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Anna Laktionova

Philosophy of Engineering and Design Technological Actions: Rationality, Argumentation, Modelling

Philosophy of Engineering and Design (Technological) Actions is seen within the context of philosophical reflections about rationalizing, argumentation, modelling as specific particularities of scientific research actions (in fundamental natural sciences and engineering ones). Engineering is inseparable from design and technology (and vice versa: design relates to engineering and technology; technology – to engineering and design). For engineering both, is and ought relations; knowing that, knowing how, and knowing as mere direct experienced effective functioning, producing; world-to-mind and mind-to-world directions, – appear valid and relevant (in different degrees, in diverse contexts).

Engineering and Design Technological Sciences open new interesting methodological perspective for nowadays investigations. From the other side, Engineering and Design Technological Sciences challenge higher and special technical education; and might play the key role for its renovating, integrating into inter-, cross- and trans- disciplinary studies. Infrastructure of Philosophy of Engineering and Design Technological Actions could include Epistemology of Engineering; Ontology of Engineering; elaborations on methodology of measurement; Ethical, Socio-Political, Environmental Studies etc. Infrastructure of Philosophy of Engineering and Design Technological Actions could correspond to Engineering and Design Technological Sciences. Mentioned philosophical and specific scientific fields remain to be open for diverse elaborations and development.

Modelling as an appropriate within both science and engineering method is analyzed by involving into consideration topics of rationality and argumentation. Rationality is epistemically relevant for argumentation and modelling. Concepts of "frames" and "orientations" in argumentation are actual for interpreting rationality of actions; and in scientific modelling. Modelling itself could be seen as a special argumentative tool constructed on the rational background and opening rational understanding for scientific discovery and engineering design technological inventing.

***Keywords**: Philosophy of Engineering and Design Technological Actions, Design, Rationality, Argumentation, Modelling, Science, Technology, Agency, Methodology of Higher and Special Technical Education of Engineering and Design Technological Sciences.*

The proposed (under the general turn to Philosophy of Action or Practical Philosophy) "Philosophy of Engineering and Design (Technological) Actions" [Laktionova 2023a] can be seen within the context of philosophical reflections about rationalizing, argumentation, modelling as specific particularities of scientific research actions (in fundamental natural sciences and engineering ones, which (the latter) are not simply reducible to the application of the first from just mentioned). When speaking about engineering (including engineering actions, sciences etc.) we mean here engineering inseparable from design and technology (and vice versa: design is always connected with engineering and technology; technology – with engineering and design). Such inseparability, connectedness can come in different degrees, even can appear potentially, but such potentiality crucially illuminates all three: engineering, design, and technology.

The modelling appears to be widely proposed and used by scientists and engineers [Ciula & Eide 2017]. Scientists are dealing with discovered phenomena. The process of discovering always includes invention (as a researcher cannot avoid to rely on some methodological and thematic frameworks; avoid being a human agent with (his/her) valuable life orientations etc. which (he/she) "brings" into (his/her) discoveries). Engineers are dealing with the invented phenomena; they must effectively function. Engineering innovations shift human agency and actions, constitute the world we are living in (and trying to scientifically investigate upon).

Let us remember that science concerns with *what is*, how things are, knowing that; technology – with *what is to be*, how things ought to be, knowing how. Technology brings the world closer to the way people want it to be. Science strives to discover the world as it is, independently from humans. Engineering changes the world as a service to the public. Inseparable engineering, design and technology do not oppose science in the mentioned sense. In science direction is from the world to the investigator, in technology – from the inventor to the world; but for engineering (in the proposed understanding) all the mentioned (both is and ought relations; knowing that, knowing how, and knowing as mere direct experienced effective functioning, producing; world-to-mind and mind-to-world directions) appear valid and relevant (in different degrees, in diverse contexts).

The brought to attention particularities of current scientific investigations imply the need of correspondent reactions in education on different levels; of taking into account methodological inputs from the procedures of rationalizing, argumentation, modelling. Modelling as an appropriate within both science and engineering method can be analyzed by involving into consideration topics of rationality and argumentation.

