responsibility structured – at least to a degree – by vocational training in 'soft skills', but reflects conceptualisations of the goals of engineering and the ways of understanding them.

Typically, these goals are defined in terms of problem-solving or infrastructure provisioning. A popular definition in Wikipedia states that:

> Engineering is the practice of using natural science, mathematics, and the engineering design process to solve technical problems, increase efficiency and productivity, and improve systems ('Engineering', 2024).

And Hammack and Anderson (2022) write that:

> Engineers solve problems by creating artifacts or systems, often before scientific understanding is available and before the public has identified a need. And the practice of engineering is defined by process, not by one's field of study.

These conceptualizations are reflected in two forms of engineering activity, themselves rooted in two modes of professional organisation. According to the first one, which might be called the corporate model, engineering is understood as a form, or in fact as a part of, business. Within this framework the goals of engineers are those related to the market success of a company and their activity is focused on innovation framed not as an answer to some existing social problem, but rather as a product which links new capabilities of acting offered to the clients with the economic, cultural, social, and, eventually, political gains of the company. It does not pick up on actual human activity and social practices, but aims at shaping them by attracting new possibilities and social dynamics. This seems to be especially apparent in the cases of products whose use is not defined, but they are rather platforms for a variety of activities which tie the user to them, e.g. PCs and smartphones.

Contrary to this, within the second mode, which might be called the consultant model, engineering might be taken as a (social) intervention. That is, it picks up on the real-life problem of some agent (individual or communal), and employs the methods of science, mathematics, and design to solve it. This orientation transforms the role of the engineer from that of an innovator to that of a 'public aide' whose actions are derivative of problems defined prior to engineering activity. Note that such problems do not exist in themselves but emerge within and from certain human activity or practices that make the engineer's products meaningful. Hence, for instance, the engineer will design a bridge not just to cross a river in some random place, not where there is a community living on a riverside, but only where there is a group of people interested in crossing it for some reason (trade, farming on the fields across the river, etc.).

It is worth highlighting that the difference between these two models rest not only on the actual form of engineering's institutionalization, but even more on the accepted conceptualisation of the goal of engineering and the social role of the profession, which makes certain choices concerning EE inevitable for professional self-understanding. Consider, for instance, the above-mentioned devotion to the public good as the key normative standard of EE. Building on it, the conceptualisation makes engineers face two important issues. First, with engineering defined as problem-solving for the public good, it becomes necessary to engage in a debate on what the public good consists in. By championing the benefits of innovation against ridiculed Luddite sentiments, engineering seems to have presupposed a conflation of innovation and the social good without giving it a second thought. With the growing interest in the ethics of innovation (e.g. Jasanoff, 2016) being an intervention aimed at providing practitioners with tools to supplement their codes of professional conduct, rather than an attempt to institutionalise engineers' ability critically to reflect on the social consequences of technological activity, engineering's failure to take part in such a debate may result in its subordination to business and hence, may limit the agency and independence of engineers in their everyday practice.

Second, placing the social good at the centre of engineering enables us to pinpoint the power structures behind it. It is not only that by furnishing the market and governments with new technology, engineering becomes involved in the (global) structures of power, but with the raising awareness of environmental changes and the surveillance core of contemporary capitalism, it would be difficult for engineering to ignore the consequences of its political role. For, to frame it in Martin's and Schinzinger's terms, if engineering is social experimentation, then the questions of who authorised these experiments, whether they are conducted with the same standards as other experiments, and whether engineers would themselves like to live with their effects, need to be asked.

The latter question brings another neglected aspect to both models of engineering activity, that is, the coherence of conduct within and outside the profession. Here, again, the situation has changed in recent decades, for engineers cannot avoid being affected by technicization of everyday life, as the line between professional and end user becomes blurred. Thus, it seems that for an appropriate form of EE, and hence of the moral and social training of future engineers, a framework which enables such cohesion becomes necessary. In the next section, I outline such a framework based on Alasdair MacIntyre's neo-Aristotelian virtue ethics.

2. Engineering as a Secondary Practice

Since its first formulation in his 1981 *After Virtue*, MacIntyre's goods-virtues-practices-institutions framework has become one of the key standpoints in ethics and has been successfully adapted to practical ethics.

According to MacIntyre, practice is

> any coherent and complex form of socially established co-operative human activity through which goods internal to that form of activity are realized in the course of trying to achieve those standards of excellence which are appropriate to, and partially definitive of, that form of activity, with the result that human powers to achieve excellence, and human conceptions of the ends and goods involved, are systematically extended (MacIntyre, 1984, p. 187).

Therefore, it is a derivative of the general human orientation toward good, that is, seeking flourishing, fulfilling one's potentialities in a life that combines personal satisfaction, expression of human powers, and meaningful social relations in a way of living which could be recognised as good for a human being.

This presents two important features of the concept of practice. First, it is a "complex form of socially established co-operative human activity". The practice is not spontaneously constructed by an agent, but rather it is a way in which a society obtains what it needs (with agriculture, masonry, and military action being the clearest examples) or in which it works (as illustrated by various forms of education, research, and art). Therefore, it answers some social needs and comes from the tradition of a society's culture. What follows is that for every practice there is a tradition of skills and norms that need to be learned in order to become an autonomous master practitioner. This involves forms of learning, transforming the initial attitudes and expectations of an apprentice so that they become subject to professional standards and social requirements of accountability, social good and established forms of cooperation. However, it does not require the apprentice to limit their creativity. For mastering a craft not only involves learning the best standards achieved so far, but also enables the practitioner to redefine them or even reshape the practice itself.

Second, a practice also emerges from human beings' pursuits of their individual goods. Not only does it provide them with means of supporting themselves and their dependants, but it is a form (one of many possible and practiced simultaneously) of developing their individual potentialities. As the goods of human activity are typically internal goods of practices (whether in the sense of consumption goods, or as forms of expression of the agent's personality), the range of possibilities of living a flourishing, meaningful life emerges from a mix of practices people are involved in. That is, the kind of person the agent might become is framed both by their own predispositions and personality and the standards of acting and knowledge obtained within the tradition of practices, and by the decisions concerning distribution of the significance of, and therefore the agent's degree of involvement in, each of them. Whatever their decision may be, however, they will need certain traits of character, that is, virtues, in order to obtain both the good of the practice and their own flourishing, and to establish the meaningful social relations, both professional and private, that make flourishing possible.

Note that seen along such lines, this framework links personal attitude, social recognition and the search for the good life with professional performance and the work ethic. It does so by highlighting the significance of practices for personal flourishing and by indicating the need for institutionalisation of practices that allow them to be maintained. As most practices require resources and infrastructure, institutions emerge as ways of supporting them with such external goods as make pursuit of the internal goods possible. However, by offering access to the external goods of money, fame, etc., an institution may corrupt practitioners by distracting them on their way towards attaining internal goods and human flourishing, which undermines the social relations of the community and transform the agents' efforts into fragmented and incommensurable lives the agents themselves find difficult to navigate.

The question thus arises whether this concept of practice can contribute to the debate on engineering activity and, consequently, its social role. Interestingly enough, the attempt to incorporate MacIntyre's framework into EE was twofold, coming both from practitioners themselves and from researchers. As for the former, a series of columns for "Structure" magazine published between 2010 and 2013 should be noted, in which Jon A. Schmidt indicated the benefits of this framework for engineers' search for moral standards in their vocation (Schmidt, 2010a, 2010b, 2011, 2013) and their ability to ground their self-understanding in a view linking the internal goods with their embeddedness in social life. The latter was first attempted by Richard W. Bowen (2010) and later by Justin Smith and his colleagues (Smith et al., 2014). For Bowen the benefit of the MacIntyrean concept of practice comes from its being an alternative normative language to that of Martin Buber. By highlighting what he takes to be the inner goods of engineering, Bowen stresses their contribution to individual flourishing and the unity of the engineer's life. Smith et al., in their turn, focus on the controlling aspect of practices and define the standards of excellence in terms of responsibilities (Smith et al., 2014, pp. 526–527). Moreover, it is important to note that while they attempt to address an account of responsibilities of engineers "qua engineers" (2014, p. 522) they in fact focus on a particular form of engineering (structural engineering) and fail to provide ways of generalising their results. Hence, the results are not only limited, but also define the internal goods of engineering as secondary to other practices, for, as Smith et al. claim, "standards of excellence in structural engineering exist to aid in the achievement of particular, evolving goals of design and research". Thus it is design and research that seem to indicate the actual goods the engineering community aims at. It is notable that Bowen also defines the internal goods of practice as "those associated with accurate and rigorous application of scientific knowledge combined with imagination, reason, judgement and experience" (Bowen, 2010, p. 142). However, this might be said also of other practices, e.g. medicine, and does not provide enough description of the internal goods to define the core of engineering practice.