Among the main figures the works of whom I am involving into this research are M. Boon (2021), A. Ciula and Ø. Eide (2017) – about modelling in

sciences, engineering, and humanities practices; E. Lord (2018) – about rationality, Harald R. Wohlrapp (2014; 2017) – about argumentation and rationality. I continue my project (proceeding with it I have made some presentations, taken part in different discussions; published an article [Laktionova 2023a] and abstract [Laktionova 2023b]; took part (without presentation) in STS-Hub) on Technology and Agency in Käte Hamburger Kolleg "Cultures of Research", RWTH Aachen University (Germany) with this article.

General methodological tools involve critical analysis, comparison, evaluation etc. of the recent findings of nowadays authors to elaborate on rationalizing, argumentation, modelling within Philosophy of Engineering and Design (Technological) Actions, which will help to maintain its thematic "infrastructure" [Laktionova 2023b] under general perspective of Philosophy of Action and Agency. Technology is seen via the concept of Agency understood as agent's potential (in Aristotelian sense) ability or capacity to act.

E. Lord investigates connection between reasons and rationality. He takes the concept of reasons responsiveness which opens understanding of interesting relations: that coherence is not enough for rationality, but incoherence is enough for irrationality; and that adequate answering to reasons is not enough for rationality, "possession of reasons" is the key to gain rationality [Lord 2018: ch. 1].

Deliberating about possessing reasons [Lord 2018: part II] he insists possessing of reasons depends on knowing them. Such an epistemic condition of possessing is necessary, but not sufficient. E. Lord introduces practical condition: facts must be acknowledged as reasons by being sensitively used by agents as reasons. Knowing a fact which plays the role of reason precedes ability of performative demonstration of practical knowledge (knowledge-how) of using it as a reason. Thus, an agent shows (his/her) possession of knowledge of the fact which is being used as a reason for (his/her) action. In such a way possessing of reasons appear rational (according to epistemic and practical conditions providing for necessity and sufficiency) for actions.

So far, reasons get normativity; further step would concern responding to normative reasons. Causal interpretation of such responding is challenged by so-called "deviant causal chains". To avoid the latter, realised within action agent's sensitivity to normative facts (as reasons) shows his rational competence. Agent's responding to reasons actualises his/her normative and/or motivating attitudes. Reacting to normative and motivating reasons could be independent: not all normative reasons are motivating and vice versa.

E. Lord is externalist about rationality: internal mental states (independently of whether their contents are true or false) are not what agent's rationality supervenes upon. Agent's rationality is constituted by possession of reasons – known (epistemically and practically) facts. Rationality is deontic: an agent ought to do something only if it appears rationally to do it (but vice

versa is not always the case). Oughtness is a function of normatively possessed by agent reasons.

E. Lord does not deliberate much about an agent as a bearer of rationality, actions, intentions, beliefs etc. Agent can be not just a person, an individual, but collective (sum of individuals), and common. Correspondently, there is place, at least, for individual, collective, and common actions, and rationality. Further, speaking about collective, and common actions in terms of interacting, collaborating, teaming is also very puzzled nowadays. Interaction can be not just between humans, but with machines, animals etc. These nuances are not the proper tasks for the present elaborating, and appear to be very philosophically complicated, independent, problematic topics in current inter- and trans-disciplinary investigations.

Rationally possessed (in previously described sense) reasons differ if concern actions, or intentions, or beliefs [Lord 2018: ch. 3]. Agent possesses reasons and rationally reacts on them: reason for acting, or intending, or believing crucially influences rationality of such acting, or intending, or believing and, thus, implies their accomplishment. Agent's rationality is appropriate responding to possessed normative reasons. Rationality before and after the action takes place can differ.

Intentions and beliefs can be involved in argumentation. Argumentation itself can be seen as action. The growth of elaborations on Informal Logic and Argumentative Theory is very intensive today. The results and findings of them have multitude of particular applications in different social investigations which include jurisprudence, law, political and economic studies, rhetorical and linguistic investigations, cultural and anthropological researches etc. The effectiveness of such applications supports from its side the mentioned growth; and applications could widespread to natural and engineering sciences. Nevertheless, and to improve such tendencies, there still remains a need for philosophical explications about it. One of the prominent attempts of such explications is the monograph of Harald R. Wohlrapp "The Concept of Argument. A Philosophical Foundation" (2014), which has received a lot of different reactions [*Informal Logic* 2017]. I intend to interpret Wohlrapp's views to clarify the concepts of validity, truth, justification, argumentation, and rationality.