This difficulties in defining the goals of engineering might be surprising, taking into account its high position in developed societies. Nevertheless, I want to argue that it is due to the form of institutionalisation of engineering that it is considered to be a coherent practice, whereas actually it is not. For neither do the problems in engineering exist in themselves, but emerge from other human activities, nor can the problem-solving attitude be identified as its *differentia specifica*, as it is found in other practices. The former might seem confusing, because in developed societies there has been a profound conflation of engineering and innovation, which seem to be taken as one. However, it might be argued that while engineers bring some visions of new technological achievements to life, they rarely themselves create those visions, which come rather from entrepreneurs, marketing research, and science.

Instead, the conceptualisation of engineering within the MacIntyrean framework may be based on the notion of secondary practice that was proposed by Geoff Moore (Moore, 2017) in order to resolve similar doubts concerning management. They were raised by Ron Beadle (Beadle, 2008), who points out that for business understood primarily as a managerial activity independent of what its practical (material) end (a service or a product) might be, no internal goods can be identified. As practices are focused on developing an agent's potentialities in accordance with social needs and communal ties, it is the goods of individual practices that are aimed at. Similarly, as Beadle stresses, an attempt to define business in terms of providing clients with goods and services they need fails, for the business-customer relation consists in capital flow between them with no regards to the substance of the exchange. In answer to this, Moore develops the idea of supportive practice aimed at sustaining primary practices (whether productive, like agriculture of fishery, or non-productive, such as science or art) and institutions embodying them. The manager's aim is thus that of providing practitioners with necessary external goods and organising their activities in a way that contributes to the further development of their potentialities and acquisition of new kinds of internal goods. Hence, running such a practice-embodying, or practice-based, institution is a practice in itself, even though it is secondary to the practice it is based on, and demands a certain set of virtues, lack of which might undermine the ability to obtain the goods of the primary practice (Bolade-Ogunfodun, Sinnicks, Akrivou, & Scalzo, 2022).

A similar debate between MacIntyre and Joseph Dunne regarding education took place in the early 2000s. It focused on the nature of teaching, with MacIntyre denying that this is a practice due to the lack of specific internal goods other than those of the subject taught, and limiting it to "a set of skills and habits put to the service of a variety of practices" (MacIntyre & Dunne, 2002, p. 5). That is, teaching is inevitably part of a specific practice and although the characteristics of the teacher might not be those of a 'regular' practitioner (as is the case with primary teachers in relation to maths and science) their teaching consists in introducing the learners to the goods, skills, and virtues typical of it and through this, in the best kind of teaching, making them part of the same tradition of practice. Against this, Dunne argues for a unified view of teaching practice on the grounds of "a sense of the importance of a teacher's care for the student as well as – and sometimes independently of – his or her care for the subject" (Dunne, 2003, p. 355).

It seems, however, that the tension between these two standpoints may be released by invoking the concept of secondary practice again. In tentative agreement with Dunne as to the qualities and methods it takes to become a good teacher, it seems fair to adhere to MacIntyre's refutation of the existence of internal goods other than those of a certain practice. For even in the case of primary school teachers, their skills are aimed at providing their students with some initial instruction, but instruction in specific practices and traditions. As the skills and methods might be found within a unified account or mode of acting, it is not due to the subjects the teachers teach, but rather, to the low level of competence in the students which demands bulk instruction in knowledge and skills that can be specialised later on. Seen along such lines, teaching – with its primary devotion to the good of the student – is aimed at making the student able to develop in certain practices and through this to develop as a human being. Thus, just as in the case of business, it is aimed at the goods of practices and the good of the learner aiming at them, and does not seem to have internal goods typical of itself.

These two examples allow us to put forward a claim according to which engineering should be regarded as another case of secondary practice. As noted above, there is some doubt whether there are any internal goods that could be ascribed to engineering, and problem solving is in fact an umbrella term for a diverse set of situations and actions from which the problems emerge. From structural engineering, mining and electrical engineering to robotics, computer and software engineering (and the variety of historical sources of these branches provides another argument for calling into question engineering's being a coherent activity), the kind of agents and their actions, goals, skills, values and social relations make an engineer's work varied beyond the degree of that of their peers in other fields. And is so because engineering is not about solving problems, but rather about providing practitioners with affordances that enhance their ability to obtain the goods specified within a given practice.

Thus, practical problem solving as a defining goal of engineering might be sustained by indicating its secondary and auxiliary character to other human activities, that is, those that develop human potentialities by enabling agents to obtain authentic goods. This picture might be blurred by our culture's fixation on innovation. With the world's biggest companies built on introducing new items, new ways of acting, and new modes of connecting with others, it might seem that their engineers are involved in a kind of activity of intrinsic worth. To this two things should be said. First, even accepting this view, it might be argued that as the striving for innovation in problem solving might be taken as the core good in some forms of engineering only, it cannot be used to claim that engineering is a coherent practice devoted to specific and distinct goods of innovation intrinsic to it. The revolution in communication and information processing is not the same in structural as in electric engineering, and innovation might be one of characteristics of good engineering, but not the aim of engineering itself. For in some cases innovation is only of secondary importance, and providing reliable and sustainable solutions may outweigh it. In fact, innovation seems to correlate with competition rather than with problem solving, and the focus given to it today is a consequence of the institutionalizing of engineering in a capitalist economy. Taken as a good, innovation makes sense only in the context of established practices, as without it, it could not bring any value to the end users, for it is in the course of practice development that the need for new forms of acting may be identified.

An unrestrained effort to innovatively supplement human good-oriented activities with technological solutions may in fact result in limiting human capacities for autonomous agency by undermining people's skills, abilities to focus and economy of effort. Hence, whether an engineered solution solves a problem or not depends largely on identifying the problem not as a problem for engineering, but a problem for some other human activity. Without discussing in detail the benefits of technological support in virtually all human activities as limiting human powers, and avoiding neo-Luddite sentiments, it is worth highlighting that the focus on engineering's contribution and innovation, and evaluating standards of excellence from this point of view, may not be compatible with human benefit. This might be illustrated by Sweden's recent turn towards traditional printed textbooks in primary education, rather than their electronic versions, as better resources for developing children's reading abilities (Associated Press, 2023, for a critical discussion see Díaz, Nussbaum, Greiff, & Santana, 2024).

Secondly, evaluation of an engineered solution to a problem depends on its contribution to the development of a primary practice. That is, a piece of engineering whose standards go beyond the actual needs (in the sense of problem generated by actual knowledge and skills) of practitioners might be a seminal product of engineering, but it would be futile if it did not add value to actions performed in a traditional way. Hence, for instance, surgery robots are evaluated not on the basis of their technical advancement, but that of their benefit for patients (for an example of such an evaluation see e.g. Yang et al., 2015). What follows is that engineering standards are secondary to those of social expectations and expected outcomes in obtaining goods identified prior to the search for an engineered solution. As they might be negotiated with the possibilities of engineering state of the art, the negotiation itself undermines the independence of the goods of engineering.

3. The Analogy Between Engineering and Education

This leads to my main point, according to which the relationship between engineers and end users echoes that between teachers and students. Framed this way, it not only sets the standards for engineering's responsibilities, but also defines engineering's, and individual engineers', social role and moral requirements on the basis of which a framework for aspiring engineers' moral education can be established. For seen along such lines, the responsibilities are not an external limitation imposed on engineering's attempts to upgrade human lives, a conflicting feature of inter-vocational tensions, but rather part of its intrinsic structure, in which care for human development and devotion to elevating human efforts in various areas of life are recognized as engineers' core activity and the basis for their social recognition. That is, with such devotion and care focused on technical aspects of efforts to flourish taken as the internal good of engineering practice, the social position of engineers might be defined in terms of their social relations, and not those of the external goods of profitability, business-oriented invention, or competitive advantage in economic and political games.