Harald R. Wohlrapp makes original elaboration on the structure of argumentation that involves reinterpreted traditional epistemological issues of knowledge, belief, justification, validity, truth, subjectivity, etc. via introducing concepts of "orientation" and "frame" understood in pragmatic and dialectical ways. It seems interesting to rethink some results of "Hamburg Group on Argumentation Theory" (in which Harald R. Wohlrapp participated; Hamburg Group on Argumentation Theory was initiated in early 80s of the 20th century) in comparison with issues on the topic of "rationality" from the per-

spective of alternative approaches of Philosophy of Action and Agency. Harald R. Wohlrapp himself aims to philosophical interpretation that grounds and clarifies argumentation concerning the human (personal, common, and socially oriented) thinking abilities and rationality (in a broad sense); and are further realized in performed (and directly or reflectively verbalized) actions. Orientations get establishment via argumentation and function pragmatically in human practice. They endorse value and validity constituting justification "without a remainder of open objections". Thus, thesis gets sufficiency and acceptance. Philosophy of argument of Harald R. Wohlrapp provides for rationality for the act of accepting/not-accepting the argument, as a sequence of propositions. Formal logical conclusions (even if correct and perfect in all their qualities) appear neither necessary nor sufficient to guarantee successful or satisfactory proceeding of interpretation, dialogue, or communication.

There took place discussion between Harald R. Wohlrapp and other prominent theorists of argumentation theory [*Informal Logic* 2017]. Giving the interpretation Wohlrapp's views, I try to establish relation and consistency between rationality, argumentation and actions. Argumentation is seen as realization of agency, seen as capacity accomplished in actions. Rationality as applied to argumentation characteristic remains to be ambiguous. It cannot be reduced to optimization, effectiveness or validity. It can have degrees, but criteria for its measuring are not clear. Justification also can come into degrees and characterizes contents that could be involved into argumentation. Argumentation itself justifies actions as it performs itself.

Harald R. Wohlrapp insists that philosophical foundation for the arguments and argumentation is in need and his monograph [Wohlrapp 2014] is an outstanding attempt to provide such one. He sees 'philosophical foundation' not as a theory of argumentation, but rather as having a meditative function connected with two tasks: to theorize about the basis of argument in terms of "orientation"; to produce tools to separate logical features of an argument from its persuasive skills (actually working and bringing (un) expected results) in the process of argumentation.

Philosophical foundation is a source of justification of a theory of argumentation. Argumentation is communication with at least some partner, who is not only seen as opponent, he also controls in the dialogue the validity and soundness of an argument. Assent as a result of the practice of argumentation is obtained by rationally proceeded sequence of dialogical communication. Rationality is not exhausted by logical features, by logical forms of presenting the opinion by an argument. From the other side rationality cannot just be reduced to optimization of information and concluding the evaluated contents as the best by applying different standards, by assent thesis that would commit to its acceptance. But rationality appears to be not just inter-, but trans-subjective, we transcend it over for what-

ever case of practice of argumentation. Argumentation is practice, it justifies itself as it performs itself.

Argumentation as an activity involves different arguments as its constituents. An argument captures the opinion of the arguer. Different arguments represent different opinions of the participants who take part in argumentation. This representation enriches opinions with structures. Opinion belongs to the arguer, it is his position, belief, conviction etc., which he is ready to propose and defend. Thus, his attitude to the content of his opinion could be described in terms of sureness which he wants to be defended and admitted as certainty. He is concerned about promoting it. But promoting it in argumentation, making it into argument provides the content of opinion with a structure, which not only clarifies it, but commits the arguer in a particular way (that could be unexpected or ineligible by him initially). Hence, argumentation appears to play the role of medium. Mediation as an argumentative advantage can be viewed in various ways, and involves different issues.

Harald R. Wohlrapp stresses meditative role of argumentation and takes its analyses to be striving to the complete elucidation of complex sophisticated arguments. According to him, clarification of the structure of an argument involves such philosophical notions as thesis, justification, opinion, knowledge, contradiction, truth etc. And it is devoted to analyse "what really happens in verbal practice when a thesis is posited based on reasons and/or criticized with objections" [Wohlrapp 2014: vi]. The elaborations of the Hamburg Group on Argumentation Theory, as Harald R. Wohlrapp admits, brought many results about structures of arguments, as well as findings of philosophical and logical etc. groups and circles working on Argumentation and Informal Logic, also the communication between them appeared very fruitful.

The argumentation results in considered and accepted "orientations". Orientations follow form theories: "theories are verbal formations that open up any domains of reality at least to the extent that people are now able to act within them" [Wohlrapp 2014: vi]. In such a way a theory overcomes its proper scientific functioning and appears significant on the level of everyday life and in other scientific and humanitarian spheres. At the same time, to play the role of orientation, it should claim not only fixation, but flexibility, to be appropriate for the pragmatic changes and developments in broad sense. Each argumentation challenges the orientations, and the theories which function as orientations. Validity of orientations in argumentation as well as validity of a thesis, validity of an argument within a particular practice of argumentation is provided by exhaustive justification when there is no any rested objection questioning each of the validities.

Validity of the thesis allows it to play the role of orientation. So, in argumentation as practice the participants are oriented by theoretical grasping that is formed dynamically. Formal logic as a static theory is not sufficient for such orienting; nevertheless, that argumentation leads to inferences. Such inferences are rather quasi-logical.

Participants of argumentation, the arguers could be individual persons as well as groups or communities. That is why to function as orientation, content needs to be such that could be acceptable from different subjective points of view. This subjectivity seems to be a problem as the same notion which is attempted to be prescribed in different way to different participants.

Logical validity of the thesis presented by the argument is important but does not guarantee that it will be accepted as such or moreover accepted in the status of orientation (that it will function as orientation). The logical quality of the argument can have degrees. Logically valid argumentative presentation is important: an argument should be sufficiently valid representation of a thesis. At the same time there is a need of force of persuasion, which should be enough for the argument, presenting a thesis, to be accepted. Logical validity of an argument does not exclude the possibility of objections. Critics and opposition are the sources of objecting an argument, even logically valid one. So far in argumentation the content presented by a logically valid argument gets assess, could be questioned, and objected. Thus, the nature of practice of argumentation is dialogical. Dialogical character of argumentation means that there is no place for lonely deliberating, but that argumentation is communication with at least some partner. The partner is not only seen as opponent who is to be persuaded by the argument and accepts the thesis; partner controls in the dialog the validity and soundness of an argument; assent might be missed.

Assent as a result of the practice of argumentation is obtained by rationally proceeded sequence of dialogical communication. Argumentation overcomes communication, as it is an incomplete mediation via orientations between different opinions from various spheres. Rationality is not exhausted by logical features, by logical forms of presenting the opinion by an argument. From the other side rationality cannot just be reduced to optimization of information and concluding the evaluated contents as the best by applying different standards, by assent thesis that would commit to its acceptance.

The logical sequence of presenting propositions in an argument guarantees the thesis as an inference. But it is not sufficient for the partner to agree with the argument; rather it makes an assent possible. Contents of the propositions involved in the argument could be evaluated differently. Such assessing depends not just on the forms or schemes of representa-

tion, but on contents as well. Very often the concrete value (for example, true / false, good / bad, appropriate / misleading etc.) is vague, unobvious for making judgment, or even unclear in formulation; the similar complications attach to the initial criteria for evaluating. Preciseness of criteria and unambiguous evaluations remain to be more widespread in proper scientific fields, but even here it is rather an ideal that is approximated in actual investigations. Argumentation is practiced more often in political, social, ethical etc. spheres, where diversity of opinions (often claimed to be independent and rational by their bearers) is involved. Such involvement complicates the possibility to find satisfactory reciprocally common grounds for the comparisons, contests or even compatibility of alternative positions.

The practice of argumentation presupposes to provide an opportunity of acceptance of the proposed via arguments views. This could be done by finding acceptable corrections of claimed opinions; and the best candidate to be a ground for doing that is knowledge. The corpus of knowledge today is so wide that we often just formally rely on and appeal to authority of scientific theories without proper appropriation of its content to be our own opinion, which we are sure about, which really matters for us. So far, even best scientifically theoretically rational argument could lack importance for me personally or for the circle of arguers, participants of argumentation who argue on the particular topic, to the content of which the best scientific orientation is not directly relevant.