Thus, the analogy between teaching and engineering as practices is based on their auxiliary role in others' flourishing. Both of them are not only defined by their role in supporting people in achieving goals set elsewhere and in terms of other life goals, but they both also provide others with tools and resources, whether intellectual, emotional, or material, as well as with ways of using them and dealing with the environment. Just as a teacher presents the best knowledge of the world achieved so far, forms of its understanding, and the culture in which the agents seek for their flourishing, an engineer offers new ways of relating to the world and other beings, provides material backbone of activities crucial for one's activity in other practices, and the flourishing of almost all of them rests, to an important degree, on engineering's ability to provide tools for probing new forms of obtaining the internal goods typical to them, setting new standards of excellence and skills, and hence, reframing what human good, as seen within a certain practice, may consist in.

This picture might be blurred by the fact that some engineering products are multifunctional and used in various practices, as is the case with products of electrical, computer, and structural engineering, and some of these products (such as PCs and smartphones) are platforms enabling involvement in a range of practices, rather than tools devoted to obtaining a defined good. Thus, it might be argued, important parts of todays' engineering cannot be defined in terms of supporting users' attempts to flourish, because they are not supporting any single good in particular. Note, however, that this mirrors the role of primary school teachers discussed above, since the role of such platforms is similar to the use of basic knowledge. Whether it will be used to support a student's efforts in science or in literature, in medical training, or in their care of others, is not decided at this stage, but rather the students decide (or rather they discover in the course of their life) what they will focus on and how that effort will be supported. Similarly, PC and smartphone designers provide users with a range of abilities of designed uses which can be customized and support certain sets of activities typical for that particular user without regard to the activities of others.

Indeed, it might be argued that the work of a teacher and that of an engineer are complementary in some areas. For, where an engineer provides an agent with the opportunity to execute and extend their powers, a teacher provides them with, or supports them in building, motivation, a rationale for using the engineer's products, and initial conceptualisations of what a human good life consists in and how the agent can utilize the technology in building it. Just as the engineer's efforts are futile without human practices and the goods the users aim at, technology sets the range of possibilities for acting and thus, the scope of interest of the educator. As the efforts of the engineer and educator might also be contradictory when corrupted by compartmentalised concepts of excellence, they both need qualities, both in the sense of sound vocational training and traits of character, which answer each other in their effort to support the agent's flourishing.

This brings up the question of the virtues that the practitioner of the secondary practice of engineering demands in order to sustain their efforts to obtain relevant goods. However much specific sets of virtues may vary across different branches of engineering, three virtues are nonetheless crucial because they make up an agent's moral character and define the core of their moral stance as a practitioner. What follows is thus not an attempt to redefine them, but rather to adjust the general virtue concepts to specific domains so that they reflect the changes in their fields and enable the agent to orient themselves as to how maintain their moral attitude in dealing with secondary activity. This seems especially important given that ascribing friendship, justice and phronesis (practical wisdom) to technically oriented practitioners might open them to ridicule and without such a supplement this effort might be rejected as trivial and inadequate.

According to Aristotle, friendship is both the essential virtue in building a pro-social attitude which enables individuals to form a liveable social environment which is based on mutual recognition, and – in its highest form –

the virtue of supporting a friend in their efforts to attain what is good and the best for them (Aristotle, 2001, pp. 1060–1063). As in the course of building a flourishing life an agent might be subject to bad influence, making false judgements, and developing character flaws, it is up to their friend to help them by correcting their actions and their character in accordance with the standards of the good they both are able to grasp. Translated into engineering, this virtue is a trait of character which enables an engineer to act towards the users in a way which goes beyond the market-oriented relation of a designer and a client. As such a relation is typical for of strangers and is regulated by market mechanisms, friendship adds an orientation towards the user's good, transforming it into a moral relationship, and indicates a contribution to the user's flourishing as the key commitment of the engineer. Note that it differs from the responsibility-based account of EE in recognizing the moral relation not as an additional feature of engineering activity, itself defined by other goods, but as a core characteristic of what the internal good of engineering consists in and hence, what defines the good engineer.