Today's world is very dialogical, argumentation is important in all the fields, including science itself, but its process, its mechanisms are still ambiguous. Admitting of significance of argumentation does not imply by itself a growth of rationality. Hopes to rely on true knowledge as orientation in argumentation are still relevant; but it is more and more obvious that the concept of truth itself suffers from deflation and relativism. The last is initially inconsistent with the concept of 'truth' as such.

Relativism, according to Harald R. Wohlrapp, is a dangerous challenge that involves importance of argumentation itself, its usefulness. Relativism 'shakes' the 'stable' formal concept of argument, where the true conclusion logically follows from true premises. The truth appears relative, but the task to persuade for accepting the argument and reject the objections to it remains. If we cannot insert true propositions to play the function of premises and conclusion, we leave the lasts with the content of opinions. Opinions are relative, opposite to true knowledge that supplies certainty. True opinion has an advantage of being pragmatically relevant, but pragmatic relevance as a correlate of truthfulness provides for conceptualization, but not for a theory. Harald R. Wohlrapp proposes to decrease the extremes of relativism and absolutism by treating an argument in terms

of *reasonableness*, and dealing with validity of the thesis not as logically formally understood, but as argumentatively valid.

Argumentative character of treating the truth saves its significance but changes its status. In the end argumentation preserves the criterion of truth and exceeds the understanding of it over formal definition and treating in terms of correspondence. So, practice of argumentation opens further understanding and cases of realization of argumentative structures, traits as well as deepens scopes of applications and contents of concomitant concepts and phenomena. The practice of argumentation cannot be reduced only to empirical examples of verbal speech actions. This practice does not have definite verges, involves conceptual and pre-conceptual clarifications by being accomplished. This practice is not available as the given data; it is realization that takes place. From inside of this realization orientations, thesis, its justification and truth get their validity witnessed and verified (or corrected, or even objected) by coming to assent or dissent among participants.

Orientation relevant to a particular practice of argumentation gets its practical application by such functioning: "Raising a validity claim by presenting a thesis is equivalent to claiming that the thesis is suitable as a (new) orientation" [Wohlrapp 2017: 163]. The content of orientation, thus, does not remain to be theoretical but appears to be practically engaged. In such a way theoretical significance and practical importance meet each other.

Argumentation as a practice involves asserting, justifying and criticizing. All these activities are directed upon the thesis. Asserting consists of stating the thesis as a proposed for the participants matter to be accepted as valid and significant relevant to the general context. Assertion of the thesis can meet justification by reasons and criticizing by objections. Asserting, justifying, and criticizing are provided by giving arguments. Arguments should appear to be solid, reliable by being directly practically experienced in argumentation, hence asserted. Justification opens and fixes the demand of thesis to play the role of orientation by the following: "In real argument, justifications can start with references to practical competences and they can contain, besides the well-known formal and informal argument schemes, operative, reflective, and abstractive steps, whose appraisal requires a close understanding of the respective issues" (Wohlrapp 2017: 165). Criticism is devoted to control the construction and support of the thesis. Doubting and contradicting are the procedures of criticizing a thesis.

Not everyone understands and accepts (and is able for understanding and accepting) the same argument evenly. Orientations are to be flexible enough to allow such variety of ways of conceiving and positively / negatively evaluating to accept an argument. That is why orientation consists of rather set of beliefs, appears to be a pragmatically actual, relevant system of possible

orientations. Then it opens possibilities for changing flexible understandings and dealings. Differences of understanding of an argument in the context of the system of orientations make the latter to be related with the notion of frame. System of orientations remains to be a structural frame, but allows differences. Frame differences need to be overcame, reunited by: "criticizing frames, ranking frames, harmonizing frames, and synthesizing frames" [Wohlrapp 2017: 166].

Validity of an argument thus is not fixed and stable, but is emergent depending on other relevant to the context of argumentation arguments that maintain or undermine it. It is not available, but can be changed, specified by emergence of further arguments. Validity can come to degrees, but remains to be not relativized, but open for specification, it is to be reached in practicing of argumentation. The last proceeds as self-reflective, self-constitutive. The explicated interpretation of Wohlrapp's views appears as a supportive illustration of the stated conceptual positions about validity, truth, justification, argumentation and rationality.

Reasons are always open for the reflection, they cannot refer to metaphysical assumptions, and they are to be pragmatically relevant. Justification also can come into degrees and characterizes contents that could be involved into argumentation. Inter-subjectivity as reciprocal reliance on common-sense understanding within participants of common world characterizes orientations and frames that play a role of implicit 'hinges' rather than unequivocal fundament that grounds and allow joint practices. But rationality appears to be not just inter-, but trans-subjective, we transcend it over for whatever case of practice of argumentation. Argumentation justifies itself as it performs itself.

Rationality and argumentation are relevant within modelling. A. Ciula and Ø. Eide (2017) analyse modelling as heuristic methodological tool in digital humanities (seen interdisciplinary) which semiotically represents (im)material phenomena. Modelling is a way to gain knowledge and meaning of such issues in different contexts (in particular, of digital humanities). Modelling can be viewed as opening the possibility of communicating between humans and computers; as fruitful mean or tool for (improving) thinking. By modelling A. Ciula and Ø. Eide [Ciula & Eide 2017: i34] primarily understand external representations of phenomena and concepts.

Modelling (as a practical semiotic thinking; and acting of constructing models) openly produces meaningfulness of reasoning, epistemically valuable contextual senses. Modelling as reasoning can be devoted to both producing and understanding (I insist on inseparability of these processes) of senses; it appears to be a common shared language; it does not only externally represent, but present (performatively accomplishing, as I claim) reasoning.

The background which precedes the modelling contribute into it and for its interpretative usage.

M. Boon [Boon 2021: 80] proposes a *methodology of scientific modelling* in the engineering (dealing with functioning of invented phenomena) and (so-called) basic sciences (dealing with discovered phenomena and trialling theories about them) by comparing scientific research in them. Modelling is constructing of models. Sciences (where hypothetical-deductive methodology remains to be relevant) are involved into technological problem-solving and innovation of design-concepts (behind them stand functional interpretations of phenomena). Phenomena take place within physical-technological circumstances. Modelling can be of physical-technological contexts for investigated phenomena; and of technological artifacts for producing phenomena.

Engineering involves scientific, technological and design counterparts. Phenomena (including items, properties, processes) investigated by engineering and (so-called) basic sciences can be natural, physical, and technological simultaneously (or not at the same time). M. Boon [Boon 2021: 81] gives examples: "For example, a membrane, an electromagnetic coil and a prosthesis are technological *objects*, which have specific *properties*, or which function by means of specific *processes*. Examples of technologically produced physical phenomena are light, sound, electricity, chemical compounds, and all kinds of material properties."

Technological contexts depend on gaining scientific knowledge about functional and quality effectiveness to provide for design and producing industrially and economically successful devices. Innovative pragmatic and fundamental approaches are relevant in engineering and science, there is "transition" between them.

M. Boon [Boon 2021: 82] properly distinguishes between phenomena and knowledge of phenomena. Knowledge of phenomena are epistemic artifacts: descriptions; concepts (such as elasticity, energy, motor, etc.); measurements; and, finally, scientific models of phenomena. There are laws which represent verbally and mathematically (reproducible physical-technological) phenomena. Knowledge is used by humans and computers for creating, designing, optimizing, controlling etc. the mentioned epistemic artifacts. Mathematical model of a phenomenon, for instance, can be applied to calculate predictions. Qualitative or quantitative knowledge of a physical-technological phenomena includes appropriate physical-technological circumstances, to name just some possible: temperature, light, chemical composition, material properties, features of the technological device etc. All phenomena are more adequately seen via attention to physical-technological circumstances, so-called [Boon 2021: 82] "embedded", in these circumstances. The "view from nowhere" on any phenomenon is not fruitful, and even impossible.

Modelling of the phenomenon is mostly accompanied with elaboration and producing, designing of correspondent technological devices, of its digital computer programming for simulation and investigative scientific proceedings. Inherent natural functioning provides samples for technologically designed concepts and functions. Physical-technological phenomena (including items, properties, processes) can be seen through their appropriate successful functioning or problematic undesired dys- or malfunctioning. These phenomena can be naturally and technologically generated and reproduced and even cause technological function or (mal-) dysfunction. The other way round: technological engineering creates and controls physical-technological phenomena. Knowledge about these appropriate functioning is knowledge-how of physical-technological phenomena, tools, devices, and their functioning.