Seeing the user not as a client, but as a fellow being involved in a network of significant relations, requires not only acting in accordance with what is good and best for them, but also maintaining a rationale for what their good consists in. That is, the virtuous engineer should get involved in a debate on what innovations and solutions are actually good for people and whether each of them is beneficial. For this a recognition of what the user requires in terms of justice is necessary. However, such a recognition deals not with what they require in terms of distributive justice, but rather what their virtue, that is, the good character enabling them to obtain human good, consists in (Aristotle, 2001, pp. 1003–1004). Hence the demands of justice as a virtue of engineering involve an engineer in a debate on what the good for a human being is and what they require to obtain it, rather than on what they wantonly fancy, or what they may be potential customers for. However, the most significant question concerns the qualities of character and mind that should be sought after in the course of their development, both in specific practices and *qua* human being. Thus, for instance, it would be of pivotal importance for an engineer to consider whether the functionalities of a product they are working on will help the user to act consistently and strengthen their ability to focus, or will involve them in a range of substitute activities that distort their attention economy. This questions attractiveness as the main selling point of the product and forces an engineer to ask not what the users may find innovative and attractive, but rather what kind of human beings the product makes them and whether the anticipated form of use was framed with their flourishing in mind.

What follows is the third crucial virtue, which I call the 'technological phronesis'. As Aristotle states, phronesis, or practical wisdom, concerns "knowing what is good for oneself" (Aristotle, 2001, p. 1029), that is, what serves one's interest and one's good. It enables the agent to adjust the general concept of human good to their situation and choose between alternative goods given in alternative ways of acting so that they add up to a coherent, flourishing life. Within engineering this may be translated into an excellence in adjusting the users' involvement in different activities with technological regimes typical of them, and designing the latter in a way that seeks to keep the coherence of the users' lives as an important objective. It may require of the engineer recognizing the place of the activity supplemented by their product in the users' lives, the ecology of its usage, and its relations with other areas of life, on the one hand, and limiting the scope of their own success in tying the users' attention with the product, on the other. This requires not only a certain attitude in design, but also – and primarily – devotion to the idea of human good as a convergent point of all human activities which in engineering's attempts to elevate them cannot be reduced to distinctive and separated spheres, and keeping in sight the users' capacity for practical reasoning as the key potentiality that engineering strives to sustain.

4. Conclusions

So far the educational framework for engineering, and EE in particular, has been shaped by the demands of the market environment for engineering work, by increasing competitiveness in business, and by the global technological arms race. This has made it focus primarily on responsibilities and professional credibility as ways of sustaining individual engineers' agency within the vocation rather than their allegiance to the users. However, this keeps the EE secondary to standards of profession and requirements of profitability and innovation. Hence, the main models of EE suffer from being auxiliary to the problem-solving orientation. This might make engineering education prone to two possible errors: limiting its ethical aspect to the bare minimum of professional codes of conduct, and reaching for some over-restrictive forms of social control. With the former tending to be limited to a fig leaf of highly restricted effectiveness in building engineers' actual conduct and the latter posing possible threads to their agency and professional effectiveness, a new framework should be sought in order to overcome those limitations.

The practice-goods-virtues-institutions framework seems to provide a kind of third-way solution or rhetorical formula which makes it possible to articulate the moral and social commitments of engineers' in terms of the goods of engineering itself, the engineers' social role, and their own attempts to build a good, flourishing life. Framing engineering as a secondary practice pushes us towards practice-oriented engineering education, that is, connecting it with the experiences, concepts of goods and standards of excellences typical to primal practices. It might thus require such an education to be focused on field studies and practical involvement in a primal practice so that engineering trainees might work out a concept of the goods aiming for which they will support the end users in, rather than shaping their actions *a priori*.

This can also highlight some doubts concerning the outlined model as being limited in its applicability. For, it might be argued, rooting engineering education in deeper studies of primary practices and their environments may work for some branches of engineering, such as medicine, but for some others, such as computer engineering, it might be of limited, if any, use. However, with the analogy between computing platforms and primary education in mind, future research can find a way to set out both the possibilities and the limits of applicability of the model.

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