Scientific elaboration about engineering design technological action understood in terms of the providing for the described functioning of physical-technological phenomena is complex. It starts with constructing design-concept(s) based on (knowledge of) physical-technological phenomena, its description and further *modelling* for technological engineering (re)producing. Further: "In the engineering sciences – technologically produced – physical-technological phenomena are conceived as *physical building blocks* for physically creating, managing and developing technological functions." [Boon 2021: 86]. Phenomena proposed to be are analysed upon modular approach. They ensure physical building blocks for design technological function.

Modular knowledge allows conceptualizing design of phenomena as reciprocally interconnected, even interacted. Thus, modular knowledge of diverse levels (higher and lower; horizontal and vertical; parallel and sequential; networks of phenomena) of phenomena's interacting involving multi-scaled models opens variable functional "mosaics" of them (physical-technological phenomena). Again, physical-technological phenomena hang on physical and technological circumstances; they are reachable, show themselves and are under control only when particular natural and technological conditions are maintained; when they are technologically tractable.

Complex modular knowledge of physical-technological phenomena via constructing multi-scale models of them is not consistent with Hempel's [Hempel 1966] hypothetical deductive method and deductive-nomological model of explanation, which still appears widespread today. The defended by Boon's methodology is a way to gain deserved to be remarked *information* about phenomenon; classical explanation appears often not accomplishable, not sufficient, or even not relevant at all!

Models are built for being employed, for provide appropriate methodology and gain results. They are not *a priori*, but are created withing the investigative purpose. Nevertheless, M. Boon gives 10 general questions (which might be seen as generalized framing or orientating) for doing modelling [Boon 2021: 89]:

(Q1) Problem context?

(Q2) Target-system or physical-technological phenomenon (P) for which the model is constructed?

(Q3) Intended epistemic function(s) of the model?

(Q4) Model type?

(Q5) Relevant (physical and/or technical) circumstances and properties (i.e., those that affect the phenomenon)?

(Q6) Measurable (physical-technological) variables (i.e., by which variables is a non-observable phenomenon connected to the tangible world, or, by which variables is the phenomenon or target-system affected)?

(Q7) Idealizations, simplifications and abstractions?

(Q8) Knowledge (theoretical knowledge, knowledge of sub-phenomena, phenomenological laws, empirical knowledge) and theoretical principles used in the construction of the model?

(Q9) Hypotheses (e.g., new concepts and explanations) 'built-in' to the model?

(Q10) Justification and testing of the model? The red arrows indicate elements that can be modified when testing and improving the model. The yellow square surrounding the modelling process indicates the testing phase in Q10.

Modelling on the given frames or orientations is actual in both basic sciences and for analysing engineering and design technological actions (and correspondent sciences). There appears no gap between them. Modelling is dependent on measurability. The latter often is problematic and is supplied, as well as possibility of testing and justification, only within the realization of the modelling itself. Via modelling such important methodological ingredients as testing and justification can become available. Modelling appears performative, not just functioning, but providing for functioning, under correspondent physical-technological circumstances, of phenomena. Via modelling phenomena can be not just represented, but performatively presented as such with the background of physical and technological circumstances.

Philosophical treatment of Engineering and Design (Technological) Actions and correspondent sciences and scientific activities can fruitfully involve topics of rationality, modelling, argumentation for its methodological philosophical basement (understood as a general background). Rationality as common-sense reliable pragmatic trying for optimization and effectiveness was elaborated with references to E. Lord [Lord 2018] findings in terms of appropriate (sensitive) responding to possessed (by knowing-how to use) normative (oughtness is a function of possession) reasons (known facts, accepted as the reasons). Rationality is relevant for argumentation and modelling. For effective argumentation [Wohlrapp 2014; Wohlrapp 2017] formal logical tools are not enough; touchstone significance of "frames" and "orientations"

in argumentation is also stimulative for an agent to possess reasons and act rationally. Modelling itself could be seen as a special argumentative tool constructed on the rational background and opening rational understanding (possible for further argumentative applications) for scientific discovery and engineering design technological inventing in general; and within particular engineering and design technological actions.

All of the topics: rationality, argumentation, and modelling, – involve deliberations about reasons and reasonableness; different aspects of them. Epistemological context has also appeared relevant in all of them. Thus, the proposed perspective is promising within philosophy of Engineering and Design (Technological) Actions; and for applications in correspondent scientific methodological elaborations. Another consequence of the proposed analysis is not opposing so-called natural, social sciences and humanities. Different branches and disciplines of them as well as engineering and design technological sciences appear and share methodology in inter- (mutual), cross- (when points from various scientific research findings meet together in one project) and trans- disciplinary (when laymen opinions are experimentally taken into scientific (might be inter- and cross- disciplinary) considerations) studies via being engaged in various labs, including life-labs. Labs themselves provide for fruitful new current educational platforms.

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***Анна Лактіонова*. Філософія інженерно-конструкторських технологічних дій: раціональність, аргументація, моделювання**

Філософія інженерно-конструкторських технологічних дій переглядається в контексті філософського осмислення раціоналізації, аргументування, моделювання як спеціальних окремих в наукових пошуках дій (в фундаментальних природничих і в інженерних науках). Інженерія нерозривно пов'язана з конструюванням (дизайном) і технологією (і навпаки: дизайн – з інженерією і технологією; технологія – з інженерією і конструюванням). В інженерії всі, стосунки *є* і *має бути*; знання що, знання як і знання як досвідне безпосереднє ефективне функціонування, продукування; напрями від світу до свідомості і від свідомості до світу, – виявляються чинними і актуальними (різними ступенями, в відмінних контекстах).

Інженерно-конструкторські технологічні науки відкривають нову цікаву методологічну перспективу для сучасних досліджень. З іншого боку, інженерно-конструкторські технологічні науки кидають виклик вищій та спеціально-технічній освіті; можуть відіграти ключову роль для оновлення освіти; сприяти інтеграції в між-, крос- та транс- дисциплінарні дослідження. Інфраструктура філософії інженерно-конструкторських технологічних дій може включати епістемологію інженерії; онтологію інженерії; розробки з методики вимірювання; етичні, соціально-політичні, екологічні дослідження тощо. Інфраструктура філософії інженерно-конструкторських технологічних дій може відповідати інженерно-конструкторським технологічним наукам. Згадані філософські та специфічні наукові галузі залишаються відкритими для різноманітних розробок і розвитку.

Моделювання, як слушний в науці і інженерії метод, аналізується завдяки залученню тематики раціональності і аргументації. Раціональність епістемічно долучна аргументації і моделюванню. Концепти «каркаси» та «орієнтації» в аргументації доречні для інтерпретації раціональності дій; і в науковому моделюванні. Саме моделювання можна передивитися як особливий аргументаційний інструмент сконструйований на раціональній основі і як ключ для раціонального розуміння наукового відкриття і інженерно-конструкторського технологічного винаходу.

Ключові слова: *філософія інженерно-конструкторських технологічних дій, дизайн, раціональність, аргументація, моделювання, наука, технологія, активність, методологія вищої та спеціально-технічної освіти інженерно-конструкторських технологічних наук.*

Laktionova, Anna, Doctor of Science (Philosophy), Senior fellow at Käte Hamburger Kolleg "Cultures of Research", RWTH Aachen University (Aachen, Germany); Professor of Department of Theoretical and Practical Philosophy, Faculty of Philosophy, Taras Shevchenko National University of Kyiv, Ukraine. Research interests: Philosophy of Engineering and Design Technological Actions, Philosophy of Action and Agency (Practical Philosophy), Analytic Philosophy of XX century, Epistemology, Moral Epistemology, Pragmatism in Contemporary Philosophy.

E-mail address: laktionovaanna@yahoo.com
https://orcid.org/0000-0001-8236-7217

Лактіонова, Анна, доктор філософських наук, старший співробітник в Кейт Гамбургер Коледжі «Культури досліджень», Рейнсько-Вестфальського технічного університету Аахена (Аахен, Німеччина); професорка кафедри теоретичної і практичної філософії філософського факультету Київського національного університету імені Тараса Шевченка (Україна). Сфера наукових інтересів: філософія інженерно-конструкторських технологічних дій, філософія дії та активності (практична філософія), аналітична філософія 20 ст., епістемологія, моральна епістемологія, прагматизм в сучасній філософії.
E-mail address: laktionovaanna@yahoo.com
https://orcid.org/0000-0001-8236-7217